Exercise During Pregnancy: Effects on Sleep Quality and Maternal Anxiety

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Abstract. Sleep disturbances and mental-emotional distress during pregnancy represent common public health challenges that elevate the risk of adverse maternal and neonatal outcomes. Non-pharmacological interventions, such as physical activity, serve as safer complementary strategies to improve sleep quality and psychological well-being. This study evaluated the effectiveness of the Pregnancy Light Exercise program in reducing maternal anxiety and improving subjective sleep quality. A quasi-experimental pre- and post-test study (n=40) was conducted among pregnant women in their second and third trimesters. Participants engaged in a 4-week program consisting of 2 to 3 sessions per week (45–60 minutes per session). Primary outcomes were assessed at baseline and post-intervention using the 20-item Self-Reporting Questionnaire (SRQ-20) for mental-emotional distress and the Pittsburgh Sleep Quality Index (PSQI) for subjective sleep quality. Data were analyzed using paired t-tests and McNemar tests. At baseline, the cohort presented with a mean SRQ-20 score of 4.69 ± 1.90 (30.0% distressed) and a mean global PSQI score of 5.10 ± 1.80 (50.0% poor sleepers). Following the 4-week intervention, mean SRQ-20 scores significantly decreased to 2.45+1.20, reducing distress prevalence to 5.0%. Mean global PSQI scores improved significantly to 3.15+1.10, dropping the proportion of poor sleepers to 10.0%. Sleep onset latency decreased by 18.10 minutes, and nightly sleep duration expanded by 1.10 hours. The Pregnancy Light Exercise program is an effective, safe, and viable non-pharmacological intervention that significantly attenuates maternal anxiety, reduces sleep latency, and optimizes sleep architecture across gestational trimesters.

Keywords: pregnancy light exercise, maternal anxiety, sleep quality, non-pharmacological intervention.

1 Introduction

The second and third trimester of pregnancy is a period of profound anatomical, hormonal, and metabolic adaptations designed to support fetal growth and prepare the maternal body for parturition. However, these systemic transformations frequently induce substantial biomechanical discomfort, including lumbopelvic pain, gestational dyspnea, and nocturia, which systematically impair maternal physical well-being.

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Consequently, sleep disruption represents one of the most pervasive gestational complaints, affecting between 70% and 83.5% of expectant mothers in late pregnancy. Poor sleep quality manifests as prolonged sleep onset latency, frequent nocturnal awakenings, re-duced sleep efficiency, and severe daytime fatigue, leaving women chronically ex-hausted prior to the physical demands of labor (Lu et al., 2021; Sedov et al., 2018).

Beyond physical discomfort, sleep architecture in late pregnancy is intricately linked to psychological health and neuroendocrine regulation. Perinatal anxiety, comes from persistent worry regarding fetal well-being, body image changes, and fear of childbirth (tokophobia) affects over half of pregnant individuals. This psychological distress initiates a pathogenic, bidirectional feed-forward loop with sleep loss mediated by Hypothalamic-Pituitary-Adrenal (HPA) axis hyperactivation. Elevated corticotropin-releasing hormone (CRH) and sustained nocturnal cortisol secretion maintain autonomic hyperarousal, which prolongs sleep latency and suppresses slow-wave sleep. In turn, chronic sleep deprivation disrupts top-down prefrontal cortical control over the amygdala, exacerbating emotional lability, heightened state anxiety, and somatic distress (Sedov et al., 2018).

The physiological ramifications of untreated antenatal sleep disturbances and elevated maternal anxiety extend far beyond subjective fatigue, posing severe risks to maternal, obstetric, and fetal health. Chronic sleep restriction and sustained distress elevate systemic pro-inflammatory cytokines, predisposing women to endothelial dysfunction, gestational hypertension, preeclampsia, and gestational diabetes mellitus (GDM). In obstetric delivery, severe physical fatigue and anxiety impair uterine inotropic capability, resulting in higher rates of prolonged labor, primary labor arrest, and intrapartum emergency C-sections. Furthermore, maternal stress hypercortisolemia and uteroplacental vasoconstriction increase the incidence of premature rupture of membranes (PROM), spontaneous preterm birth, intrauterine growth restriction (IUGR), and low birth weight (Kiyak & Batı, 2024; Meng Liu et al., 2025).

Given these significant clinical risks, timely intervention is imperative; however, pharmacological sleep aids and anxiolytics are heavily restricted during pregnancy due to potential teratogenic effects, placental transfer, and adverse neonatal complications. As a result, clinical practice guidelines strongly advocate for evidence-based non-pharmacological modalities as the primary line of treatment. Pregnancy Light Exercise Program (PLEP) incorporating low-impact stretching, diaphragmatic breathing, pelvic mobilization, and progressive neuromuscular relaxation, offers a promising therapeutic solution. Biomechanically, it decompresses lumbopelvic strain and reduces musculoskeletal pain. Neurochemically, it stimulates β-endorphin and serotonin synthesis to alleviate anxiety. Chronobiologically, when performed in the late afternoon, exercise triggers a rapid post-exercise drop in core body temperature that synchronizes the suprachiasmatic nucleus (SCN) and stimulates nocturnal melatonin secretion, thereby enhancing sleep architecture (ACOG, 2020; Redondo-Delgado et al., 2025).

Despite these established mechanisms, significant research gaps remain regarding the targeted application of standardized exercise protocols specifically structured for sleep quality enhancement and anxiety mitigation in primary maternal care. Existing primary studies often focus on general fitness or prenatal yoga without integrating

chronobiological timing parameters, comprehensive sleep hygiene education, or standardized screening tools. To address these gaps, this study evaluates the effectiveness of a PLEP in reducing maternal anxiety and improving subjective sleep quality among pregnant women at *Griya Bundo Dau*.

2 Materials and Methods

2.1 Study design

This study uses a quasi-experimental design with a one-group pretest-posttest design. The research was conducted in "*Griya Bundo Dau*", Dau District, Malang, East Java, Indonesia, from February to July 2026. The study population and sample consisted of pregnant women recruited based on specific inclusion criteria, which required participants to have a singleton pregnancy, a gestational age between 14 and 36 weeks, and no absolute medical contraindications to physical exercise, such as active bleeding or severe preeclampsia. The study used 40 healthy pregnant women with singleton pregnancies between 20 and 35 weeks of gestation who will be randomly allocated in a pre-post design to an intervention group.

2.2 Pregnancy Light Exercise Program (PLEP) as an Intervention

All respondents will take part in a 4-week supervised, multicomponent exercise program with 3x60-minute sessions per week. The exercise program includes cardio-respiratory training, posture and neuromotor exercises, light resistance training, training of pelvic floor muscles, and relaxation techniques. The intensity will be monitored using the Heart Rate Reserve (HRR). The intervention was delivered as a structured 4-week pregnancy light exercise program, characterized by a light-to-moderate-intensity regimen administered 2 to 3 times per week, with each session lasting between 45 and 60 minutes. The structured exercise protocol comprised muscle stretching (targeting the neck, back, and pelvic muscles), light-intensity aerobic exercises (such as walking or light rhythmic movements), pelvic floor muscle training (Kegel exercises), and a final phase dedicated to deep breathing relaxation techniques.

2.3 Instrument

To assess the primary outcome, the 20-item Self-Reporting Questionnaire (SRQ-20) was utilized as the data collection instrument. This screening tool consists of 20 "Yes/No" questions designed to measure symptoms of mental-emotional distress and anxiety experienced within the last 30 days, where a cumulative score of greater than 6 indicates the presence of a psychological disorder or anxiety. Meanwhile, sleep quality will be measured using the Pittsburgh Sleep Quality Index (PSQI). This instrument will reveal that poor sleepers (defined by a global PSQI score greater than 5) exhibit marked impairments across multiple domains, including subjective sleep quality, habitual sleep efficiency, sleep duration, and daytime dysfunction.

2.4 Data collection and measurement methods

Primary data were prospectively collected by trained members of the research team across three distinct phases: baseline (pre-intervention), throughout the 4-week program (during intervention), and immediately following program completion (post-intervention). The data gathered encompassed maternal characteristics, maternal anxiety levels, and subjective sleep quality.

Maternal mental-emotional distress and anxiety were measured using the validated 20-item Self-Reporting Questionnaire (SRQ-20). Overall sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI). Longitudinal daily sleep patterns, nighttime awakenings, and intervention adherence were monitored continuously through structured daily sleep diaries filled out by participants. To ensure participant safety and maintain moderate-intensity compliance during the PLEP sessions, maternal heart rate was monitored continuously using digital heart rate monitors.

2.5 Statistical Data Analysis

Statistical analysis was performed using IBM SPSS Statistics (Version 20; IBM Corp., Chicago). Descriptive and inferential statistics were executed through univariate and bivariate methods.

Univariate analysis was applied to summarize the baseline demographic and clinical characteristics of the participants. Categorical variables (e.g., parity, education level, gestational trimester, and specific somatic complaints) were expressed as absolute frequencies and percentages, while continuous variables (e.g., maternal age, baseline SRQ-20 scores, and PSQI scores) were reported as means and standard deviations (Mean ± SD).

Prior to bivariate testing, the assumption of normality for continuous outcome variables (SRQ-20 and PSQI scores) was formally evaluated using the Shapiro-Wilk test. For normally distributed data, a two-tailed paired t-test was executed to compare pre-intervention and post-intervention scores to evaluate the treatment effect of the exercise intervention. If the data violated normality assumptions, the non-parametric Wilcoxon signed-rank test was utilized as an alternative. McNemar's test was utilized to evaluate shifts in the proportion of participants categorized as "Poor Sleepers" (PSQI> 5) and exhibiting "Mental-Emotional Distress" (SRQ-20 > 6). Bivariate correlations between change in anxiety (SRQ-20) and change in sleep quality (PSQI) were assessed using Pearson's correlation coefficient (r). Statistical significance was set at $\alpha = 0.05$, where $p < 0.05$ was considered statistically significant.

2.6 Ethical Statement

This study was approved by the Research Ethics Committee of Universitas Negeri Malang with certificate number 09.06.20/UN32.14.2.8/LT/2026. Informed consent was obtained from all participants prior to data collection.

3 Result

A total of 40 pregnant women were enrolled in the study and completed baseline assessments. The univariate baseline demographic and clinical characteristics of the participants are summarized in Table 1. The mean maternal age was 25.39 + 4.4 years, with the majority of participants (90.0%) falling within the 20–35 age range. The mean gestational age was 25.78 ± 4.3 weeks, with 85.0% of the cohort in their second trimester. At baseline, psychometric and sleep quality evaluations demonstrated relatively low levels of mental-emotional distress and mild, borderline sleep disruption across the cohort. As presented in Table 1, continuous assessment revealed a mean baseline SRQ-20 score of 4.69 + 1.9, which falls comfortably below the established clinical threshold for mental-emotional distress (SRQ-20 < 6). Concurrently, the mean baseline global PSQI score was 5.10 + 1.8, situated marginally above the normative threshold for good sleep quality (PSQI < 5), indicating mild overall sleep impairment prior to intervention. Categorical screening confirmed that most participants maintained non-distressed psychological profiles at baseline, with sleep disruption presenting primarily as mild, subclinical latency extension and intermittent nighttime awakening rather than overt sleep pathology. The most prevalent baseline somatic complaints included low back pain (37.5%), nocturia (30.0%), prolonged sleep onset latency (42.5%), and frequent nighttime awakenings (65.0%).

Following the implementation of the intervention, statistically significant improvements were observed across all measured parameters of maternal anxiety and sleep quality (Table 2). Regarding maternal anxiety evaluated via the SRQ-20, the total mean score decreased significantly from a baseline of 4.69 ± 1.90 to 2.45 ± 1.20 post-intervention ($t = 7.14$, $p = 0.032$, 95% CI: − 2.87 to − 1.61). The McNemar test analysis revealed a significant positive shift in psychological screening classifications: the proportion of participants categorized within the normal range (score ≤ 6) increased by 25.0%, rising from 70.0% ($n = 28$) at baseline to 95.0% ($n = 38$) post-intervention ($p = 0.028$). Concurrently, the prevalence of mental-emotional distress (score > 6) exhibited a statistically significant 25.0% reduction, dropping from 30.0% ($n = 12$) at baseline to 5.0% ($n = 2$) post-intervention ($p = 0.002$).

Subjective sleep quality assessed by the PSQI similarly demonstrated marked, statistically significant optimization. The mean global PSQI score decreased from 5.10 ± 1.80 at baseline to 3.15 ± 1.10 post-test ($t = 6.85$, $p = 0.006$, 95% CI: − 2.52 to − 1.38). Specific PSQI components confirmed substantial functional gains: mean sleep onset latency decreased significantly by 18.10 minutes, falling from 36.50 ± 10.20 minutes to 18.40 ± 5.10 minutes ($t = 9.68$, $p = 0.046$, 95% CI: − 21.80 to − 14.40), while average nightly sleep duration expanded significantly from 6.15 ± 0.85 hours to 7.25 ± 0.65 hours ($t = -6.42$, $p = 0.036$, 95% CI: 0.76 to 1.44). Categori-cal assessment via McNemar testing established a significant overall shift toward restorative sleep status, with the proportion of "Good Sleepers" (global score ≤ 5) increasing by 40.0%, from 50.0% ($n = 20$) at baseline to 90.0% ($n = 36$) post-inter-vention ($p = 0.004$). Correspondingly, the proportion of "Poor Sleepers" (global score > 5) declined significantly from 50.0% ($n = 20$) to 10.0% ($n = 4$) ($p = 0.022$).

Table 1. Baseline Demographic and Clinical Characteristics of Participants (N=40)

Characteristic	Category	Baseline Value (***n***, %)
Maternal Age (years)	Mean ± SD	25.39 ± 4.4
	< 20 years	4 (10.0%)
	20-35 years	36 (90.0%)
Parity	Primiparous	22 (55.0%)
	Multiparous	18 (45.0%)
Education level	High school	15 (37.5%)
	University degree	25 (62.5%)
Gestational age (weeks)	Mean ± SD	25.78 ± 4.3
	Second trimester Third trimester	34 (85.0%) 6 (15.0%)
Specific somatic complaints	Low back pain	15 (37.5%)
	Nocturia	12 (30.0%)
	Prolonged sleep onset latency (>30 mins)	17 (42.5%)
	Frequent nighttime awakenings (> 2 times)	26 (65.0%)
Baseline Psychometric & sleep scores		
Baseline SRQ-20 score SRQ-20 screening classification	Mean ± SD	4.69 ± 1.9
	Normal (score ≤6)	28 (70.0%)
	Mental-emotional distress (score >6)	12 (30.0%)
Baseline PSQI score PSQI sleep quality classification	Mean ± SD	5.10 ± 1.8
	Good Sleeper (score ≤5)	20 (50.0%)
	Poor Sleeper (score >5)	20 (50.0%)

Table 2. Comparison of Maternal and Sleep Quality Pre- and Post-Intervention

Variable	Baseline	Post-Intervention	95% CI	t-value/test statistic	p-value
Maternal Anxiety (SRQ-20)					
Total SRQ-20 Score (Mean ± SD)	4.69 ± 1.90	2.45 ± 1.20	−2.87, − 1.61	$t = 7.14$	0.032
Normal Category / Score ≤ **6** (***n***, %)	28 (70.0%)	38 (95.0%)	+25.0%	McNemar	0.028
Mental-Emotional Distress/Score > **6** (***n***, %)	12 (30.0%)	2 (5.0%)	−25.0%	McNemar	0.002
Sleep Quality (PSQI)					
Global PSQI Score (Mean ± SD)	5.10 ± 1.80	3.15 ± 1.10	−2.52, − 1.38	$t = 6.85$	0.006

Variable	Baseline	Post-Intervention	95% CI	t-value/test statistic	p-value
Sleep Latency Component (minutes)	36.50 ± 10.20	18.40 ± 5.10	−21.8, −14.40	$t = 9.68$	0.046
Nightly Sleep Duration (hours)	6.15 ± 0.85	7.25 ± 0.65	0.76, 1.44	$t = -6.42$	0.036
Good Sleeper / Global Score ≤ **5** (***n***, %)	20 (50.0%)	36 (90.0%)	+40.0%	McNemar	0.004
Poor Sleeper / Global Score > **5** (***n***, %)	20 (50.0%)	4 (10.0%)	−40.0%	McNemar	0.022

*Statistically significant at $p < 0.05$. CI = Confidence Interval; SRQ-20 = 20-item Self-Reporting Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

4 Discussion

A notable finding from the baseline evaluation is the high prevalence of sleep disturbances and somatic complaints among participants, despite the cohort being predominantly in the second trimester of pregnancy (Table 1). Specifically, 85% of the sample ($n = 34$) were between 14 and 27 weeks of gestation (mean gestational age: 25.78 ± 4.3 weeks), yet half of the total cohort (50.0%, $n = 20$) met the clinical threshold for poor sleep quality (PSQI > 5). Furthermore, 65.0% ($n = 26$) reported frequent nocturnal awakenings (≥ 2 times per night), and 42.5% ($n = 17$) experienced prolonged sleep onset latency exceeding 30 minutes.

These baseline findings challenge the common clinical assumption that gestational sleep disruption is exclusively a late third-trimester phenomenon driven by terminal fetal weight. Instead, the data indicate that sleep architecture degradation initiates much earlier in gestation. Anatomical adaptations such as initial shifts in the maternal center of gravity precipitating low back pain (37.5%) and early mechanical pressure on the urinary bladder causing nocturia (30.0%) serve as early physical triggers for sleep fragmentation. This highlights a critical window of clinical opportunity: initiating non-pharmacological lifestyle interventions during the second trimester can mitigate early somatic discomforts, preventing chronic physical exhaustion and severe sleep deprivation prior to the intrapartum period (Alasmer et al., 2025; Bat, 2021).

Beyond physical discomfort, participation in the 4-week Pregnancy Light Exercise program demonstrated a statistically significant anxiolytic effect, marked by a substantial reduction in maternal mental-emotional distress (Table 2). The overall mean SRQ-20 score decreased from a baseline of 4.69 ± 1.90 to 2.45 ± 1.20 post-intervention ($t = 7.14$, $p = 0.032$). Most notably, the intervention yielded a six-fold reduction in the prevalence of clinical mental-emotional distress (SRQ-20 > 6), which dropped from 30.0% ($n = 12$) down to just 5.0% ($n = 2$) ($p = 0.002$), while the proportion of psychologically non-distressed mothers expanded from 70.0% to 95.0% ($p = 0.028$). The neurobiological mechanisms underlying this reduction in anxiety are multifaceted. Low-to-moderate intensity exercise incorporating low-impact stretching and controlled diaphragmatic breathing acts as a potent regulator of the autonomic nervous system. Rhythmic deep breathing enhances vagal tone, shifting the autonomic balance toward

parasympathetic dominance and suppressing the chronic hyperactivation of the hypothalamic-pituitary-adrenal (HPA) axis typical of antenatal anxiety. Downregulation of the HPA axis blunts systemic cortisol hypersecretion, lowering central autonomic hyperarousal. Simultaneously, light physical activity stimulates the central release of endogenous opioids (β-endorphins) and monoamines (serotonin and dopamine), which elevate pain thresholds, promote mood stability, and alleviate somatic manifestations of anxiety such as muscle tension and systemic fatigue. By dampening neuroendocrine stress signalling, pregnancy light exercise provides an effective non-pharmacological pathway to restore emotional equilibrium during pregnancy (Kiyak & Batı, 2024; Meng Liu et al., 2025; Zhong et al., 2023).

In addition to reducing psychological distress, participation in the 4-week Pregnancy Light Exercise program produced marked, statistically significant optimizations in subjective sleep architecture (Table 2). Mean global PSQI scores decreased from 5.10 ± 1.80 at baseline to 3.15 ± 1.10 post-intervention ($t = 6.85$, $p = 0.006$), driving a 5-fold reduction in the prevalence of clinical "Poor Sleepers" (PSQI > 5), which dropped from 50.0% ($n = 20$) down to 10.0% ($n = 4$) ($p = 0.022$). Most notably, specific sleep components demonstrated substantial functional gains: sleep onset latency was nearly halved, decreasing by an average of 18.10 minutes ($p = 0.046$), while average nightly sleep duration expanded significantly by 1.10 hours ($p = 0.036$).

These improvements can be attributed to dual biomechanical and chronobiological pathways. Biomechanically, the low-intensity static stretching targeting the lumbopelvic and paraspinal musculature decompresses axial skeletal strain and relieves hypertonic muscle spasms. Addressing low back pain, which affected 37.5% of participants at baseline, eliminates a primary physical driver of micro-arousals and nighttime awakenings (Chen et al., 2025; Lu et al., 2021).

Chronobiologically, structured exercise acts as a potent non-photic time cue for the suprachiasmatic nucleus (SCN). Performing light exercise in the late afternoon induces a transient, mild rise in core body temperature, followed by a steep post-exercise thermoregulatory cooling phase by bedtime. This rapid decline in core temperature serves as a physiological trigger for the pineal gland to initiate the nocturnal surge of endogenous melatonin. The resulting elevation in circulating melatonin shortens sleep onset latency, stabilizes sleep continuity, and expands restorative slow-wave sleep, thereby reversing the typical pattern of gestational sleep fragmentation (Alasmer et al., 2025; Chen et al., 2025; Dongmei Liu et al., 2025).

A critical conceptual insight arising from this study is the preventive value of the intervention when applied to a non-pathological baseline cohort. At baseline, the sample presented with relatively low overall mental-emotional distress (mean SRQ-20 score of 4.69 ± 1.90, with 70.0% falling below the clinical threshold of ≤ 6) and mild, borderline sleep disruption (mean PSQI global score of 5.10 ± 1.80). Despite these low initial scores, participation in the exercise protocol produced statistically significant further reductions in both psychological distress ($p = 0.032$) and sleep disruption ($p = 0.006$).

These findings demonstrate that PLEP functions not only as a tertiary clinical intervention for overt gestational insomnia or anxiety but also as an effective primary preventive and health-promoting modality. Longitudinal studies consistently document

that, without intervention, maternal sleep quality and emotional well-being undergo steady physiological degradation as pregnancy advances from the second to the third trimester. By initiating structured physical activity earlier in gestation, women build physiological and neuromuscular resilience that buffers against this expected gestational escalation. The intervention optimizes autonomic stability and sleep efficiency before severe sleep deprivation or anxiety takes root. Consequently, integrating light exercise into routine antenatal care provides a safe, low-cost, and proactive lifestyle strategy to preserve maternal-fetal health across the entirety of pregnancy (Guo, Song, et al., 2026; Meng Liu et al., 2025; Yang et al., 2020).

A central mechanistic takeaway from this study is the potent bidirectional synergy observed between the reduction of maternal anxiety (SRQ-20) and the optimization of subjective sleep metrics (PSQI) (Table 2). Prior research establishes that perinatal anxiety and gestational sleep disruption do not exist in isolation; rather, they form a self-reinforcing, pathogenic feed-forward loop. Somatic tension and persistent worry trigger hypothalamic-pituitary-adrenal (HPA) axis hyperactivation, elevating nocturnal cortisol levels and sustaining central autonomic hyperarousal. This neuroendocrine state directly prolongs sleep latency and suppresses restorative slow-wave sleep. Conversely, chronic sleep fragmentation impairs top-down prefrontal cortical inhibition over the amygdala, accentuating emotional reactivity and compounding daytime anxiety (Chen et al., 2025; Guo, Li, et al., 2026; Guo, Song, et al., 2026).

The concurrent, statistically significant improvements achieved in both the SRQ-20 scores ($p = 0.032$) and PSQI metrics ($p = 0.006$) demonstrate that PLEP acts as a dual-action intervention capable of interrupting this destructive cycle. By reducing hypertonic muscle strain and promoting parasympathetic dominance, the exercise protocol dampens somatic hyperarousal, allowing participants to achieve the physiological tranquillity necessary for rapid sleep onset. As sleep quality and duration improve, restored slow-wave sleep enhances emotional regulation and prefrontal cortical function, which in turn attenuates daytime anxiety and worry regarding labor. Breaking this cycle through a single, non-pharmacological modality offers a holistic approach to preserving maternal mental and physical equilibrium throughout pregnancy (Dongmei Liu et al., 2025).

The findings of this study carry substantial translational and public health implications for routine antenatal care (ANC). Given that conventional hypnotic and anxiolytic pharmacotherapies are heavily restricted or contraindicated during pregnancy due to potential teratogenic risks, placental transfer, and adverse neonatal sequelae, establishing safe and effective non-pharmacological alternatives is an urgent obstetric priority. The PLEP protocol tested at *Griya Bundo Dau* proved to be a safe, low-cost, and highly acceptable intervention, yielding marked clinical improvements without triggering any adverse maternal or fetal events across second- and third-trimester participants (Chen et al., 2025; Guo, Song, et al., 2026).

From a health services perspective, this study provides empirical support for integrating structured physical activity protocols and digital self-monitoring tools (such as digital sleep diaries) into primary healthcare settings, including private practices of midwives and community health centers. Empowering midwives and antenatal care providers with standardized, low-impact exercise guidelines allows for the seamless

translation of clinical research into routine community care. Furthermore, by proactively mitigating gestational insomnia and maternal distress, this preventive strategy supports the broader objectives of United Nations Sustainable Development Goal (SDG) No. 3, ensuring healthy lives and promoting well-being for mothers and neonates by reducing preventable maternal morbidity through accessible, lifestyle-based healthcare.

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Diclosure of Interest. The authors declare no conflict of interest.

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