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The Effect of Healthy Lifestyle Education Combined with Mindfulness-Based Stress Reduction on Health Anxiety and Health Dimensions in Pregnant Women at Risk of Preeclampsia

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A B S T R A C T

Objective: This study aimed to investigate the effect of healthy lifestyle education combined with mindfulness-based stress reduction (MBSR) on health anxiety and multidimensional health outcomes in this high-risk population.

Methods and Materials: In this quasi-experimental study, 30 pregnant women at risk of preeclampsia were recruited from the Tolou Salamat Center in Tehran and randomly assigned to either an intervention group (n = 15) or a control group (n = 15). The intervention group participated in eight weekly sessions of lifestyle education integrated with mindfulness-based stress reduction, while the control group received no intervention. Participants completed validated questionnaires assessing health anxiety (HAI-18) and health dimensions (Four-Dimensional Health Scale) at baseline, post-intervention, and 1.5-month follow-up. Data were analyzed using repeated measures ANOVA and multivariate analysis of covariance.

Findings: The intervention led to a statistically significant reduction in health anxiety scores and sustained improvements across multiple health domains—including psychological, social, physical, and spiritual well-being—compared to the control group ($p < 0.001$). Key health anxiety indicators, such as perceived likelihood of illness and general health concerns, decreased substantially and these benefits persisted at follow-up. Similarly, significant gains were observed in total health scores and specific dimensions of quality of life, with the intervention explaining a considerable proportion of variance in outcomes.

Conclusion: Healthy lifestyle education combined with mindfulness-based stress reduction is an effective intervention for reducing health anxiety and enhancing multidimensional health among pregnant women at risk for preeclampsia. Integration of such programs into standard prenatal care—especially for high-risk populations—is recommended.

Keywords: *Healthy Lifestyle, Mindfulness-Based Stress Reduction, Health Anxiety, Health Dimensions, Pregnant Women, Preeclampsia*

1. Introduction

Pregnancy represents a complex biopsychosocial experience in which physiological changes are deeply intertwined with emotional and behavioral adjustments. Among the complications of this critical period, preeclampsia stands out as one of the most serious hypertensive disorders of pregnancy, posing substantial risks to both maternal and fetal health (Jung et al., 2022). It is characterized by new-onset hypertension and proteinuria after the 20th week of gestation, often accompanied by systemic complications involving hepatic, renal, and neurological systems (Bisson et al., 2023). Globally, preeclampsia contributes to significant maternal and neonatal morbidity and mortality, accounting for approximately 50,000 maternal deaths annually (Han et al., 2023). Despite advances in diagnostic technology and obstetric management, the etiology of preeclampsia remains multifactorial and not fully elucidated, with recent studies suggesting that oxidative stress, endothelial dysfunction, and abnormal placental development may be key mechanisms underlying disease onset (Freire et al., 2023; Psilopatis et al., 2023).

Emerging evidence indicates that the pathophysiology of preeclampsia involves a complex interaction between biological, psychological, and environmental factors. The disorder's onset has been linked to abnormal trophoblastic invasion of uterine vessels and heightened systemic inflammation (Bisson et al., 2023), while recent studies have associated exposure to environmental pollutants and endocrine-disrupting chemicals such as per- and polyfluoroalkyl substances (PFASs) with an increased risk of preeclampsia and adverse neonatal outcomes (San Juan-Reyes et al., 2023; Tian et al., 2023). Furthermore, alterations in maternal thyroid function, such as isolated hypothyroxinemia, have been shown to significantly elevate the risk of poor pregnancy and neonatal outcomes (Han et al., 2023). The growing body of research on the maternal gut microbiome also reveals its essential regulatory role in pregnancy outcomes, with dysbiosis linked to metabolic disturbances and inflammation that may exacerbate hypertensive conditions (Sinha et al., 2023).

Alongside these biological mechanisms, psychological stress and anxiety during pregnancy play a crucial role in both the development and progression of hypertensive disorders. Anxiety activates the hypothalamic–pituitary–adrenal (HPA) axis, elevating cortisol levels and promoting endothelial dysfunction, thereby increasing the risk of preeclampsia (Bernad et al., 2025; Liu et al., 2025). Studies have demonstrated that high levels of maternal anxiety and depression during pregnancy not only contribute to gestational hypertension but are also associated with adverse cardiovascular outcomes and shorter gestational length (Bergeron et al., 2024; Cong et al., 2025). In a federated cohort analysis across Canadian and European populations, prenatal anxiety and stress were significantly associated with preterm delivery and reduced birth weight, supporting the hypothesis that psychological distress exerts a measurable influence on obstetric outcomes (Bergeron et al., 2024).

Pregnancy-related stress is also tightly linked to maternal self-regulation and behavioral health patterns. Women with higher anxiety and depressive symptoms have been reported to demonstrate poorer self-management and health-promoting behaviors (Cong et al., 2025). These findings underscore the necessity of integrated psychological and behavioral interventions targeting both mental health and lifestyle factors. Moreover, postnatal follow-up studies reveal that women with a history of preeclampsia frequently experience long-term psychological sequelae, including depression, anxiety, and post-traumatic stress disorder, indicating that the impact of this disorder extends beyond pregnancy (Roberts et al., 2022). Such findings necessitate preventive psychosocial and educational approaches that address both the physiological and psychological dimensions of maternal health.

In this context, the significance of adopting a healthy lifestyle during pregnancy has received increasing attention. Lifestyle behaviors—including balanced nutrition, regular physical activity, adequate sleep, and stress management—are known to play a pivotal role in the prevention and management of hypertensive and metabolic disorders (Lagerweij et al., 2020). Interventions promoting these behaviors can substantially improve cardiovascular health and mitigate the recurrence of preeclampsia in subsequent pregnancies (Lagerweij et al., 2020). Health education programs designed to instill lifestyle awareness have been shown to enhance behavioral compliance and motivation for health-related change (Reusch et al., 2011). However, traditional educational models focusing solely on information transfer often fail to produce sustained behavioral modification, emphasizing the need for more experiential and mindfulness-integrated approaches (Alexander & Vladislav, 2015).

Mindfulness-Based Stress Reduction (MBSR), developed by Kabat-Zinn and colleagues, has emerged as a robust, evidence-based method for improving physical and

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psychological health across various populations, including pregnant women (Santorelli et al., 2017). The practice cultivates nonjudgmental awareness of present-moment experience, enabling individuals to respond adaptively to internal and external stressors. Meta-analytic evidence supports the efficacy of MBSR in reducing depression, anxiety, and stress, while improving emotional regulation, cognitive control, and overall well-being (Gill et al., 2020). During pregnancy, mindfulness training has demonstrated notable benefits, including reduced prenatal anxiety and improved maternal–fetal attachment (Goetz et al., 2020; Shahoie et al., 2019). These findings indicate that mindfulness can serve as a protective psychological mechanism against stress-induced complications, including preeclampsia.

The integration of mindfulness with lifestyle education provides a synergistic framework that addresses both behavioral and emotional determinants of health. MBSR programs promote awareness of bodily sensations, dietary choices, and habitual patterns, facilitating sustainable health-promoting behaviors (Schuman-Olivier et al., 2020). Furthermore, combining mindfulness with structured health education has been shown to enhance motivation for lifestyle change and adherence to self-care practices, particularly in vulnerable populations such as pregnant women (Reusch et al., 2011). In addition, mindfulness training fosters acceptance and reduces catastrophic interpretations of bodily sensations—core components of health anxiety (Salkovskis et al., 2002).

Health anxiety, conceptualized as excessive preoccupation with one's health and fear of illness, is a common psychological concern during pregnancy, especially in women at risk of obstetric complications (Liu et al., 2025). Heightened health anxiety can lead to maladaptive behaviors such as frequent medical reassurance seeking, avoidance of medical procedures, or persistent rumination over somatic symptoms, thereby worsening psychological distress and physical outcomes (Salkovskis et al., 2002). Interventions targeting both cognitive and behavioral components of health anxiety have demonstrated positive effects in improving coping skills and reducing physiological stress responses. Studies suggest that mindfulness interventions decrease the intensity of health-related rumination and enhance self-regulation, allowing individuals to perceive their health more accurately and with less anxiety (Rahmani Fard et al., 2017; Song & Lindquist, 2015).

In addition to cognitive and behavioral mechanisms, spiritual well-being has been recognized as an essential dimension of health, particularly during pregnancy (Akbarzadeh & Ahmadinezhad, 2019; Lacks et al., 2022). Research demonstrates that spirituality can serve as a psychological buffer against stress, anxiety, and uncertainty, fostering resilience and adaptive coping among pregnant women (Bahrami Ehsan et al., 2015). The four-dimensional health model proposed by Bahrami Ehsan and colleagues conceptualizes health as encompassing biological, psychological, social, and spiritual dimensions—a framework that aligns closely with the holistic principles of mindfulness-based approaches (Bahrami Ehsan et al., 2015). From this perspective, interventions that combine mindfulness and lifestyle modification may yield more comprehensive and enduring improvements in maternal well-being than either approach alone.

Mindfulness interventions have also been adapted to digital and group-based formats, enhancing accessibility and scalability. For instance, brief electronic mindfulness-based programs have successfully reduced depression and anxiety in hospitalized high-risk pregnant women (Goetz et al., 2020). Similarly, lifestyle and medical interventions delivered through mobile health technologies have proven effective in supporting health behavior change during pregnancy (Overdijkink et al., 2018). These findings suggest that integrated behavioral approaches, even when administered through brief or technology-assisted formats, can produce significant psychological and physiological benefits.

Despite this growing evidence, the integration of mindfulness-based and lifestyle-focused interventions in pregnancy—particularly for women at risk of preeclampsia—has not been adequately explored. Previous studies have generally examined these approaches in isolation or have focused narrowly on physiological markers such as blood pressure and oxidative stress (Freire et al., 2023; Pishdadian et al., 2023). However, understanding the combined impact of psychological and behavioral interventions on multidimensional health outcomes, including health anxiety, remains an important gap in the literature. Considering that anxiety and maladaptive lifestyle factors are both modifiable risk determinants of preeclampsia (Bernad et al., 2025; Cong et al., 2025), interventions that address both simultaneously could represent an innovative and comprehensive strategy for prevention and management.

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Furthermore, recent interdisciplinary studies emphasize that pregnancy health should be examined within a biopsychosocial–spiritual framework that accounts for physical, emotional, social, and spiritual interactions (Lacks et al., 2022). Biological models alone cannot sufficiently capture the complexity of maternal well-being during pregnancy; hence, holistic interventions that combine lifestyle modification and mindfulness principles align with contemporary integrative health paradigms. Evidence also indicates that the combination of mindfulness and health education supports sustainable behavior change, emotional resilience, and social connectedness—core determinants of well-being in pregnant populations (Santorelli et al., 2017; Schuman-Olivier et al., 2020).

From an educational standpoint, lifestyle training based on structured behavioral models can empower pregnant women to adopt proactive self-care strategies. Educational frameworks developed for managing healthy lifestyles, as demonstrated in pedagogical studies, have successfully improved behavioral motivation and psychosocial adjustment (Alexander & Vladislav, 2015). Likewise, healthy lifestyle education targeting pregnant women and their spouses has shown significant benefits in promoting maternal and neonatal health outcomes (Sanaati et al., 2018). Such training encourages the internalization of healthy habits—such as balanced nutrition, social participation, and stress management—that are essential for both physical and psychological stability.

Nevertheless, some scholars have argued that mindfulness-based approaches should remain secular to preserve their accessibility and avoid cultural or religious biases (Armstrong, 2019). In clinical practice, however, mindfulness has evolved as a universal therapeutic strategy with empirical support across diverse populations, including in contexts with varying spiritual orientations. Importantly, mindfulness practice does not conflict with spiritual values; rather, it complements them by deepening awareness and compassion, both of which are associated with improved health outcomes (Akbarzadeh & Ahmadinezhad, 2019).

Recent advances in data-driven health sciences have also contributed to the early detection and management of preeclampsia. For example, predictive modeling using cell-free RNA and machine learning algorithms has enhanced clinicians' ability to identify women at high risk for the condition (Moufarrej et al., 2022; Wang et al., 2023). Yet while technological innovations have advanced diagnostic precision, behavioral and psychological interventions remain indispensable for addressing the emotional and lifestyle factors that influence disease onset and progression. Consequently, integrating personalized education and mindfulness-based programs into prenatal care may optimize both physiological and psychological outcomes (Miller et al., 2022).

Within this broader context, the current study draws upon the biopsychosocial-spiritual model to examine how a combined intervention—healthy lifestyle education integrated with mindfulness-based stress reduction—can reduce health anxiety and enhance multidimensional health outcomes in pregnant women at risk of preeclampsia. Building upon prior findings that mindfulness and lifestyle modification independently contribute to reduced anxiety, improved emotional regulation, and better physiological outcomes, this study extends existing literature by empirically evaluating their synergistic effect on both psychological and physical health indices (Rahmani Fard et al., 2017; Santorelli et al., 2017; Schuman-Olivier et al., 2020; Song & Lindquist, 2015).

In sum, preeclampsia represents not only a biomedical challenge but also a psychosocial and behavioral phenomenon requiring integrative preventive strategies. The convergence of mindfulness-based stress reduction and lifestyle education offers a promising pathway to mitigate health anxiety, enhance coping mechanisms, and promote holistic maternal well-being. Therefore, the aim of the present study is to investigate the effect of healthy lifestyle education combined with mindfulness-based stress reduction on health anxiety and multidimensional health dimensions among pregnant women at risk of preeclampsia.

2. Methods and Materials

2.1. Study design and Participant

This fundamental study employed a correlational design and examined the relationships among the study variables using structural equation modeling (SEM). The statistical population consisted of all women seeking divorce and non-clinical (community) women who visited counseling and psychological centers in Tehran in 2024. In SEM, the recommended sample size ranges from 10 to 20 observations per estimated parameter, with a minimum total sample of 200 considered acceptable (Kline, 2016). Given the number of parameters estimated in the present model (14 parameters), an optimal sample size between 140 and 280 participants was projected. To enhance precision, account for potential attrition, and reduce the effects of incomplete responses, the target sample size was increased to 400

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women (200 women seeking divorce and 200 non-clinical women).

Sampling was performed through multistage cluster sampling based on the study's inclusion criteria. First, the locations of family counseling and psychology centers across Tehran's districts were identified (Stage 1). Second, 10 of the city's 22 districts were randomly selected (Stage 2). Third, from the active psychology centers in those selected districts, two centers per district were randomly chosen (Stage 3). Finally, women seeking divorce and community women attending these centers were screened for inclusion criteria and willingness to participate, and those who met the criteria were recruited as the study sample (Stage 4).

Following approval of the proposal by the Research Council of the Department of Psychology at Islamic Azad University, Arak Branch, ethics approval was obtained from the Biomedical Research Ethics Committee. With an official letter of introduction, the researcher first mapped the family counseling and psychology centers across Tehran. Next, 10 of the 22 districts were randomly selected, and from the active centers within those districts, two centers per district were randomly chosen (total = 20 centers).

After meetings with center administrators, presentation of documentation, and explanation of the study aims and procedures (eligibility criteria, instruments, and completion process), client files were screened. Potential participants were contacted by phone, informed about the study, assured of confidentiality and anonymity, and invited to participate. Those who met the inclusion criteria and provided informed consent either completed paper questionnaires at the centers or, if preferred, received a secure electronic link to complete the measures online. Administration was individual and untimed. Recruitment continued until the target N = 400 was achieved. Participants were thanked and informed that study results would be shared upon request.

2.2. Measures

Self-Compassion Scale (SCS). The 26-item SCS developed by Neff (2003a) assesses self-compassion across six subscales: self-kindness (Items 5, 12, 19, 23, 26), self-judgment (Items 1, 8, 11, 16, 21), common humanity (Items 3, 7, 10, 15), isolation (Items 4, 13, 18, 25), mindfulness (Items 9, 14, 17, 22), and over-identification (Items 2, 6, 20, 24). Items are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Items 1, 2, 4, 6, 8, 11, 13, 16, 18, 20, 21, 24, and 25 are reverse-scored. The six dimensions cluster into three bipolar components: self-kindness versus self-judgment, common humanity versus isolation, and mindfulness versus over-identification. Subscale scores are obtained by summing item scores within each dimension, and the overall self-compassion score is calculated as the mean of the six components. Neff (2003a) reported strong psychometric properties (Cronbach's α = .92 overall; subscales α = .75–.81; two-week test–retest reliability = .93; convergent validity with the Rosenberg Self-Esteem Scale, r = .59). In Iran, Momeni et al. (2013) reported evidence of convergent and divergent validity with self-esteem (r = .22), the Beck Depression Inventory (r = −.34), and the Beck Anxiety Inventory (r = −.41); internal consistency α = .70; and 10-day test–retest reliability r = .89.

Young Schema Questionnaire–Short Form (YSQ-S3). The 75-item short form (Young, 1998), derived from the original 205-item version, assesses early maladaptive schemas on a 6-point Likert scale ranging from 1 (completely untrue) to 6 (completely true). It includes 15 subscales: Emotional Deprivation (Items 1–5), Abandonment (6–10), Mistrust/Abuse (11–15), Social Isolation/Alienation (16–20), Defectiveness/Shame (21–25), Failure (26–30), Dependence/Incompetence (31–35), Vulnerability to Harm/Illness (36–40), Enmeshment (41–45), Subjugation (46–50), Self-Sacrifice (51–55), Emotional Inhibition (56–60), Unrelenting Standards (61–65), Entitlement (66–70), and Insufficient Self-Control/Self-Discipline (71–75). Each schema score is the mean of its five items (range = 5–30). A total schema score can be calculated by summing all 15 schema scores (range = 75–450). In the original validation, Cronbach's α ranged from .83 (Enmeshment/Undeveloped Self) to .96 (Defectiveness/Shame), with test–retest reliability in non-clinical samples ranging from .50 to .82; factor structure and criterion validity were supported (Young, 1998). In Iran, Divandari et al. (2009) reported 3-week test–retest reliability of .60–.87, overall α = .94 (subscales .65–.92), and convergent/divergent validity with self-esteem (r = −.32), dysfunctional attitudes (r = .55), positive affect (r = −.23), and negative affect (r = .59).

Affective Flexibility Scale (AFS). The 10-item scale by Fu et al. (2018) measures affective flexibility using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Reported Cronbach's α was .78, with concurrent validity shown through a correlation with psychological well-being (r = .18). Confirmatory factor analysis (CFA) indices were satisfactory (CFI = .96, NFI = .98, NNFI = .97, IFI = .98, RFI = .96, GFI = .98, RMSEA = .078; Fu et al.,

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2018). As no Persian validation was available, the items were translated and a pilot test was conducted with 100 participants (divorced and community women). The pilot yielded Cronbach's α = .77, and first-order CFA supported the factor structure.

2.3. Data Analysis

Data analyses included both descriptive and inferential statistics. Descriptively, means and standard deviations were calculated for demographic and study variables. Inferential analyses involved Pearson correlations, confirmatory factor analysis (CFA), and structural equation modeling (SEM) to test the hypothesized model. Analyses were conducted using SPSS (Version 26) and AMOS (Version 24). The bootstrap procedure in AMOS was used to test the mediating role of affective flexibility. To evaluate the theoretical model, a multi-group model comparison with equality constraints on structural weights was conducted. The significance level for all tests was set at α = .05.

3. Findings and Results

An analysis of the mean age of participants by group indicated that ages ranged from 25 to 36 years. The results of significance testing, with a p-value greater than 0.05, indicated that there was no significant difference between the two groups in terms of age. Thus, it can be concluded that the groups were homogeneous with respect to age.

As shown in Table 1, the implemented intervention led to a significant reduction in various indicators of health anxiety in the experimental group. For the "disease occurrence" index, a comparison of means shows that the experimental group experienced a significant decrease in the mean score after the intervention (from 9.10 to 6.66). The "disease consequences" mean score decreased from 8.23 to 6.18 after the intervention and showed a slight increase during the follow-up phase (to 7.11), indicating that the reduction was largely maintained over time. In the "health concerns" index for the experimental group, the mean score decreased from 6.13 at pretest to 8.94 at post-test and this effect was maintained at follow-up. In contrast, the control group exhibited no considerable changes across the study phases. Therefore, the intervention appears to have effectively reduced health-related worries and anxieties, thus improving the psychological well-being of the participants.

Table 1

Comparison of Means and Standard Deviations of Health Anxiety Scores Between the Two Groups at Three Times: Before, After the Intervention, and Follow-Up

Construct	Group	Pre-Intervention Mean	Pre-Intervention SD	Post-Intervention Mean	Post-Intervention SD	Follow-Up Mean	Follow-Up SD
Health Anxiety							
Illness Likelihood	Intervention	10.9	1.56	6.66	0.891	7.11	0.911
	Control	11.7	1.94	10.3	1.44	11.9	1.90
Illness Consequences	Intervention	23.8	3.74	18.6	2.65	19.3	2.76
	Control	24.1	3.88	23.4	3.19	24.9	3.91
General Health Worries	Intervention	13.6	1.65	8.94	0.971	9.33	1.01
	Control	14.3	2.11	13.6	1.69	13.9	1.88
Total Health Anxiety Score	Intervention	53.7	6.03	47.5	5.68	48.3	5.92
	Control	52.8	6.67	51.6	6.14	52.1	6.89

The results in Table 2 confirm the positive and sustained effect of the intervention on improving various dimensions of psychological and physical health in the intervention group. The data demonstrate that, following the intervention, the intervention group showed a substantial improvement in the overall health score (from 94.1 to 118.3), and this improvement was maintained at the follow-up stage as well. Additionally, an examination of the standard deviations indicates that, in addition to the changes in mean scores, the variation of scores within the intervention group remained acceptable, suggesting convergence in participants' responses.

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Table 2

Comparison of Means and Standard Deviations of Health Dimensions Scores Between the Two Groups at Three Time Points: Before, After the Intervention, and at Follow-up

Construct	Group	Pre-Intervention Mean	Pre-Intervention SD	Post-Intervention Mean	Post-Intervention SD	Follow-Up Mean	Follow-Up SD
Social Connection	Intervention	25.8	3.00	31.2	2.85	30.5	3.11
	Control	25.6	3.10	26.5	3.01	26.0	2.69
Illness-Related Limitations	Intervention	9.25	1.55	11.6	1.44	11.3	1.64
	Control	9.33	1.45	9.87	1.66	9.61	1.59
Energy and Vitality	Intervention	7.43	1.26	9.0	1.11	8.83	1.24
	Control	7.36	1.25	7.66	1.24	7.57	1.31
Purpose in Life	Intervention	8.85	1.52	11.3	1.40	11.0	1.56
	Control	8.91	2.49	9.23	2.47	9.0	1.23
Anxiety	Intervention	20.6	1.66	14.7	3.39	14.4	2.29
	Control	21.5	1.72	20.3	2.30	20.8	1.94
Fatigue	Intervention	25.1	2.83	20.6	3.79	19.9	2.74
	Control	24.8	3.74	23.3	4.65	22.6	4.85
Spirituality	Intervention	23.2	2.26	27.9	3.84	26.1	3.76
	Control	24.6	2.94	25.2	3.11	25.1	3.90
Physical Health	Intervention	11.7	2.63	15.9	2.97	14.8	2.67
	Control	11.02	2.58	12.1	2.55	12.0	1.95
Functional Impairment	Intervention	15.7	2.63	10.9	2.97	11.8	2.67
	Control	14.02	2.58	13.1	2.55	14.0	1.95
Health Evaluation	Intervention	4.56	0.914	7.98	0.614	7.63	0.889
	Control	4.0	0.748	4.97	0.719	4.01	0.569
Total Health Dimensions Score	Intervention	94.1	6.55	118.3	7.69	117.5	6.11
	Control	93.7	5.64	96.4	6.33	96.0	6.45

In this section, to evaluate the effectiveness of the interventions at the post-test and follow-up stages, univariate and multivariate analysis of covariance (ANCOVA and MANCOVA) were performed. Before conducting the ANCOVA, the assumptions necessary for its application were examined through a series of preliminary statistical tests to ensure the validity of the analysis. The Shapiro–Wilk test was used to assess the normality of the data distribution across all dependent variables at the pre-test, post-test, and follow-up stages for both the experimental and control groups. The results indicated that all variables had significance levels greater than 0.05, confirming that the distributions did not significantly deviate from normality and thus met the normality assumption. Additionally, Levene's test was employed to examine the homogeneity of variances across groups at the pre-test stage. The results revealed that the significance levels for all measured variables—including disease onset, disease consequences, general health concerns, vitality, anxiety, fatigue, spirituality, and physical health—were also greater than 0.05, thereby confirming equality of variances between the groups. To further verify the equality of covariance matrices among the dependent variables, Box's M test was conducted, yielding a non-significant result ($F = 0.897$, $p = 0.678$), which met the criterion for homogeneity of covariance matrices. Collectively, these outcomes demonstrated that all statistical assumptions for performing ANCOVA were satisfied, validating the use of this parametric procedure for subsequent analyses.

According to the results presented in Table 3, the calculated F values for the effect of the three measurement phases at an alpha level of 0.05 are significant for the variables of disease occurrence, disease consequences, and overall health anxiety. This indicates that there are significant differences among the mean scores of disease occurrence, disease consequences, and overall health anxiety across the pre-test, post-test, and follow-up phases. In other words, the intervention had a significant impact on the scores of disease occurrence, disease consequences, and overall health anxiety (time: $F = 2048.8$, Sig = 0.001; group * time: $F = 56.1$, Sig = 0.001).

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Table 3

Multivariate Analysis of Variance for Disease Occurrence, Disease Consequences, and Overall, Health Anxiety Variables

Variable	Test	Value	F	Hypothesis df	Error df	Significance Level	Eta Squared
Time	Wilks' Lambda	0.002	2048.8	7	22	0.001	0.998
Group × Time	Wilks' Lambda	0.053	56.1	7	22	0.001	0.947

As shown in Table 4, the intervention—healthy lifestyle education combined with mindfulness-based stress reduction—had a significant effect on improving disease occurrence, disease consequences, and overall health anxiety. According to the eta squared results, the intervention was able to explain a considerable proportion of the variance in these variables. In fact, there were significant differences between the experimental and control groups regarding disease occurrence, disease consequences, and overall health anxiety.

Table 4

Test of Between-Group Effects for Disease Occurrence, Disease Consequences, and Overall, Health Anxiety Variables

Variable(s)	Source of Variance	SS	df	MS	F	Significance Level	Eta Squared
Disease Onset, Disease Consequences, and General Health Concern	Group	1088.5	1	1088.5	55.09	0.001	0.663
	Error	553.2	28	19.7			

The results of Mauchly's test of sphericity for the variables of disease onset, disease consequences, and overall health anxiety revealed statistically significant values ($p < 0.05$), indicating that the assumption of equal covariances among the repeated measurements across the three assessment phases was violated. In other words, the variances of the differences between time points were not homogeneous for these variables. Consequently, to address this violation and maintain the accuracy of the within-group comparisons, the Greenhouse–Geisser correction was applied to adjust the degrees of freedom. This correction ensured that the interpretation of repeated measures results for disease onset, disease consequences, and overall health anxiety remained statistically valid and robust despite the lack of sphericity.

According to Table 5, time had a significant effect on the variables of disease occurrence, disease consequences, and overall health anxiety, explaining a considerable proportion of their variance. In fact, there were significant differences between at least two of the assessment phases for these components.

Table 5

Test of Within-Group Effects for Disease Occurrence, Disease Consequences, and Overall Health Anxiety Variables

Variable(s)	Test	Source of Variance	SS	df	MS	F	Sig.	Eta Squared
Disease Onset, Disease Consequences, and General Health Concern	Greenhouse-Geisser	Time	696.02	1.15	348.01	167.1	0.001	0.856
		Time × Group	524.02	1.15	452.8	125.8	0.001	0.818
		Error	116.6	32.3	3.60			

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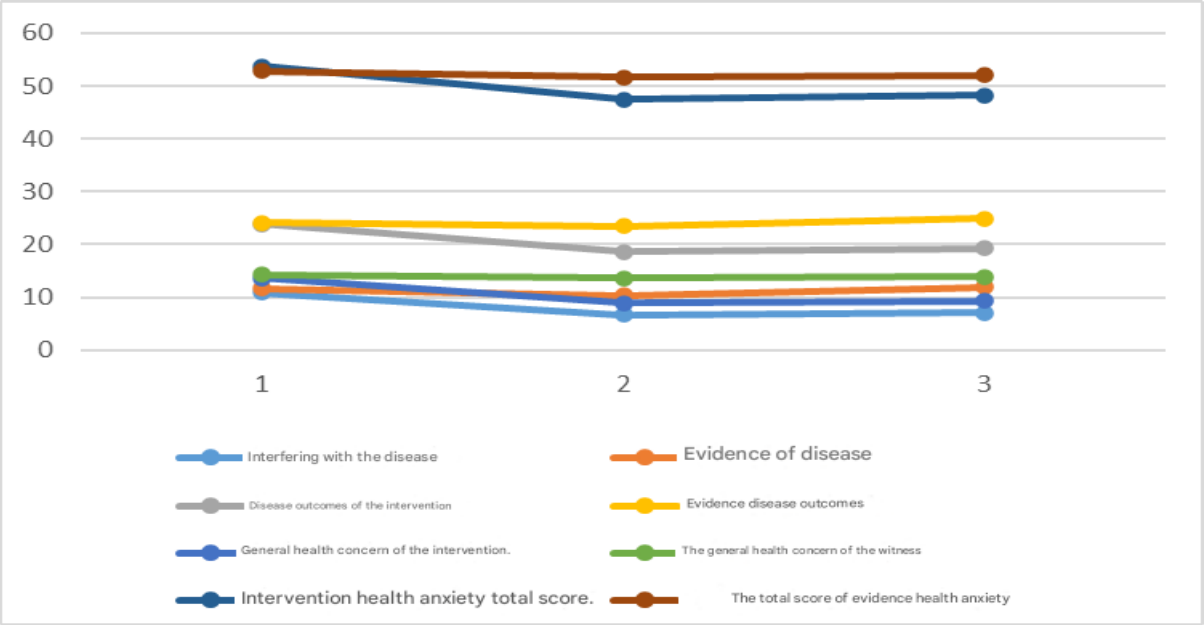
Figure 1

Line Chart of Health Anxiety Scores by Group Across Measurement Phases



According to the results in Table 6, the calculated F values for the effect of the three measurement phases at an alpha level of 0.05 are significant for the variables of social relationships, limitations in activities due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation. Consequently, there are significant differences among the mean scores of these variables across the pre-test, post-test, and follow-up phases. This means that the intervention had a significant effect on the scores of social relationships, limitations in activities due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation (time: F = 28.5, Sig = 0.001; group * time: F = 21.1, Sig = 0.001).

Table 6

Multivariate Analysis of Variance for Social Relationships, Limitations in Activities Due to Illness, Energy and Vitality, Life Purpose, Anxiety, Fatigue, Spirituality, Physical Health, Impaired Functioning, and Health Evaluation Variables

Variable	Test	Wilks' Lambda	F-value	df Hypothesis	df Error	Significance Level	Eta Squared
Time	Wilks' Lambda	0.099	28.5	7	22	0.001	0.901
Group × Time	Wilks' Lambda	0.130	21.1	7	22	0.001	0.870

As shown in Table 7, the intervention—healthy lifestyle education combined with mindfulness-based stress reduction—had a significant effect on improving the variables of social relationships, limitations in activities due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation. According to the eta squared results, the intervention was able to explain a considerable proportion of the variance in these variables. In fact, there were significant differences between the experimental and control groups in social relationships, limitations in activities due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation variables.

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Table 7

Test of Between-Group Effects for Social Relationships, Limitations in Activities Due to Illness, Energy and Vitality, Life Purpose, Anxiety, Fatigue, Spirituality, Physical Health, Impaired Functioning, and Health Evaluation Variables

Construct	Source of Variance	SS	df	MS	F	Significance Level	Eta Squared
Social connection, disease-related activity limitations, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, performance weakness, health assessment	Group	418.1	1	418.1	6.43	0.001	0.609
	Error	426.8	28	9.58			

The results of Mauchly's test of sphericity for the variables related to social relationships, activity limitations due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation also showed significant values ($p < 0.05$). This finding confirmed that the assumption of sphericity was not met for these interrelated measures, suggesting unequal covariances among repeated assessments across the study phases. As a result, the Greenhouse–Geisser correction was again employed to compensate for this violation and to produce more reliable F-ratios in the analysis of within-group effects. Applying this statistical adjustment allowed for precise interpretation of longitudinal changes in participants' social, psychological, physical, and spiritual health dimensions following the intervention.

According to Table 8, time had a significant effect on the variables of social relationships, limitations in activities due to illness, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, impaired functioning, and health evaluation, accounting for a considerable proportion of the variance in these variables. In fact, there were significant differences between at least two of the assessment phases for these components.

Table 8

Test of Within-Group Effects for Social Relationships, Limitations in Activities Due to Illness, Energy and Vitality, Life Purpose, Anxiety, Fatigue, Spirituality, Physical Health, Impaired Functioning, and Health Evaluation Variables

Variable	Test (Correction)	Source of Variance	SS	df	MS	F	Significance Level	Eta Squared
Social connection, disease-related activity limitations, energy and vitality, life purpose, anxiety, fatigue, spirituality, physical health, performance weakness, health assessment	Greenhouse-Geisser	Time	588.6	1.02	572.02	2.67	0.001	0.706
		Time × Group	577.08	1.02	560.8	9.65		
		Error	244.9	28.8	8.50			

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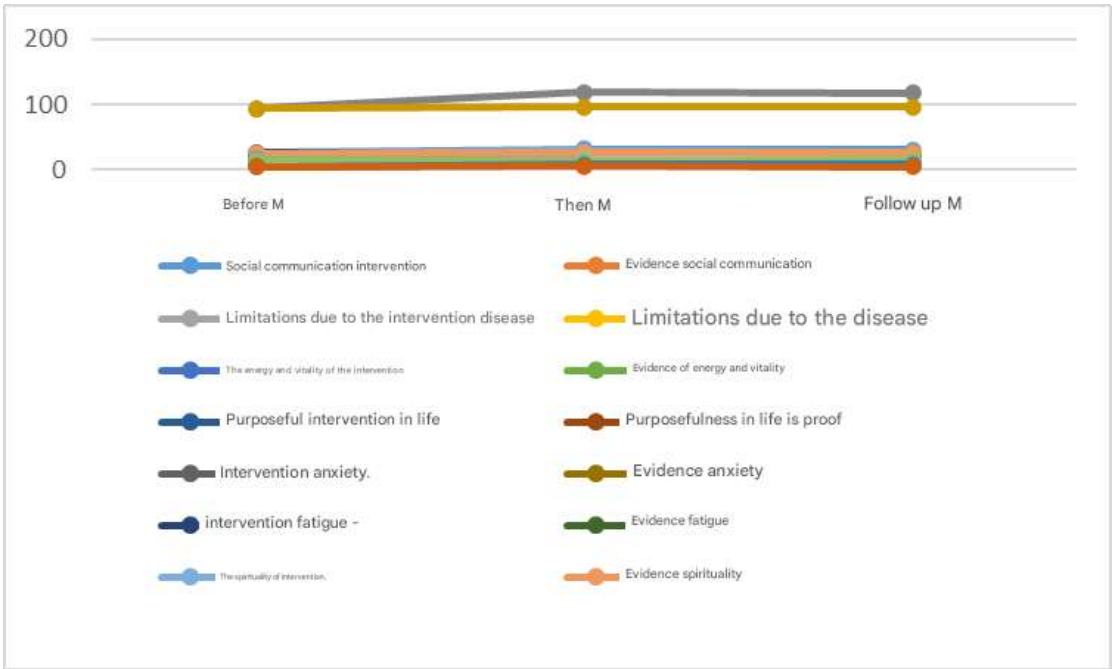
Figure 2

Line Graph of Women's Health Dimension Scores in the Groups Across Measurement Phases



The results of repeated measures ANOVA indicated that healthy lifestyle education combined with mindfulness-based stress reduction led to significant improvements in the psychological and social well-being of pregnant women at risk for preeclampsia. This intervention improved the participants' psychological status and reduced their anxiety levels, while also enhancing their social indices compared to the pre-test and the control group. All of these significant changes were observed and recorded in the experimental group following the implementation of the educational program.

4. Discussion and Conclusion

The results of the present study revealed that the combined intervention of healthy lifestyle education and mindfulness-based stress reduction (MBSR) significantly reduced health anxiety and improved various dimensions of health—psychological, physical, social, and spiritual—among pregnant women at risk of preeclampsia. The findings showed that after the eight-session intervention, the participants in the experimental group demonstrated a remarkable decline in health anxiety indicators, including perceived likelihood of illness and general health concerns, and these effects were sustained at follow-up. Moreover, substantial improvements were observed in health domains such as energy and vitality, social relationships, physical health, spirituality, and overall quality of life. These outcomes confirm that integrating lifestyle education with mindfulness-based approaches can meaningfully enhance the biopsychosocial-spiritual well-being of pregnant women facing high-risk conditions.

From a physiological standpoint, these findings can be understood in light of the mechanisms linking stress, anxiety, and preeclampsia. Elevated stress and anxiety activate the hypothalamic–pituitary–adrenal (HPA) axis, leading to increased cortisol production and endothelial dysfunction, both of which contribute to hypertensive disorders during pregnancy (Bernad et al., 2025; Liu et al., 2025). Previous research has shown that anxiety and depressive symptoms are more prevalent among women at risk of preeclampsia and are directly associated with disease severity and poorer obstetric outcomes (Bergeron et al., 2024; Cong et al., 2025). By addressing both the psychological and behavioral dimensions of maternal health, the current intervention effectively reduced anxiety-related physiological arousal, aligning with earlier studies suggesting that mindfulness practices can downregulate the HPA axis and improve cardiovascular regulation (Gill et al., 2020; Schuman-Olivier et al., 2020). Consequently, this dual intervention likely modulated both the cognitive appraisals and biological pathways that sustain anxiety and stress

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responses in pregnancy, leading to observable clinical and psychological improvements.

In the present study, the significant reduction in total health anxiety scores across post-test and follow-up phases suggests that the mindfulness component played a central role in changing participants' cognitive and emotional reactions toward bodily sensations and health-related concerns. Mindfulness enhances awareness of thoughts and feelings as transient experiences rather than absolute truths, thus reducing catastrophic thinking patterns and worry cycles (Santorelli et al., 2017; Song & Lindquist, 2015). Earlier evidence indicates that MBSR programs can successfully lower anxiety levels in pregnant women, improve coping skills, and foster emotional balance (Rahmani Fard et al., 2017; Shahoie et al., 2019). Similarly, research in non-pregnant populations has demonstrated that mindfulness leads to sustained improvements in stress resilience and cognitive flexibility (Gill et al., 2020; Goetz et al., 2020). These converging findings support the interpretation that the reduction in health anxiety observed in the current study was primarily driven by enhanced self-regulation and cognitive restructuring facilitated through mindfulness practices.

At the behavioral level, lifestyle education complemented mindfulness training by promoting self-efficacy and active engagement in health-enhancing habits. Participants were educated about nutrition, physical activity, sleep hygiene, and stress management—behaviors known to influence both blood pressure regulation and general well-being (Alexander & Vladislav, 2015; Lagerweij et al., 2020). Lifestyle modification is particularly crucial for women at risk of preeclampsia because metabolic and cardiovascular factors are major contributors to disease progression (Bisson et al., 2023; Han et al., 2023). The observed improvements in physical and social health dimensions suggest that participants internalized these behavioral principles, translating cognitive awareness into action. Consistent with these results, prior work by Reusch et al. demonstrated that interactive, small-group lifestyle education was more effective in motivating behavioral change compared to information-only sessions (Reusch et al., 2011). This underscores that the experiential and mindfulness-integrated nature of the intervention may have amplified participants' commitment to lifestyle adjustments.

Moreover, improvements in vitality, social connection, and spiritual well-being suggest that the intervention engaged multiple facets of health consistent with the biopsychosocial-spiritual model proposed by Bahrami Ehsan et al. (Bahrami Ehsan et al., 2015). This holistic model posits that human health cannot be fully understood through biological factors alone but must integrate psychological stability, social relationships, and spiritual meaning. The current results demonstrate that the intervention successfully targeted each of these interdependent dimensions. Spiritual well-being, for instance, was notably enhanced in the experimental group—a finding supported by Akbarzadeh and Ahmadinezhad, who reported that spiritual health strongly correlates with reduced perceived stress and greater social support among women with preeclampsia (Akbarzadeh & Ahmadinezhad, 2019). Likewise, mindfulness training has been shown to strengthen spiritual awareness and existential acceptance, fostering a sense of peace and coherence during stressful life periods (Lacks et al., 2022). Thus, the present study contributes to a growing body of evidence supporting the inclusion of spirituality in maternal health frameworks.

Another important finding concerns the sustained improvements in social and emotional functioning. Social health scores increased significantly after the intervention and remained high at follow-up, suggesting that mindfulness and lifestyle education enhanced interpersonal awareness and empathy. This outcome aligns with prior research demonstrating that mindfulness practices enhance social connectedness by reducing reactivity and promoting compassionate communication (Schuman-Olivier et al., 2020). Additionally, lifestyle interventions that include social components—such as peer support or group discussions—are known to improve perceived social support and compliance with health behaviors (Overdijkink et al., 2018; Sanaati et al., 2018). The current study's group-based format may have reinforced these benefits, as shared experiences among pregnant women likely fostered mutual encouragement and collective motivation.

The physiological basis for these multidimensional improvements may involve both direct and indirect mechanisms. Mindfulness interventions can attenuate systemic inflammation and oxidative stress, two core biological pathways implicated in preeclampsia (Freire et al., 2023). Lifestyle education, on the other hand, encourages dietary and behavioral modifications that reduce oxidative load and improve vascular health (Bernad et al., 2025; Bisson et al., 2023). Together, these approaches may have produced synergistic effects on participants' biological regulation. Supporting this interpretation, San Juan-Reyes et al. found that oxidative stress markers are elevated among women with preeclampsia exposed to environmental

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pollutants, emphasizing the role of modifiable behavioral and environmental factors in disease progression (San Juan-Reyes et al., 2023). Therefore, reducing stress and promoting healthier behaviors could mitigate these adverse processes.

The improvements in vitality and energy observed in this study further validate the intervention's holistic efficacy. Enhanced vitality likely resulted from the reduction of fatigue and anxiety through mindfulness techniques and increased physical activity stemming from lifestyle training. Similar results have been reported in pregnant populations practicing mindfulness-based interventions, showing reductions in perceived fatigue and emotional distress (Goetz et al., 2020; Shahoie et al., 2019). These findings are consistent with research by Miller et al., who indicated that maternal aging and psychosocial factors modulate physiological resilience during pregnancy, suggesting that psychological well-being directly affects maternal adaptation to biological demands (Miller et al., 2022). Consequently, interventions that enhance emotional regulation and healthy behavior collectively strengthen maternal resilience, leading to improved pregnancy outcomes.

A noteworthy observation of the present research was the significant increase in spirituality and life purpose scores following the intervention. Mindfulness practices inherently cultivate awareness, gratitude, and acceptance, which correspond closely with spiritual dimensions of health (Santorelli et al., 2017). The enhancement of spiritual well-being may also have mediated improvements in other domains such as anxiety and perceived vitality, consistent with evidence suggesting that spirituality acts as a protective factor against stress-related disorders (Akbarzadeh & Ahmadinezhad, 2019; Lacks et al., 2022). This multidimensional relationship illustrates how cognitive, emotional, and existential factors interact within a comprehensive health framework.

Furthermore, the findings regarding reduced anxiety and improved social relationships align with prior investigations into mindfulness and behavior change. Schuman-Olivier et al. highlighted that mindfulness fosters intrinsic motivation and self-awareness, facilitating sustained behavioral transformation (Schuman-Olivier et al., 2020). In addition, cognitive behavioral models of health anxiety emphasize that maladaptive beliefs about health can be modified through attentional control and cognitive reappraisal—both mechanisms central to mindfulness training (Salkovskis et al., 2002). The current study thus supports the theoretical integration of cognitive-behavioral and mindfulness-based frameworks in addressing health anxiety among pregnant women.

The present findings are also consistent with neurobiological evidence showing that mindfulness practice enhances prefrontal regulation of the amygdala, leading to reduced stress reactivity and improved emotional balance (Gill et al., 2020). These effects can contribute to better blood pressure control and lower systemic inflammation, both essential for managing hypertensive risks in pregnancy. Furthermore, integrating lifestyle and mindfulness interventions mirrors global health trends advocating for personalized and preventive maternal care (Wang et al., 2023). With the increasing use of machine learning and genomic technologies in early detection of preeclampsia, such behavioral interventions offer complementary, low-cost strategies to improve outcomes (Moufarrej et al., 2022).

Collectively, these results indicate that the dual intervention approach addresses both proximal (psychological) and distal (physiological and behavioral) determinants of maternal health. This integrated design aligns with recent calls for holistic models of prenatal care that move beyond pharmacological or purely medical management to include psychoeducational and behavioral dimensions (Bernad et al., 2025; Lagerweij et al., 2020). By reinforcing positive health behaviors and promoting mindful awareness, this approach strengthens maternal resilience and potentially reduces the recurrence of hypertensive complications in future pregnancies.

Finally, the sustained benefits observed at follow-up highlight the intervention's lasting impact, a finding consistent with previous research indicating that mindfulness and lifestyle programs can induce long-term behavioral and neurophysiological changes (Rahmani Fard et al., 2017; Song & Lindquist, 2015). The observed maintenance of reduced anxiety and enhanced multidimensional health underscores the durability of the learning and coping skills gained through the intervention. Thus, the present study contributes new empirical evidence supporting the long-term value of integrated mindfulness and lifestyle interventions for high-risk pregnant populations.

5. Limitations and Suggestions

Despite these encouraging findings, this study has several limitations that should be acknowledged. The small sample size and use of purposive sampling limit the generalizability of the results to the broader population of pregnant women

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with preeclampsia risk. The quasi-experimental design without an active control group restricts the ability to infer causal mechanisms or distinguish between intervention-specific and general therapeutic effects. Furthermore, all outcome measures relied on self-report instruments, which may be influenced by social desirability bias or participants' subjective perceptions. The relatively short follow-up period precludes conclusions about long-term maintenance of the observed improvements. Additionally, the study did not control for confounding variables such as socioeconomic status, prior mental health history, and family support, which may have influenced both anxiety and health outcomes.

Future studies should employ larger, randomized controlled trials across diverse cultural and socioeconomic contexts to enhance the external validity of findings. Longitudinal designs with extended follow-up periods would be valuable for examining the durability of intervention effects on maternal and neonatal outcomes. Researchers are also encouraged to integrate objective physiological measures—such as blood pressure monitoring, cortisol levels, and oxidative stress biomarkers—to complement self-reported data and clarify the biological mechanisms underlying psychological change. Comparative studies evaluating different delivery modes (in-person vs. digital mindfulness and lifestyle programs) could provide insights into scalability and accessibility. Moreover, examining mediating variables such as emotional regulation, social support, or spiritual well-being would further elucidate how these factors contribute to health improvements in high-risk pregnancies.

In practical terms, integrating lifestyle education and mindfulness-based stress reduction into prenatal care programs could provide a cost-effective and accessible strategy for improving maternal health. Health professionals, particularly midwives and clinical psychologists, should be trained to deliver combined behavioral and mindfulness interventions tailored to the unique needs of pregnant women at risk of preeclampsia. Incorporating brief mindfulness exercises and health education modules into routine prenatal visits may enhance self-efficacy, reduce anxiety, and promote healthier behaviors. Collaborative partnerships between healthcare providers and mental health specialists can help establish holistic care pathways emphasizing both physical and psychological well-being. Finally, policymakers should consider supporting such integrative programs within national maternal health guidelines to promote sustainable improvements in women's health outcomes during pregnancy and beyond.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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