Jurnal Riset Kesehatan Poltekkes Depkes Bandung

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

Effectiveness of walking and prenatal yoga on stress, cortisol, and blood pressure among pregnant women at high risk of preeclampsia

Efektivitas Jalan Kaki dan Yoga Prenatal terhadap Stres, Kortisol, dan Tekanan Darah Pada Wanita Hamil Berisiko Tinggi Preeklampsia

Hamimatus Zainiyah[1*], Dwi Wahyuning Tiyas[1], Dana Daniati[1], Alis Nurdiana[1], Vivin Wijiastutik[1], Mukhoirotin Mukhoirotin[2]

[1]Department of Midwifery, Universitas Noor Huda Mustofa, Jawa Timur, Indonesia
[2]Department of Nursing, Faculty of Health Science, Universitas Pesantren Tinggi Darul Ulum , Jawa Timur, Indonesia
*Email: matus.061283@yahoo.co.id

ABSTRACT

Background: *Preeclampsia is associated with vascular dysfunction, sympathetic nervous system activation, and increased stress responses. Elevated pregnancy-related stress and cortisol levels may contribute to early blood pressure dysregulation preceding preeclampsia.*
Objective: *This study evaluated the effectiveness of a combined walking and prenatal yoga program in reducing stress, cortisol levels, and blood pressure among pregnant women at high risk of preeclampsia.*
Methods: *A quasi-experimental pretest–posttest control group study was conducted among 58 high-risk pregnant women recruited through multistage sampling with matching to ensure comparable risk factors between groups. The intervention group received a combined walking and prenatal yoga program for 12 weeks. Outcomes included pregnancy-related stress, cortisol levels, systolic blood pressure, diastolic blood pressure, and mean arterial pressure (MAP). Stress was measured using the Revised Prenatal Distress Questionnaire (NuPDQ), cortisol levels using ELISA, and blood pressure using a calibrated sphygmomanometer. Data were analyzed using Mann–Whitney U, independent t-test, Chi-square, paired t-test, and Wilcoxon signed-rank tests with $p<0.05$.*
Results: *Compared with the control group, the intervention reduced pregnancy-related stress (Δ −3.58 vs +2.34), cortisol (Δ −1.38 vs +1.33), systolic blood pressure (Δ −1.89 vs +7.41), diastolic blood pressure (Δ −5.68 vs +6.37), and MAP (Δ −5.03 vs +1.96), with all outcomes showing significant differences ($p<0.05$) and moderate-to-large effect sizes (ES=0.66–1.36).*
Conclusion: *The combined walking and prenatal yoga program effectively improved psychological and physiological outcomes and may serve as an early non-pharmacological strategy for preeclampsia prevention.*

Keywords: *cortisol, preeclampsia, pregnancy-related stress, prenatal yoga, walking*

ABSTRAK

Latar Belakang: Preeklampsia berhubungan dengan disfungsi vaskular, aktivasi sistem saraf simpatis, dan peningkatan respons stres. Peningkatan stres selama kehamilan dan kadar kortisol dapat berkontribusi terhadap disregulasi tekanan darah pada tahap awal sebelum terjadinya preeklampsia.
Tujuan: Penelitian ini bertujuan untuk mengevaluasi efektivitas program kombinasi jalan kaki dan yoga prenatal dalam menurunkan stres, kadar kortisol, dan tekanan darah pada ibu hamil dengan risiko tinggi preeklampsia. Penelitian quasi-eksperimental dengan desain pretest–posttest control group dilakukan pada 58 ibu hamil risiko tinggi yang

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

direkrut melalui multistage sampling dengan prosedur matching untuk memastikan kesetaraan faktor risiko antar kelompok. Kelompok intervensi menerima program kombinasi jalan kaki dan yoga prenatal selama 12 minggu. Luaran penelitian meliputi stres terkait kehamilan, kadar kortisol, tekanan darah sistolik, tekanan darah diastolik, dan mean arterial pressure (MAP). Tingkat stres diukur menggunakan Revised Prenatal Distress Questionnaire (NuPDQ), kadar kortisol diukur menggunakan metode ELISA, dan tekanan darah diukur menggunakan sfigmomanometer terkalibrasi. Data dianalisis menggunakan uji Mann–Whitney U, independent t-test, Chi-square, paired t-test, dan Wilcoxon signed-rank dengan nilai p<0,05.

Hasil: Dibandingkan dengan kelompok kontrol, intervensi menurunkan stres terkait kehamilan (Δ −3,58 vs +2,34), kadar kortisol (Δ −1,38 vs +1,33), tekanan darah sistolik (Δ −1,89 vs +7,41), tekanan darah diastolik (Δ −5,68 vs +6,37), dan MAP (Δ −5,03 vs +1,96). Seluruh luaran menunjukkan perbedaan yang bermakna secara statistik (p<0,05) dengan ukuran efek sedang hingga besar (ES=0,66–1,36).

Kesimpulan: Kombinasi jalan kaki dan yoga prenatal efektif menurunkan indikator stres psikologis dan fisiologis serta memperbaiki regulasi tekanan darah pada ibu hamil berisiko tinggi sebagai strategi pencegahan dini preeklamsia.

Kata kunci: jalan kaki, kortisol, preeklamsia, stres terkait kehamilan, yoga prenatal

INTRODUCTION

Preeclampsia is a leading cause of maternal and perinatal morbidity and mortality globally.[1] Characterized by new-onset hypertension after 20 weeks of pregnancy and potential organ impairment, it remains a significant public health concern.[2] Several risk factors, including advanced age, obesity, medical comorbidities, previous or family history of preeclampsia, multifetal pregnancy, nulliparity, and long interpregnancy intervals, increase the likelihood of its occurrence. [3,4]

Apart from established biological factors, growing literature underscores the role of pregnancy-related psychological stress in the pathophysiology of preeclampsia.[5] Stress in pregnant women can trigger an increase in cortisol levels through the activation of the hypothalamic-pituitary-adrenal (HPA) axis. When pregnant women experience physical or psychological stress, the hypothalamus will send signals by releasing Corticotropin Releasing Hormone (CRH). This hormone then stimulates the anterior pituitary gland to produce Adrenocorticotropic Hormone (ACTH). Subsequently, ACTH is transported to the adrenal cortex through blood vessels and stimulates the production of cortisol hormone.[6] The increase in cortisol is actually a body adaptation mechanism to maintain physiological balance, such as increasing metabolism, blood glucose levels, and cardiovascular response when facing stress. However, if the stress condition persists, the continuously rising cortisol levels can lead to sympathetic nervous system activation, blood vessel constriction, increased blood pressure, MAP and decreased immune system function.[7] In pregnant women, this condition can trigger endothelial dysfunction, which plays a role in increasing the risk of preeclampsia. [8]

Current approaches to preeclampsia prevention primarily focus on early detection and pharmacological management, whereas lifestyle-based non-pharmacological interventions have not been optimally integrated into routine antenatal care, particularly for high-risk pregnant women.[8] Light- to moderate-intensity physical activity, such as walking, has been shown to improve blood pressure regulation by enhancing cardiovascular function, increasing nitric oxide production, and reducing sympathetic nervous system activity.[9] Regular walking also contributes to stress reduction and promotes better neuroendocrine balance during pregnancy. [10]

In addition, prenatal yoga represents a mind–body exercise that combines physical postures, breathing techniques, and relaxation practices, and has been shown to

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

effectively reduce pregnancy-related stress and cortisol levels.[11,12] Prenatal yoga enhances parasympathetic activity, attenuates physiological stress responses, and supports vascular adaptation during pregnancy.[13] The combination of walking and prenatal yoga may therefore provide synergistic benefits in controlling stress, suppressing cortisol secretion, and stabilizing blood pressure among pregnant women at risk. [10,14]

Walking and prenatal yoga have been shown in earlier research to enhance maternal health and lower stress levels during pregnancy. Nevertheless, the majority of research has solely examined psychological effects without concurrently assessing physiological biomarkers like blood pressure and cortisol levels. Furthermore, there is yet little data on the combined benefits of walking and prenatal yoga for expectant mothers who are at high risk of preeclampsia. The link between stress regulation, activation of the hypothalamic-pituitary-adrenal (HPA) axis, cortisol release, and hemodynamic responses in this high-risk group has not been thoroughly studied. Thus, by examining the combined effects of walking and prenatal yoga on psychological, hormonal, and hemodynamic parameters such as stress, cortisol levels, and blood pressure among pregnant women at high risk of preeclampsia, this study adds uniqueness.

METHODS

Study design

This study used a quasi-experimental design with a pretest–posttest control group approach. The study was conducted at primary healthcare centers in Bangkalan Regency, East Java, Indonesia, from July to November 2025. The study involved pregnant women at high risk of preeclampsia and examined the effects of a structured walking and prenatal hatha yoga program on pregnancy-related stress, salivary cortisol levels, and blood pressure.

Data source and sampling procedure

Primary data were collected directly from pregnant women using a structured questionnaire, salivary cortisol samples, and blood pressure measurements. Information on sociodemographic and obstetric characteristics was obtained through interviews and antenatal care records.

The study population comprised pregnant women at high risk of preeclampsia who received antenatal care at the selected Puskesmas in Bangkalan Regency, East Java, Indonesia. Women were eligible if they met the predefined criteria for moderate or high risk of preeclampsia. High-risk criteria included multiparity with a previous history of preeclampsia and multifetal pregnancy. Moderate-risk criteria included maternal age ≥35 years, nulliparity, multiparity with a new partner, an interpregnancy interval ≥10 years, a family history of preeclampsia or hypertension in the mother or sister, pregnancy resulting from donor sperm, oocyte, or embryo insemination, pre-pregnancy obesity or a BMI >30 kg/m² at the first antenatal visit, and MAP >90 mmHg.

Women with insulin-dependent diabetes mellitus, chronic hypertension, renal disease, antiphospholipid syndrome, or proteinuria (dipstick >+1 on two examinations conducted 6 hours apart) were excluded. Women with musculoskeletal conditions that could interfere with exercise participation or who were participating in another structured exercise or intervention program during the study period were also excluded.

The sample size was determined using the Lemeshow formula based on parameters from previous studies. A minimum of 23 participants was required for each group. Allowing for a potential 20% loss to follow-up, the sample size was increased to 29 participants per group, giving a total of 58 participants.

Participant recruitment involved two stages. First, a Puskesmas in Bangkalan Regency with a high volume of antenatal care visits, adequate facilities for screening,

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

and support for the implementation of the walking and prenatal hatha yoga program was purposively selected as the study site. Second, pregnant women attending antenatal care were screened consecutively during six screening periods. All women who met the eligibility criteria were invited to participate, and recruitment continued until the required sample size was reached.

Because eligible high-risk pregnant women were not available in sufficient numbers during each screening period, recruitment was carried out in phases. For each group of eligible participants, demographic, obstetric, and clinical characteristics were assessed before group assignment.

To improve comparability between groups and reduce the influence of potential confounding factors, participants were matched according to maternal age, parity, gestational age, BMI, SBP, DBP, MAP, marital history, history of preeclampsia, family history of preeclampsia, and multiparity with an interpregnancy interval >10 years. Participants with similar characteristics were then assigned to the intervention or control group based on the matching procedure. The same procedure was applied to participants recruited during subsequent screening periods until 58 participants had been enrolled, with 29 participants in each group.

The comparability of the two groups at baseline was assessed statistically by comparing their demographic, obstetric, and clinical characteristics before the intervention.

Variables of the study

The intervention variable was a structured program combining moderate-intensity walking and prenatal hatha yoga. The outcomes assessed were pregnancy-related stress, salivary cortisol levels, SBP, DBP, and MAP. All outcome variables were measured at baseline and again after the 12-week intervention.

Measurement and instruments

Pregnancy-Related Stress

Pregnancy-related stress was measured using an adapted and validated version of the Revised Prenatal Distress Questionnaire (NuPDQ). The questionnaire contains 17 items covering physical, maternal–fetal, childbirth, role adaptation, and socioeconomic concerns during pregnancy. Each item is scored on a three-point Likert scale (0 = not at all, 1 = somewhat bothersome, and 2 = very bothersome), giving a total score of 0–34. Higher scores indicate greater pregnancy-related stress. The questionnaire was completed independently by the participants. In this study, the instrument showed good internal consistency, with a Cronbach's alpha of 0.82.

Salivary Cortisol

Salivary cortisol was measured using an ELISA kit (Eagle Biosciences, COR32-K01) following the manufacturer's instructions. Unstimulated saliva was collected using the passive drool method. To reduce the influence of circadian variation, samples were collected between 09:00 and 11:00 a.m.

Participants were asked to avoid eating, consuming beverages other than water, brushing their teeth, chewing gum, and vigorous physical activity for 60–120 minutes before collection. Approximately 1–2 mL of saliva was collected in sterile polypropylene tubes. Samples were kept at 2–8°C during transportation and stored at −20°C until laboratory analysis. Cortisol concentrations were subsequently determined using the ELISA procedure recommended by the manufacturer.

Blood Pressure

Blood pressure was measured using a calibrated sphygmomanometer and an appropriately sized cuff. Measurements were taken after participants had rested in a

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

seated position for at least 10 minutes, with their back supported, feet flat on the floor, and arm positioned at heart level.

Participants were asked to avoid caffeine, smoking, and strenuous physical activity for at least 30 minutes before measurement. Two blood pressure measurements were obtained at 1–2-minute intervals, and the mean of the two readings was used for analysis.

Mean Arterial Pressure

MAP was calculated from SBP and DBP using the following equation:

MAP = (SBP + 2 × DBP) / 3

Data collection

Data collection began after participants had been screened for eligibility and provided written informed consent. Baseline measurements of pregnancy-related stress, salivary cortisol, SBP, DBP, and MAP were obtained before the intervention.

Participants in the intervention group followed a 12-week program combining moderate-intensity walking and prenatal hatha yoga. Walking was performed for 20–30 minutes, three to four times per week. Participants were instructed to maintain a moderate level of exertion, defined as an intensity that allowed them to continue a conversation without excessive fatigue. The target intensity was approximately 50–70% of maximal heart rate.

Prenatal hatha yoga was conducted twice a week for 30 minutes under the supervision of a trained prenatal yoga instructor. The sessions included pranayama breathing, pregnancy-adapted yoga postures, stretching, and relaxation exercises. The sessions were conducted in small groups at the Puskesmas. Participants were also encouraged to practice basic breathing and relaxation techniques at home.

The control group continued to receive routine antenatal care according to standard clinical practice, including the prescribed antenatal supplementation and/or prophylactic treatment, but did not participate in the structured walking and prenatal yoga program.

Adherence to the intervention was monitored throughout the 12-week period. Attendance at supervised yoga sessions was recorded, while participation in walking and home-based exercises was documented using adherence records.

At the end of the 12-week intervention, the same outcome measurements were repeated in both groups using the same procedures and instruments applied at baseline.

Ethical considerations

The study received ethical approval from the Research Ethics Committee of Noor Huda Mustofa University (Approval No. 008/KEPK/UNIV-NHM/EC/XI/2024). Before enrollment, participants were informed about the study procedures, potential benefits, and possible risks. Written informed consent was obtained from all participants. Confidentiality of participant information and research data was maintained throughout the study.

Data analysis

Data were analyzed using IBM SPSS Statistics version 29. Descriptive statistics were used to present the participants' baseline characteristics. The Shapiro–Wilk test was used to assess the normality of continuous data.

Within-group and between-group comparisons were performed using parametric or nonparametric tests, depending on the distribution of the data. Changes in the outcome variables from baseline to post-intervention were assessed for each group, and differences between the intervention and control groups were subsequently compared. Effect sizes were expressed using Cohen's d where applicable. A p-value <0.05 was considered statistically significant.

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

RESULTS

Table 1 presents the baseline characteristics of the intervention and control groups (N = 58). The analysis showed no significant differences between the two groups in demographic, obstetric, or clinical characteristics prior to the intervention (all p > 0.05). Variables including age, parity, gestational age, body mass index (BMI), systolic blood pressure, diastolic blood pressure, and mean arterial pressure were comparable between groups. In addition, obstetric history variables such as marital history, previous history of preeclampsia, family history of preeclampsia, and interpregnancy interval did not differ significantly. These findings indicate that the intervention and control groups were comparable at baseline.

Table 1. Baseline and outcome comparisons by group (N = 58).

Characteristics	Group		*p-Value*
	Control	Intervention	
Age (year)[b] *	28 (17-45)	25 (17-48)	0.761
Parity[b] *	1 (1-6)	1 (1-7)	0.921
Gestational age (weeks)[b]*	15 (13-16)	15 (13-16)	0.554
BMI (Kg/m^2) [a]**	27.93 ± 4.53	28.43 ± 4,52	0.732
Sistole (mmHg) [b]*	120 (100-130)	115 (100-150)	0.942
Diastole (mmHg) [b]*	75 (60-80)	75 (60-100)	0.440
MAP (mmHg) [b]*	90.8 (73.30-114.20)	83.3 (73.30-107.50)	0.118
Married more than once (n) ***			
No	17 (69 %)	20 (58.6%)	0.160
Yes	12 (31 %)	9 (14.4%)	
History of preeclampsia (n) ***			
No	22 (75.9%)	24 (82.8%)	0.075
Yes	7 (25.1%)	5 (17.2%)	
History of preeclampsia in mother			
or sibling (n) ***	26 (89.7%)	21 (72.4%)	
No	3 (10.3%)	8 (27.6%)	0.176
Yes			
Multipara with a birth interval			
of more than 10 years (n) ***			
No	24 (82.8%)	22 (75.9%)	0.347
Yes	5 (17.2%)	7 (24.1%)	

[a]Data are presented as mean ± SD for normally distributed variables and [b] median (minimum–maximum) for non-normally distributed variables; * Mann–Whitney U test; ** independent t test; *** Chi-square test.

Table 2. Effects of the intervention on dependent variables: comparison between groups (N = 58)

Variable	Group	Pretest	Posttest	Delta post-pre	Between groups test	
					p-value 95% (CI)	Effect size 95% (CI)
Pregnancy-related stress	Control	23.34±3.58 24 (15-29)	25.68±2.22 26 (20-29)	2.34 ± 3.49	<0.001	1.16 (0.59–1.71)
	Paired sample test	p=0.001				
	Intervention	23.40±4.53 25 (13-30)	19.82±3.77 20 (14-27)	−3.58 ± 6.40		

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

	Paired sample test	p=0.005				
Cortisol	Control	12.55±1.85 12.41 (10.20-16.50)	13.88±1.69 13.5 (11.70-17.10)	1.33 ± 1.63	<0.001	1.02 (0.47–1.57)
	Wilcoxon signed-rank test	p=<0.001				
	Intervention	14.59±1.66 15.10 (11.70-17.10)	13.21±1.74 12.60 (10.10-17.60)	-1.38± 1.78		
	Wilcoxon signed-rank test	p=<0.001				
Systole	Control	115.17±8.91 120 (100-130)	122.93±10.57 120 (110-140)	7.41 ± 9.97	<0.001	1.36 (0.79–1.94)
	Wilcoxon signed-rank test	p=<0.001				
	Intervention	115.34±8.23 115 (100-130)	113±6.56 110 (105-130)	−1.89 ± 5.24		
	Wilcoxon signed-rank test	p=0.018				
Diastole	Control	73.10±6.46 75 (60-80)	79.48±6.59 80 (70-90)	6.37 ± 5.32	<0.001	1.25 (0.68–1.81)
	Wilcoxon signed-rank test	p=<0.001				
	Intervention	75.86±9.54 75 (60-100)	70.17±4.72 70 (60-80)	−5.68 ± 7.28		
	Wilcoxon signed-rank test	p=<0.001				
MAP	Control	88.58±7.94 90.80 (73.30-114.20)	90.54±7.04 92.50 (73.33-98.33)	1.96 ± 8.68	0.014	0.66 (0.12–1.19)
	Wilcoxon signed-rank test	p=0.047				
	Intervention	86.43±8.35 83.30 (73.30-107.50)	81.40±5.85 80.83 (73.30-93.33)	−5.03± 7.43		
	Wilcoxon signed-rank test	p=0.003				

As shown in Table 2, the intervention produced superior effects compared with the control condition, resulting in significant reductions in psychological stress, cortisol levels, and cardiovascular indicators. The magnitude of these changes was substantial, highlighting the effectiveness of the intervention.

https://doi.org/10.34011/juriskesbdg.v18i2.3254

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e-ISSN: 2579-8103
p-ISSN:1979-8253

Based on Cohen's effect size interpretation, the intervention showed a large effect on pregnancy stress , cortisol levels , systolic blood pressure, and diastolic blood pressure (1.25). A medium effect was observed for mean arterial pressure (MAP).

DISCUSSION

This study showed that among pregnant women at high risk of preeclampsia, the combined walking and prenatal yoga intervention significantly decreased cortisol levels, systolic and diastolic blood pressure, MAP, and pregnancy stress. The intervention may offer clinically significant benefits in enhancing maternal physiological adaptability during pregnancy, according to the large effect sizes seen in stress control and blood pressure outcomes.

The reduction in perceived pregnancy-related stress aligns with existing evidence that prenatal yoga can lower psychological distress and enhance emotional well-being in pregnant women. Systematic reviews have reported that pregnancy yoga significantly reduces symptoms of stress, anxiety, and depression, and improves mental resilience when compared to routine care or no intervention. [15,16] Moreover, randomized controlled trials document immediate and sustained reductions in salivary cortisol levels following prenatal yoga sessions, supporting the role of yoga in modulating the biological stress response. [17–19]

Cortisol functions as a primary stress hormone reflecting activation of the hypothalamic–pituitary–adrenal (HPA) axis, and chronically elevated levels during pregnancy have been linked to adverse maternal and fetal outcomes. Thus, the observed decline in cortisol suggests that the combined intervention facilitates adaptive neuroendocrine regulation. [20] Prenatal yoga has been shown to decrease HPA axis reactivity and enhance parasympathetic activity, further supporting its use as a non-pharmacological method for stress reduction. [21]

Physical activity, including walking and structured prenatal exercise, has been associated with improved cardiovascular adaptation and maintenance of blood pressure within safe limits during pregnancy. [22] Aerobic activity such as walking enhances vascular endothelial function and peripheral blood flow, which may contribute to better regulation of systemic blood pressure in pregnant women. [23] Yoga practice complements aerobic exercise by promoting autonomic balance, reducing sympathetic overdrive, and fostering relaxation, which collectively support blood pressure control. [24]

Several systematic reviews and meta-analyses indicate that pregnancy yoga interventions result in significant reductions in perceived stress and may support mental health in pregnant populations, although evidence for long-term cortisol reduction is mixed.[15] Furthermore, broader research on physical activity during pregnancy suggests that regular moderate exercise is linked to lower risk of hypertensive disorders and a positive effect on both systolic and diastolic blood pressure [25].

The observed hemodynamic benefits in this study likely arise through a combination of enhanced cardiorespiratory fitness from walking and improved autonomic regulation from yoga. Regular aerobic exercise improves vascular health and may reduce peripheral vascular resistance, while yoga fosters parasympathetic dominance, collectively contributing to blood pressure stabilization.[22] These mechanisms highlight how combined physical and mind–body practices can impact underlying physiological systems relevant to preeclampsia risk.

The study's findings also underscore the interconnected nature of psychological stress, neuroendocrine regulation, and cardiovascular function in pregnancy a relationship supported by the broader literature on physical activity, stress biomarkers, and maternal outcomes.[26,27] Consequently, interventions that target both psychological

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

and physiological domains may offer more comprehensive benefits than those focusing solely on either domain.

From a clinical perspective, these findings highlight the potential role of combined walking and prenatal yoga programs as a practical and low-cost intervention that can be incorporated into routine antenatal care. Integrating structured physical activity and mind–body exercises may help improve both psychological well-being and cardiovascular stability in pregnant women, particularly those at increased risk for hypertensive disorders. Such lifestyle-based interventions may complement conventional medical monitoring and contribute to more holistic maternal care.

This study offers several strengths. First, it evaluates a combined intervention consisting of walking and prenatal yoga, integrating aerobic physical activity with mind–body practices, which has been less frequently explored in previous research. Second, the study simultaneously assessed psychological stress, neuroendocrine response (cortisol), and hemodynamic parameters, providing a more comprehensive understanding of the interaction between psychological and physiological pathways in pregnant women at risk of preeclampsia. These multidimensional measurements allow a broader interpretation of how lifestyle-based interventions may influence maternal health.

Due to its quasi-experimental approach, this study has a number of drawbacks. Because the participants were not assigned at random, selection bias and residual confounding may be more likely. In order to improve group comparability, matching procedures were carried out based on maternal characteristics and preeclampsia risk factors; however, the results may still have been impacted by uncontrolled confounding variables like medication intake, dietary patterns, regular daily physical activity, and sleep at night. Additionally, it was not possible to properly evaluate participant adherence to at-home walking and relaxation routines, which could introduce performance bias. The results of the intervention may possibly have been impacted by variations in adherence to the exercise program.

To reduce potential bias and enhance intervention consistency, however, a systematic intervention methodology, baseline data matching, supervised prenatal yoga sessions led by a qualified instructor, and repeated screening were used. To strengthen the evidence base and elucidate the precise contributions of walking and prenatal yoga components to stress regulation, cortisol reduction, and blood pressure control among pregnant women at high risk of preeclampsia, carefully planned randomized controlled trials, and standardized intervention protocols is advised.

CONCLUSION

Walking and prenatal yoga together seem to improve hemodynamic stability, lower pregnancy-related stress, and regulate cortisol levels in women who are at high risk for preeclampsia. These results imply that integrative exercise regimens could help lower the physiological and psychological risk factors linked to preeclampsia and could be a practical, low-risk non-pharmacological strategy to promote the physical and mental well-being of expectant mothers. It is advised that future research using randomized controlled designs validate these results and provide additional insight into the precise roles played by each intervention component.

ACKNOWLEDGEMENT

This study was supported by Universitas Noor Huda Mustofa, which provided the necessary facilities and resources for the completion of this research.

https://doi.org/10.34011/juriskesbdg.v18i2.3254

Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

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Vol 18 No 2, Oktober 2026
e-ISSN: 2579-8103
p-ISSN:1979-8253

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