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Using the Strava application for walking physical activities to control the risk of pre-eclampsia

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ABSTRACT

Background: Pre-eclampsia affects approximately 2–10% of pregnancies worldwide and remains a leading cause of maternal morbidity and mortality. Its occurrence is strongly associated with pregnancy-related risk factors, including elevated blood pressure and excessive maternal weight. This study aimed to evaluate the effectiveness of walking activity, monitored using the Strava application, in controlling blood pressure and reducing the risk of pre-eclampsia among women in their second and third trimesters of pregnancy.

Methods: This study employed a quasi-experimental design with a pretest–posttest control group. Thirty pregnant women in their second and third trimesters who were at risk of pre-eclampsia due to elevated blood pressure were purposively recruited, with 15 participants assigned to the intervention group and 15 to the control group. Data collection, conducted between April and May 2024 in Jagakarsa District, South Jakarta, utilized a demographic questionnaire, a blood pressure monitoring sheet, and the Strava application to track physical activity. Blood pressure outcomes were analyzed using paired and independent t-tests.

Results: The data followed a normal distribution ($p > 0.05$). The participants had a mean age of 30.6 years (SD = 5.87), with 46.7% primiparous, 53.3% multiparous, 90% overweight, and 10% normal body weight. Before the intervention, 80% of participants exhibited insufficient physical activity. After the walking intervention monitored via Strava, significant reductions were observed in the intervention group's systolic blood pressure (from 143.3 to 130.9 mmHg) and diastolic blood pressure (from 92.9 to 86.7 mmHg) ($p < 0.05$), with mean decreases of 12.4 mmHg and 6.1 mmHg, respectively. By contrast, no significant changes were observed in the control group. Subgroup analysis confirmed significant reductions in blood pressure across confounding factors, including age, parity, and body weight status.

Conclusion: Regular walking activity, monitored using the Strava application, was effective in reducing blood pressure and mitigating the risk of pre-eclampsia among women in their second and third trimesters of pregnancy. Incorporating structured physical activity programs during pregnancy, in conjunction with the management of maternal age, parity, and weight, may contribute to the prevention of pre-eclampsia.

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INTRODUCTION

Maternal health encompasses the period before pregnancy, during pregnancy, at childbirth, and throughout the postpartum phase. The health and well-being of women, particularly mothers, are essential for achieving the sustainable development goals (SDGs). One of the targets of SDG 3.1 is to reduce the global maternal mortality ratio to fewer than 70 deaths per 100.000 live births by 2030.[1] In 2020, an estimated 287.000 maternal deaths occurred worldwide during pregnancy and childbirth.[2] The highest number of maternal deaths was recorded in Africa (approximately 207.490), followed by Southeast Asia (around 39.209), the Eastern Mediterranean (about 33.633), the Americas (around 9.360), and the Western Pacific (around 8.462).[2] In contrast, Europe reported the lowest prevalence, with approximately 1.372 maternal deaths.[2] In Indonesia, the maternal mortality rate was estimated at 7.826 deaths in 2020.[1,2]

The incidence of pre-eclampsia ranges from 2% to 10% of all pregnancies worldwide.[3] In developing countries, the prevalence is estimated at 1.8–16.7%, whereas in developed countries it is around 0.4%.[3] Complications that contribute to maternal mortality can occur before pregnancy and worsen during pregnancy if not adequately managed. Approximately 75% of maternal deaths are associated with postpartum hemorrhage, postpartum infection, pregnancy-induced hypertension, pre-eclampsia and eclampsia, complications during labor, and unsafe abortion.[1-3]

One preventive effort against pre-eclampsia is engaging in regular physical activity. Physical activity helps burn calories and fat, thereby reducing fat mass and preventing fat accumulation.[4] It is defined as any bodily movement produced

by skeletal muscles that requires energy expenditure.[5] Physical activity is not limited to sports but also includes leisure-time activities such as walking, cycling, playing, and recreational activities.[5] Regular physical activity is known to prevent and control non-communicable diseases such as cardiovascular disease, hypertension, diabetes, stroke, and certain types of cancer. In addition, it supports weight management, improves mental health, and enhances overall quality of life.[5]

Physical activity carried out during pregnancy can reduce major pregnancy complications such as pre-eclampsia and gestational diabetes.[6] Pregnant women are advised to avoid high-risk activities such as horse riding, sea diving, and sports at heights.[6] Physical activities that are safe and suitable for pregnant women are walking, swimming, stationary cycling, and yoga.[7]

During pregnancy, physical activity has been shown to reduce major complications such as pre-eclampsia and gestational diabetes.[6] However, pregnant women are advised to avoid high-risk activities, including horseback riding, scuba diving, and sports with a high risk of falls.[6] Safer alternatives include walking, swimming, stationary cycling, and prenatal yoga.[7] Morning physical activity is particularly beneficial, as it may enhance productivity, lower blood pressure, improve sleep quality, and increase metabolism throughout the day.[8] For instance, a 30-minute moderate-paced walk can cover a distance of 2.0–2.5 km and burn approximately 125 calories.[9] Pregnant women are also advised to consume small, easily digestible meals 30–60 minutes before exercise.[9]

Recent evidence demonstrates a strong association between regular physical activity and a reduced risk of pre-eclampsia. Meta-analyses have shown that moderate-intensity exercise during pregnancy, including walking, significantly lowers the incidence of gestational hypertension and pre-eclampsia by improving vascular function, reducing oxidative stress, and enhancing endothelial nitric oxide bioavailability.[6,10]

Walking is particularly emphasized because of its accessibility, safety, and low impact. Unlike more strenuous forms of exercise, walking is feasible across all trimesters and carries minimal risk of injury or uterine trauma, making it suitable for women with diverse fitness levels.[11] The proposed mechanisms by which walking reduces pre-eclampsia risk include improved endothelial function, reduced systemic vascular resistance, and enhanced placental perfusion, all of which mitigate the hypertensive responses characteristic of pre-eclampsia.[12] Walking also contributes to weight management and improved insulin sensitivity, both of which play an important role in reducing the risk of pre-eclampsia. Furthermore, evidence from recent studies suggests that walking interventions may be as effective as structured aerobic exercise programs in lowering blood pressure during pregnancy, while offering higher adherence rates, thereby making them more feasible within routine antenatal care.[9,13]

Based on this background, the present study aimed to analyze the effectiveness of walking activity monitored using the Strava application in controlling blood pressure and reducing the risk of pre-eclampsia among pregnant women in their second and third trimesters.

METHODS

This study employed a quasi-experimental design with a pretest–posttest control group. The study population consisted of pregnant women in their second and third trimesters who were at risk of developing pre-eclampsia. A total of 30 participants were recruited through purposive sampling, with 15 assigned to the intervention group and 15 to the control group. The inclusion criteria were second- and third-trimester pregnant women with high blood pressure. The study was conducted between April and May 2024 in the Jagakarsa and Pasar Minggu districts of South Jakarta. Data were collected using a demographic questionnaire and an observation sheet.

Physical activity was objectively measured and monitored using the Strava application, which was installed on each participant's smartphone prior to the intervention. Participants were trained on how to operate the application, including starting, pausing, and ending sessions. A study-specific Strava group was created to automatically record walking data in real time, enabling the research team to track adherence and compliance. Walking sessions were standardized to 150 minutes per week of moderate-intensity walking (approximately 30 minutes per session, five days per week), consistent with the guidelines of the world health organization (WHO) and the american college of obstetricians and gynecologists (ACOG). Strava's GPS-based tracking recorded walking time, distance, average pace, and route. Adherence was reviewed weekly, and participants meeting ≥150 minutes of walking per week were classified as adherent. To enhance compliance, weekly reminders were sent via WhatsApp, and participants who failed to meet their weekly targets received follow-up phone calls for counseling and encouragement. Bi-weekly antenatal visits were conducted to review progress, address technical issues with Strava, and reinforce education on proper app usage.

Walking data were extracted weekly from Strava in CSV format, including duration, distance, and speed. These data were cross-verified with manual logs maintained by participants to ensure accuracy. For validation, a subset of participants (n = 5) underwent pedometer cross-checks, which showed >95% concordance with Strava records. Missing data due to technical issues (e.g., GPS errors) were addressed by requesting screenshots or manual logs. If these were unavailable, the sessions were excluded using listwise deletion.

This structured monitoring system combining automated app-based tracking, regular reminders, and direct supervision ensured the accuracy, completeness, and standardization of physical activity data across all participants. To further ensure validity, participants' GPS-enabled routes were verified against known local walking paths. Strava's automated distance and pace calculations were also cross-validated against pedometer readings in a subset of participants (n = 5), yielding >95% concordance.

Data were analyzed using SPSS version 22. Statistical analysis included normality testing, frequency distribution, mean difference testing, paired t-tests, and independent t-tests.

RESULTS

Throughout the study period, no adverse events, including falls, injuries, or obstetric complications related to walking activity, were reported in either group. All participants tolerated the intervention well, and no cases of preterm labor or pregnancy-related complications attributable to the intervention were observed. Study retention was excellent, with no dropouts during the intervention or follow-up phases; all 30 participants (15 in the intervention group and 15 in the control group) completed the study as planned. Consequently, a per-protocol analysis was conducted, and no imputation for missing data was required.

The normality test using the Shapiro–Wilk method indicated that the data were normally distributed (p > 0.05). As shown in Table 1, the majority of respondents (76.7%) were aged 20–35 years, while 23.3% were >35 years. In terms of parity, 46.7% were primiparous and 53.3% multiparous. Regarding nutritional status, 90% of participants were classified as overweight, and 10% had normal body weight.

As presented in Table 2, prior to the intervention, 80% of respondents reported insufficient walking activity, while only 20% reported adequate walking activity.

The effect of walking activity monitored using the Strava application on blood pressure is summarized in Table 3. In the intervention group, mean systolic blood pressure decreased significantly from 143.3 mmHg to 130.9 mmHg (mean difference: 12.4 mmHg; 95% CI: 6.3–18.5; $p = 0.001$), and mean diastolic blood pressure decreased from 92.9 mmHg to 86.7 mmHg (mean difference: 6.1 mmHg; 95% CI: 0.8–11.5; $p = 0.028$). By contrast, no significant changes were observed in the control group for either systolic or diastolic blood pressure ($p > 0.05$).

The comparison of walking activity levels with blood pressure control is presented in Table 4, which shows no significant difference in systolic or diastolic blood pressure between participants categorized as having insufficient and sufficient walking activity ($p > 0.05$).

Subgroup analyses based on confounding factors are detailed in Table 5. Among participants aged 20–35 years, systolic blood pressure decreased by 10.3 mmHg (95% CI: 1.1–19.6; $p = 0.033$), while diastolic blood pressure decreased by 10.4 mmHg (95% CI: 4.7–16.2; $p = 0.003$). For those aged >35 years, systolic blood pressure decreased by 15.5 mmHg (95% CI: 5.6–25.4; $p = 0.010$), whereas diastolic blood pressure did not change significantly. Based on parity, multiparous women experienced a significant reduction in systolic blood pressure (mean difference: 16.7 mmHg; 95% CI: 10.2–23.2; $p < 0.001$), while primiparous women showed a significant reduction in diastolic blood pressure (mean difference: 9.6 mmHg; 95% CI: 2.6–16.6; $p = 0.019$). Regarding maternal weight status, women with normal weight experienced the greatest reduction in systolic blood pressure (mean difference: 21.0 mmHg; 95% CI: 0.7–41.3; $p = 0.047$), where as overweight women showed reductions in both systolic blood pressure (mean difference: 10.3 mmHg; 95% CI: 3.4–17.1;

Table 1. Characteristics of 15 pregnant women in both intervention and control groups

Characteristics	Intervention		Control		Total	
	n	%	n	%	n	%
Age						
20-35 years	9	60.0	14	93.3	23	76.7
> 35 years	6	40.0	1	6.7	7	23.3
Parity						
Primipara	5	33.3	9	60.0	14	46.7
Multipara	10	66.7	6	40.0	16	53.3
Weight of pregnant women						
Normal	3	20.0	0	0.0	3	10.0
Overweight	12	80.0	15	100.0	27	90.0

Table 2. Walking activity levels among pregnant women in the intervention group were measured with the Strava application

Walking activity levels	N	%
Less	12	80.0
Enough	3	20.0

N, frequency

Table 3. The effect of physical activity walking with the Strava application on the blood pressure of pregnant women who are at risk of developing pre-eclampsia

Variable	Mean ± SD	Mean difference (CI 95%)	*p*-value
Intervention group			
SBP pre	143.3±12.0	12.4 (6.3-18.5)	0.001
SBP post	130.9±8.1		
DBP pre	92.9±9.6	6.1 (0.8-11.5)	0.028
DBP post	86.7±7.4		
Control group			
SBP pre	147.5±11.3	1.9 (-5.6-9.3)	0.598
SBP post	145.6±13.9		
DBP pre	96.7±7.9	4.1 (-1.0- 9.1)	0.106
DBP post	92.6±6.8		

CI, confidence interval; DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 4. The effect of walking activities with Strava on controlling the risk of pre-eclampsia

Walking activities	Mean difference (CI 95%)			
	SBP post-test	*p*-value	DBP post-test	*p*-value
Less	131.0	0.953	87.7	0.073
Enough	130.7		83.0	

CI, confidence interval; DBP: diastolic blood pressure; SBP: systolic blood pressure

Table 5. The effect of physical activity walking with Strava on the blood pressure of pregnant women at risk of pre-eclampsia based on age, parity and weight of pregnant women factors

Variable	Mean ± SD	Mean difference (CI 95%)	*p*-value
Age			
20-35 years			
SBP pre	140.1 ± 14.2	10.3 (1.1-19.6)	0.033
SBP post	129.8 ± 9.7		
DBP pre	95.4 ± 9.7	10.4 (4.7-16.2)	0.003
DBP post	85.0 ± 7.0		
> 35 years			
SBP pre	148.2 ± 5.8	15.5 (5.6-25.4)	0.010
SBP post	132.7 ± 5.6		
DBP pre	89.0 ± 8.8	-0.3 (-1.3-9.6)	0.935
DBP post	89.3 ± 7.7		
Parity			
Primipara			
SBP pre	133.2 ± 8.9	3.8 (-8.6-16.2)	0.443
SBP post	129.4 ± 7.1		
DBP pre	92.4 ± 5.8	9.6 (2.6-16.6)	0.019
DBP post	82.8 ± 8.5		
Multipara			
SBP pre	148.4 ± 10.2	16.7 (10.2-23.2)	0.000
SBP post	131.7 ± 8.9		
DBP pre	93.1 ± 11.3	4.4 (-3.5-12.3)	0.240
DBP post	88.7 ± 6.2		
Weight of pregnant women			
Normal			
SBP pre	148.3 ± 10.8	21.0 (0.7-41.3)	0.047
SBP post	127.3 ± 8.4		
DBP pre	90.7 ± 4.5	-0.3 (-29.1-28.5)	0.965
DBP post	91.0 ± 9.8		
Overweight			
SBP pre	142.1 ± 12.4	10.3 (3.4-17.1)	0.007
SBP post	131.8 ± 8.2		
DBP pre	93.1 ± 11.3	4.4 (-3.5-12.3)	0.240
DBP post	88.7 ± 6.2		

CI, confidence interval; DBP: diastolic blood pressure; SBP: systolic blood pressure.

p = 0.007) and diastolic blood pressure (mean difference: 4.4 mmHg; 95% CI: -3.52-12.32; p = 0.240).

DISCUSSION

During the intervention, several participants reported challenges in maintaining regular walking activity. The most commonly cited barriers included time constraints due to household responsibilities and childcare, fatigue associated with pregnancy, limited safe walking spaces in their neighborhood, and weather-related issues (e.g., heavy rain or extreme heat). In addition, a few participants noted a lack of social support from family members, which occasionally reduced their motivation to engage in scheduled walking sessions.

The physical activity of walking with Strava in controlling the risk of pre-eclampsia in pregnant women in the first trimester showed a significant effect. However, this was not the case for pregnant women who were at risk of experiencing pre-eclampsia in the control group. Physical activity has both immediate and long-term effects on blood pressure. As a direct effect, physical activity causes a temporary increase in blood pressure to meet higher oxygen needs. Meanwhile, the long-term effects of regular physical activity cause a decrease in resting blood pressure through various physiological adaptations.

Regular physical activity can provide changes to the heart, such as increasing the strength of the heart muscle, making the heartbeat strong and regular, thereby increasing blood vessel capacity due to relaxation and vasodilation.[14] Physical activity carried out for 16–60 minutes, 3–5 times per week, can improve cardiovascular function. The duration of physical activity depends on the intensity of the activity. Light physical activity done regularly can improve health. Walking is a type of light physical activity that can help reduce the risk and prevent the incidence of cardiovascular disease.[15] The Strava application is a platform that can be used to measure and record a person's physical activity.[16]

The goal of physical activity is to improve or maintain physical fitness. Choosing the right type of exercise and physical activity helps reduce the risk of gestational hypertension disorders.[10] Regular physical activity during pregnancy can increase placental blood flow, which is associated with increased fetal-placental oxygen transport. Regular physical activity can also provide important benefits for pregnant women, such as improving cardiovascular function, controlling excessive weight gain during pregnancy, and reducing the risk of complications associated with hypertension.[12]

When using antihypertensive drugs, physical activity should be controlled to assess their effectiveness. However, several factors can lower blood pressure, such as pregnant women who regularly take antihypertensive drugs or receive support from family and health workers. Antihypertensive drugs are used by pregnant women with a history of chronic hypertension before and during pregnancy to prevent complications in the mother and fetus.[17] Family support helps in controlling diet and complying with medication. In addition, with family support, a healthy lifestyle can be better maintained and implemented.[18] Apart from family support, support from health workers also greatly influences the health of pregnant women. More frequent interactions with healthcare providers, including routine blood pressure monitoring and personalized guidance,

contribute to better management of hypertension during pregnancy, labor, and the postpartum period.[19]

Research shows that most pregnant women who are at risk of experiencing pre-eclampsia, characterized by high blood pressure, are aged 20–35 years. According to previous studies, pregnant women aged 20–35 years can experience hypertension due to physiological and lifestyle factors.[20] Unhealthy lifestyle factors cause pregnant women to exercise less and increase stress, thereby worsening the risk of hypertension. An unhealthy lifestyle causes increased blood pressure in young women.

Other information by Nurfatimah et al. stated that a good and safe reproductive age is between 20 and 35 years. Pregnant women under the age of 20 generally have biologically immature reproductive organs and may not be emotionally ready to face pregnancy.[21] On the other hand, pregnant women over 35 years of age often experience a decrease in body function due to degenerative processes that affect peripheral blood vessels. The risk of pre-eclampsia in pregnant women is associated with hypertension and increases after the age of 35 years. At this age, tissue and organ changes occur, making them less flexible due to aging. Hypertension in pregnancy is known to be associated with increasing maternal age. This is related to high levels of oxidative stress and low levels of nitric oxide associated with aging, which adversely affect endothelial relaxation.[22]

According to Gebregziabher et al., age can be a factor that influences the level of physical activity in pregnant women.[23] Research shows that pregnant women aged <19 years and >35 years are less active in physical activity during pregnancy than pregnant women aged 25–29 years. Generally, younger pregnant women (<30 years) have a higher fitness level and can perform various types of physical activity safely.[23]

Thus, regarding the parity factor, pregnant women who are most at risk of experiencing pre-eclampsia based on high blood pressure are multiparous. According to Nurfatimah et al., hypertension in pregnancy is more common in multiparous mothers.[21] Giving birth repeatedly can increase the risk in subsequent pregnancies. Having more than four pregnancies can increase pregnancy complications, one of which is hypertension. With each pregnancy, the uterus stretches, and if pregnancies continue, it causes the uterus to weaken, resulting in complications during pregnancy, childbirth, and even after delivery. Meanwhile, first-time pregnant women have a higher risk of experiencing hypertension because they are more likely to feel anxious during pregnancy. Research by Yurianti et al. also found that primiparous pregnant women are more susceptible to hypertension.[14] This is because primiparous pregnant women often experience stress when facing childbirth. Emotional stress in primiparous women results in increased release of corticotropin-releasing hormone (CRH) by the hypothalamus, which then triggers an increase in cortisol. The role of cortisol is to prepare the body to respond to stress by increasing the sympathetic response, including increased cardiac output and blood pressure.

According to Gebregziabher et al., parity can also influence the level of physical activity in pregnant women.[23] Primiparous mothers are more likely to be less active during pregnancy compared to multiparous mothers. This is because caring for a higher number of children requires a higher level of activity. The results of this study also showed that most pregnant women at risk of developing pre-eclampsia, characterized by high blood pressure, were overweight. Research shows that obesity and high BMI during pregnancy are risk factors for gestational hypertension.[24] Excess weight increases heart rate, and as body mass increases, more blood is needed to circulate oxygen and nutrients to body tissues. This results in increased blood volume, thereby raising pressure on the artery walls.[20]

According to Syed Nor et al., a higher BMI is associated with lower levels of physical activity in pregnant women.[25] Pregnant women with a high BMI often have difficulty remaining physically active due to physical limitations, fatigue, and discomfort. Obesity can also reduce pregnant women's motivation to exercise.

This study has several limitations that should be acknowledged. First, the relatively small sample size (n = 30) limits the statistical power and generalizability of the findings, and larger randomized trials are needed to validate these results. Second, although participants were matched by gestational age and baseline blood pressure, unmeasured confounders such as dietary intake (e.g., sodium consumption), adherence to antihypertensive medications, and psychosocial stress levels may have influenced blood pressure outcomes. These factors were not systematically assessed in this study and could partially account for the observed reductions in blood pressure.

Additionally, physical activity was monitored primarily through Strava, which, although validated, may still be susceptible to technical errors or participant misreporting, particularly for sessions conducted indoors where GPS accuracy is reduced. Moreover, the study was conducted in a single-district setting, which may limit the applicability of the results to other populations with different socio-environmental conditions.

CONCLUSION

Based on the research results that regular physical activity helps control the risk of pre-eclampsia by reducing blood pressure, while also considering maternal age, weight, and parity during pregnancy. Therefore, pregnant women in the second and third trimesters may reduce their risk of developing pre-eclampsia through regular walking activity.

Future studies should incorporate detailed dietary assessments, medication adherence tracking, and standardized psychosocial evaluations to better account for these potential confounders. Combining objective physical activity monitoring with such comprehensive covariate data will allow for more robust conclusions regarding the independent effect of walking on pre-eclampsia risk reduction.

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ETHICS CONSIDERATION

This research has been approved by the Ethical Clearance Committee of the Tanjung Karang Health Polytechnic with No. No.227/KEPK-TJK/II/2024. Before data is collected. This research has paid attention to research ethics, where there is informed consent for participants.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this study.

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AUTHOR CONTRIBUTIONS

SM contributed to the conceptualization, methodology, and data collection. TRL contributed to supervision, project administration, and manuscript writing. OTH contributed to data analysis and review of the manuscript. All authors read and approved the final manuscript.

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