Original Article

Health Belief Model Analysis on the Relationship Between Ergonomic Behavioral Awareness and Low Back Pain in Pregnant Women: A Cross-Sectional Mediation Study

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ABSTRACT

Background: Low back pain is a common health complaint experienced by pregnant women, both nationally and regionally. Its high prevalence highlights the need for attention to preventive strategies during pregnancy. This study aims to analyze the role of the Health Belief Model (HBM) in mediating the relationship between ergonomic behavioral awareness and the incidence of low back pain in pregnant women.

Methods: A quantitative, cross-sectional survey was conducted among 140 pregnant women in their second or third trimester who reported low back pain. Data were collected using structured questionnaires and analyzed using Structural Equation Modeling (SEM) based on Smart PLS. This study was reported following the STROBE guidelines for cross-sectional studies.

Results: Ergonomic behavioral awareness had a strong negative effect on the incidence of low back pain ($\beta = -0.715$; $p < 0.001$), and a positive impact on the Health Belief Model ($\beta = 0.801$; $p < 0.001$). The Health Belief Model also had a statistically supported negative effect on low back pain ($\beta = -0.264$; $p < 0.001$). Furthermore, a significant indirect effect was observed between ergonomic awareness and back pain through the Health Belief Model as a mediating variable ($\beta = -0.211$; $p < 0.001$).

Conclusion: Ergonomic awareness plays a crucial role in reducing low back pain in pregnant women, both directly and indirectly through improved health beliefs. Strengthening HBM components may enhance ergonomic practices, which could be integrated into routine pregnancy education and health promotion efforts.

***Keywords*:** Health Belief Model; Ergonomic Behavioral Awareness; incidence of low back pain; Pregnant Women.

Implications for Practice:

- Increasing awareness of ergonomic behavior among pregnant women can serve as a preventive strategy to reduce lower back pain during pregnancy.
- Health education programs for expectant mothers should integrate Health Belief Model (HBM) components to enhance their perception of susceptibility and benefits, and reduce perceived barriers to adopting ergonomic practices.
- Antenatal care providers should include ergonomic counseling and simple posture correction exercises as part of routine maternal health services.
- Training midwives and health workers to deliver ergonomics-based interventions grounded in HBM can improve maternal comfort and prevent musculoskeletal complications.

Introduction

Pregnancy is a crucial phase in a woman's life marked by various physiological, hormonal, and psychological changes (Pritschet et al., 2024; Wieczorek et al., 2023). These adaptations often bring discomfort, particularly in different trimesters. Common complaints include morning sickness, constipation, varicose veins, hemorrhoids, lower urinary tract symptoms, lower extremity swelling, and notably, low back pain (Alfiyani et al., 2024; Putri et al., 2020).

Low back pain (LBP), specifically lumbosacral pain, is one of the most prevalent physical complaints during pregnancy (Prananingrum, 2022; Purnawinadi & Sitanggang, 2022). As pregnancy progresses, the enlarging uterus and shifting center of gravity alter posture and contribute to increased mechanical stress on the spine. These discomforts are often intensified by daily activities such as frequent bending, prolonged walking, or lifting heavy objects, especially when the mother is fatigued (Yolandini et al., 2024; Zein & Dwiyani, 2022).

Research shows that LBP negatively impacts pregnant women's daily functioning, affecting basic tasks such as walking, sitting, sleeping, sexual activity, and self-care (Arummega et al., 2022). In literature, Colla et al. (2017) note that LBP affects up to 50% of pregnancies, significantly impairing quality of life. Additional studies indicate even higher rates, with 70% of pregnant women experiencing pain severe enough to limit daily activity. Research from Citko et al. (2018) and Salari et al. (2023) reveals that around 70% of expectant mothers suffer from back discomfort, which is so severe that it forces them to rest and hinders their ability to carry out everyday tasks. Pain intensity tends to peak in the third trimester. For instance, at 20 and 32 weeks of gestation, LBP was experienced by 76% and 90% of women, respectively, with increasing proportions reporting moderate to severe pain as pregnancy advances (Ariani et al., 2024; Backhausen et al., 2019).

Regionally, data underscores the same trend. In rural Jigawa State, Nigeria, 44.9% of pregnant women experiencing LBP lacked ergonomic practice (Muhammad et al., 2022). In Indonesia, national data from 2023 reported 6,439 pregnant women, 68% of whom experienced LBP (Alvionita et al., 2024). In Central Java alone, 314,492 pregnant women experienced back pain in 2015 (Suryanti et al., 2021). These figures reflect a substantial burden, making LBP during pregnancy not just a common discomfort but a serious public health issue.

The phenomenon of high cases of back pain is closely related to the low awareness of pregnant women of the importance of applying ergonomic behaviors in daily activities. Ergonomic behavior in pregnant women is a series of physical actions or habits that are carried out consciously to maintain correct posture, prevent injury, and reduce muscle and joint tension during pregnancy. This behavior aims to adapt daily activities to the physiological changes that occur during pregnancy, especially in terms of weight distribution, changes in the center of gravity, and increased pressure on the spine and joints.

However, many pregnant women do not understand that incorrect posture, improper sitting and standing, and physical activity that is not adapted to the conditions of pregnancy can worsen back pain complaints. This lack of knowledge and understanding causes pregnant women to tend to overlook the importance of ergonomic behaviors in their daily lives. Anatomical and physiological changes during pregnancy, such as abdominal enlargement and shifting of the center of gravity, demand adjustments to physical activity so as not to put excessive pressure on the lower back. Without proper ergonomic behavior, the risk of back pain not only increases, but can also interfere

with daily activities, sleep quality, and even impact childbirth preparation.

Several studies highlight the role of poor ergonomics in the onset of LBP during pregnancy (Bryndal et al., 2020; Y. Fransiska & Suryani, 2024; Rahayu et al., 2020). However, bridging the gap between knowledge and practice requires more than just information dissemination; it requires a behavior change approach grounded in psychological Theory.

This is where the Health Belief Model (HBM) becomes relevant. HBM is a psychological framework used to understand and predict health behaviors by focusing on individuals' perceptions and beliefs (Herlina et al., 2021; Suryani & Purwodiharjo, 2020). According to HBM, a person's opinions about an illness and the methods they can use to lessen its incidence influence their health-related actions. In particular, this model posits that an individual's beliefs and perceptions impact their health behaviors. This means that when people believe they are at risk of contracting a disease, they will take the appropriate steps to prevent it, provided they are reminded of the behavior and anticipate positive health outcomes (Dewi et al., 2019). It posits that behavior change is influenced by perceived susceptibility to a health condition, perceived severity, perceived benefits of taking action, perceived barriers, cues to action, and self-efficacy (Berhimpong et al., 2020; Melati et al., 2024).

HBM has been proven effective in changing health behaviors, including among pregnant women (Haryanti et al., 2024). By applying HBM, researchers can assess how pregnant women perceive the risk of LBP and their motivation to adopt ergonomic practices. If HBM influences ergonomic awareness, it may serve as a mediating factor, connecting awareness and actual health outcomes, such as pain reduction.

Despite the clear importance of both ergonomic awareness and behavioral models like HBM, there is a limited understanding of how these factors interact, particularly whether HBM mediates the relationship between ergonomic awareness and LBP incidence. This forms a crucial gap in the literature, especially in the context of preventive maternal health care. Therefore, the formulation of the problem in this study is focused on: (1) Is there an effect of ergonomic behavioral awareness on the incidence of low back pain in pregnant women? (2) Is there an effect of ergonomic behavioral awareness on the implementation of the Health Belief Model in pregnant women? (3) Is there an effect of the Health Belief Model on the incidence of low back pain in pregnant women? and (4) Does the Health Belief Model mediate the relationship between ergonomic behavioral awareness and the incidence of low back pain in pregnant women?

Thus, it is important to conduct a study entitled "Health Belief Model Analysis on the Relationship Between Ergonomic Behavioral Awareness and Low Back Pain in Pregnant Women: A Cross-Sectional Mediation Study". This research is expected to contribute to promotive and preventive efforts, especially for health workers in providing education to pregnant women about the importance of implementing ergonomic behaviors and increasing health awareness through a psychological approach based on the HBM model.

Based on the explanation above, the framework of thought in this study can be described as presented in **Figure 1**.

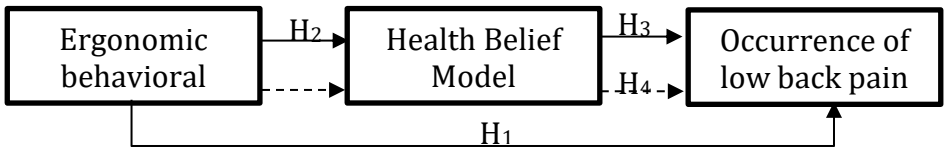

Figure 1. Frame of Mind Chart

Based on the chart above, several hypotheses can be proposed in this study. First, it is hypothesized that awareness of ergonomic behavior affects the incidence of low back pain in pregnant women (H1). Second, the Health Belief Model is believed to influence ergonomic behavioral awareness in pregnant women (H2). Third, the Health Belief Model is also hypothesized to have a direct effect on the incidence of low back pain in pregnant women (H3). Lastly, it is proposed that the Health Belief Model mediates the relationship between ergonomic behavioral awareness and the incidence of low back pain in pregnant women (H4).

Methods

Study Design

This type of research is quantitative with an associative descriptive approach. This study aims to determine the relationship and effect of ergonomic behavioral awareness on the incidence of low back pain in pregnant women with the Health Belief Model (HBM) as a mediating variable. A quantitative approach was chosen to measure the magnitude of the influence between variables statistically through structural model analysis.

Participants

The target population consists of pregnant women in their second and third trimesters, attending selected community health centers (Puskesmas) and maternity clinics in Karanganyar, Sukoharjo, and Boyolali districts, Central Java, Indonesia. The number of samples was determined using the minimum sample size approach for SEM-PLS, which is 10 times the number of variable indicators in the model (Hair et al., 2010). The total indicators of the three questionnaires in this study was 14. So the number of samples in this study (10 x 14 indicators) is 140 respondents. The sampling technique used is purposive sampling, which is with the following criteria, as pregnant women in the second or third trimester of the second or third trimester, experiencing complaints of low back pain, and willing to be respondents. Respondents with incomplete questionnaires were excluded from the analysis. Final data included 140 fully completed responses with no missing values due to real-time checking by research assistants during data collection (**Figure 2**).

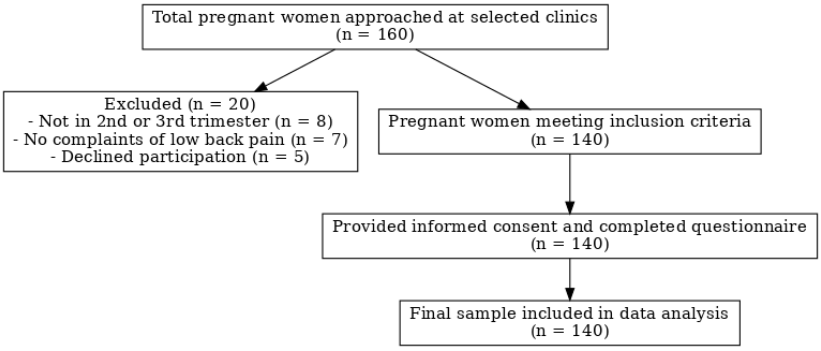

Figure 2. Diagram of respondent selection

Instruments

Each questionnaire used a 4-point Likert scale and has undergone prior psychometric validation. A summary of instruments, indicators, scoring categories, and sample items is provided below.

Ergonomic Behavioral Awareness

Measurement of ergonomic behavioral awareness includes working with neutral/non-awkward positions and postures, reducing excessive loads, reducing excessive repetitive movements, minimizing static positions, minimizing pressure at certain points, and stretching at work (Sartika et al., 2025). The scale used is 1-4 ("Never", "Infrequently", "Often", "Always"). The overall scoring results of the ergonomic behavioral awareness questionnaire question item, with a score range of 12-23, were mild, scores of 24-35 were moderate, and scores of 36-48 were high. To support clinical use, a simplified screening version of the ergonomic awareness tool can be created with brief, practical items using a yes/no or 4-point scale. This allows midwives to quickly assess risk during antenatal visits and offer targeted ergonomic advice based on the results.

Ergonomic Behavioral Awareness Questionnaire

1. I make sure my sitting position is upright and balanced when doing activities.
2. I keep my back straight when standing for long periods.
3. I avoid carrying heavy items during pregnancy.
4. I divide the load of the carry-on evenly between both hands.
5. I set a break time after performing repetitive movements such as sweeping or typing.
6. I limit repetitive activity so that muscle tension doesn't occur.
7. I avoid sitting or standing for too long in one position.
8. I change my body position periodically during activities.
9. I use a pillow or support to reduce the pressure on my back while sitting.
10. I avoid sitting in a hard chair without a comfortable base.
11. I routinely do light stretches to relax my muscles while working.
12. I take the time to walk or move lightly between activities.

Health Belief Model (HBM)

The Health Belief Model (HBM) measurement uses the following indicators: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (Melati et al., 2024). The scale used is 1-4 ("Strongly agree", "Agree", "Disagree", "Strongly Disagree"). The overall scoring results of the HBM questionnaire question items with a score range of 12-29 were light, and the score range of 30-48 was high.

Health Belief Model Questionnaire

1. I felt at risk of developing back pain during pregnancy.
2. I believe that without proper behavior, the chances of me experiencing back pain are quite high.
3. The back pain I experience can interfere with my daily activities.
4. Back pain during pregnancy can have a serious impact on my health.
5. Maintaining proper posture can reduce the risk of back pain.
6. Implementing ergonomic behaviors during pregnancy was beneficial for my body's comfort.
7. I find it difficult always to maintain the correct posture.
8. I don't have enough information on how to sit, stand, or move ergonomically while pregnant.
9. Advice from health workers motivated me to implement ergonomic behaviors.

10. Information from books or social media makes me aware of the importance of maintaining posture during pregnancy.
11. I am confident that I can maintain my body position correctly during pregnancy.
12. I feel like I'm able to apply ergonomic habits even though I'm busy.

Incidence of Low Back Pain

The measurement of the incidence of low back pain uses a questionnaire adopted from the A Self-Rating Pain and Distress Scale (Zung, 1983), which includes physical and sensory aspects. The questionnaire sheet on the incidence of low back pain consisted of 20 questions, using a Likert scale with the category "always" with a score of 4, "Often" with a score of 3, "rarely" with a score of 2, and "never" with a score of 1. The results of the respondents' answers will then be categorized into light risk, medium risk, and severe risk. The overall scoring results of the questionnaire question item for the incidence of low back pain with a score range of 20-39 were mild, the score range of 40-59 was moderate, and the score range of 60-80 was severe.

Lower Back Pain Incidence Questionnaire

1. I feel heat in the lower back area
2. I feel stiffness in my lower back
3. I felt a stabbing pain in my lower back
4. I feel lower back pain before doing work activities
5. I feel pain in my lower back continuously while doing work
6. I feel pain in my lower back after doing work activities
7. I feel pain in my lower back only when doing work
8. I feel low back pain at rest
9. I find it difficult to bend over
10. I can't walk because of lower back pain
11. I find it difficult to rotate my body left and right
12. I feel tingling in the lower back area
13. I didn't feel any pain from my back to my legs
14. The back pain I felt healed on its own in a moment.
15. The back pain I felt healed at rest
16. I think back pain while sitting
17. I felt a numbness. from my lower back to my feet
18. Trauma due to an accident that causes pain in the lower back area
19. I checked myself to report the pain to the clinic health center
20. I used to take medication to relieve the pain I was suffering from

All instruments demonstrated acceptable psychometric properties in a pilot test (n=30), including: (1) Cronbach's Alpha > 0.7 for internal consistency, (2) AVE > 0.5 indicating convergent validity, and (3) Test-retest reliability was conducted after two weeks on a subset of 20 respondents (Pearson's r > 0.8 across instruments).

Data Collection

The data were collected between February and March 2025 at several community health centers (Puskesmas) and maternity clinics across Karanganyar, Sukoharjo, and Boyolali, Central Java, Indonesia. The primary researcher conducted the data collection process with the assistance of trained research assistants who were midwifery students familiar with maternal health. Before data collection, all assistants received a one-day briefing on the study protocol, ethical considerations, and how to assist respondents in completing the questionnaires. Data collection was carried out in person using paper-based questionnaires, which were distributed to pregnant women who met the inclusion criteria after obtaining their informed consent.

Data Analysis

The data was analyzed using Partial Least Squares-Structural Equation

Modeling (PLS-SEM) with the help of SmartPLS software. This technique is used because it is able to analyze latent relationships between variables, including mediation models. There are two stages of evaluation of the measurement model used in PLS-SEM, namely the measurement model (outer model) and the structural model (inner model).

Ethical Considerations

This research involved human participants (pregnant women), making ethical compliance essential. The primary ethical considerations addressed included obtaining informed consent, ensuring participant anonymity, maintaining data confidentiality, and minimizing any potential psychological or physical discomfort during data collection. All respondents were informed of their right to withdraw at any point without consequences. The study was reviewed and approved by the Health Research Ethics Committee of the Faculty of Medicine, University of Muhammadiyah Surakarta. The Ethical Clearance Letter was issued under approval number: 5575/B.1/KEPK-FKUMS/II/2025. No additional approvals were required for this research.

Results

Descriptive data explains the conditions or circumstances of the respondents, which should be taken into account as extra information to comprehend the study's findings. The respondents in this study were categorized according to their age, district, occupation, last educational attainment, pregnancy, and trimester.

Table 1. Characteristics of Research Respondents

Characteristic	Frequency	Percentage
Age		
17-25 years old	81	57,86%
26-35 years old	44	31,43%
36-45 years old	17	10,71%
Origin of the Region (Regency)		
Karanganyar	45	32,14%
Sukoharjo	51	36,43%
Boyolali	44	31,43%
Final Education		
Elementary/Equivalent	2	1,43%
Junior High School/Equivalent	4	2,86%
High School/Equivalent	76	54,29%
College	58	41,43%
No School	0	0,00%
Work		
Private	38	27,14%
Self employed	32	22,86%
PNS	9	6,43%
Housewives	61	43,57%
Pregnancy to-		
First	58	41,43%
Second	69	49,29%
≥ 3 times	13	9,29%
Trimester		
Second	54	38,57%
Third	86	61,43%

Based on **Table** 1, the majority of respondents in this study were aged 17–25 years old (57.86%), with most coming from Sukoharjo Regency (36.43%), followed by Karanganyar (32.14%) and Boyolali (31.43%). Most of the respondents had their last education in high school/equivalent (54.29%), followed by universities (41.43%), while only a few had a junior high school/equivalent education (2.86%) and elementary school/equivalent (1.43%). In terms of employment, the majority of respondents were housewives (43.57%), followed by private workers (27.14%) and self-employed (22.86%). In terms of pregnancy, most were undergoing a second pregnancy (49.29%), followed by the first pregnancy (41.43%), and more than three pregnancies (9.29%). Meanwhile, most of the respondents were in the third trimester of pregnancy (61.43%) and the rest in the second trimester (38.57%). This data reflects the diversity of respondent characteristics that can affect the level of ergonomic awareness and health beliefs embraced during pregnancy.

The research variables in this study consisted of ergonomic behavioral awareness, Health Belief Model (HBM), and incidence of low back pain. The characteristics of these variables can be explained as follows:

Table 2. Data Characteristics of Research Variables

Characteristic	Frequency	Percentage
Ergonomic Behavioral Awareness		
Low	14	10,00%
Moderate	45	32,14%
High	81	57,86%
Health Belief Model		
Low	30	21,43%
High	110	78,57%
Occurrence of low back pain		
Light	70	50,00%
Moderate	50	35,71%
Heavy	20	14,29%

Source: Primary data processed (2025)

Based on Table 2, most respondents had a high level of ergonomic behavioral awareness (57.86%), followed by a moderate level (32.14%), and only a small percentage had low awareness (10%). In terms of the Health Belief Model (HBM), the majority of respondents showed a high level of health confidence (78.57%), while the rest were relatively low (21.43%). Regarding the incidence of low back pain during pregnancy, most respondents experienced pain in the mild category (50%), followed by the moderate category (35.71%), and only 20% experienced severe pain. This data shows that most pregnant women have good ergonomic awareness and health confidence, which has the potential to lower the risk of severe low back pain.

Measurement Model Analysis (Outer Model)

Convergent validity

Convergent validity is the evaluation of the values obtained from outer loadings. Outer loadings are considered high when their correlation with the structure being measured exceeds 0.7, although a value of 0.6 has been deemed sufficient to meet the convergent validity requirement **(Table 3).**

Table 3. Loading Factor

Variable	Indicators	Loading Factor	Rule of Thumb	Conclusion
Ergonomic Behavioral Awareness (KPE/X)	KPE_1	0,814	0,700	Valid
	KPE_2	0,864	0,700	Valid
	KPE_3	0,843	0,700	Valid
	KPE_4	0,844	0,700	Valid
	KPE_5	0,793	0,700	Valid
	KPE_6	0,847	0,700	Valid
	KPE_7	0,856	0,700	Valid
	KPE_8	0,881	0,700	Valid
	KPE_9	0,838	0,700	Valid
	KPE_10	0,876	0,700	Valid
	KPE_11	0,830	0,700	Valid
	KPE_12	0,822	0,700	Valid
Health Belief Model (HBM/Z)	HBM_1	0,873	0,700	Valid
	HBM_2	0,872	0,700	Valid
	HBM_3	0,876	0,700	Valid
	HBM_4	0,849	0,700	Valid
	HBM_5	0,777	0,700	Valid
	HBM_6	0,851	0,700	Valid
	HBM_7	0,855	0,700	Valid
	HBM_8	0,861	0,700	Valid
	HBM_9	0,851	0,700	Valid
	HBM_10	0,837	0,700	Valid
	HBM_11	0,840	0,700	Valid
	HBM_12	0,855	0,700	Valid
Incidence of Low Back Pain (NPB/Y)	NPB_1	0,826	0,700	Valid
	NPB_2	0,834	0,700	Valid
	NPB_3	0,839	0,700	Valid
	NPB_4	0,851	0,700	Valid
	NPB_5	0,858	0,700	Valid
	NPB_6	0,785	0,700	Valid
	NPB_7	0,752	0,700	Valid
	NPB_8	0,861	0,700	Valid
	NPB_9	0,833	0,700	Valid
	NPB_10	0,804	0,700	Valid
	NPB_11	0,858	0,700	Valid
	NPB_12	0,815	0,700	Valid
	NPB_13	0,844	0,700	Valid
	NPB_14	0,860	0,700	Valid
	NPB_15	0,840	0,700	Valid
	NPB_16	0,821	0,700	Valid
	NPB_17	0,838	0,700	Valid
	NPB_18	0,811	0,700	Valid
	NPB_19	0,851	0,700	Valid
	NPB_20	0,843	0,700	Valid

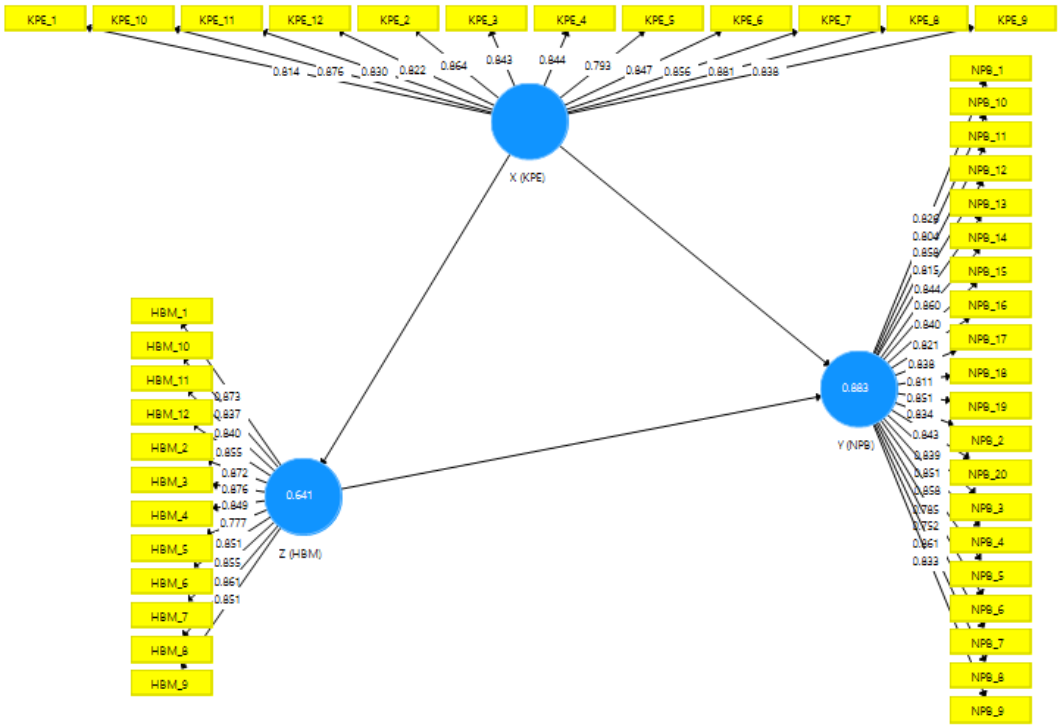

Figure 2. Data Processing

Average variance extracted (AVE)

The validity of the convergence can also be tested through another approach by examining the Average Variance Extracted (AVE) value, which states that a good model has an AVE value greater than 0.50 in each of its constructs. The following is the AVE value of each construct.

Table 4. Average Variance Extracted (AVE) Results

Yes	Variable	Average Variance Extracted (AVE) Results
1	Ergonomic Behavioral Awareness (X)	0,710
2	Health Belief Model (Z)	0,691
3	Incidence of Low Back Pain (Y)	0,723

Based on **Table 4** presented, it can be seen that all variables have an AVE value above 0.50. Therefore, it can be concluded that the AVE value has met the requirements and shows a positive level of validity.

Discriminant validity

Suppose the correlation value between a component and its index is higher than the corresponding between the component and the index of other block components. In that case, it can be said that the measurement model has good discriminative validity. The following are the results of the cross-loading value on each indicator after data processing using SmartPLS 4.0.

Table 5. Cross-Loading Results

Variable	Indicators	KPE (X)	HBM (Z)	NPB (Y)
Ergonomic Behavioral Awareness (KPE/X)	KPE_1	**0,814**	0,694	-0,788
	KPE_2	**0,864**	0,684	-0,757
	KPE_3	**0,843**	0,673	-0,745
	KPE_4	**0,844**	0,629	-0,750
	KPE_5	**0,793**	0,648	-0,694
	KPE_6	**0,847**	0,672	-0,846
	KPE_7	**0,856**	0,677	-0,763
	KPE_8	**0,881**	0,712	-0,841
	KPE_9	**0,838**	0,669	-0,793
	KPE_10	**0,876**	0,692	-0,849
	KPE_11	**0,830**	0,714	-0,730
	KPE_12	**0,822**	0,628	-0,791
Health Belief Model (HBM/Z)	HBM_1	0,771	**0,873**	-0,795
	HBM_2	0,679	**0,872**	-0,699
	HBM_3	0,708	**0,876**	-0,785
	HBM_4	0,623	**0,849**	-0,659
	HBM_5	0,693	**0,777**	-0,659
	HBM_6	0,717	**0,851**	-0,697
	HBM_7	0,622	**0,855**	-0,692
	HBM_8	0,733	**0,861**	-0,780
	HBM_9	0,651	**0,851**	-0,703
	HBM_10	0,676	**0,837**	-0,650
	HBM_11	0,629	**0,840**	-0,672
	HBM_12	0,637	**0,855**	-0,708
Incidence of Low Back Pain (NPB/Y)	NPB_1	-0,752	-0,738	**0,826**
	NPB_2	-0,788	-0,639	**0,834**
	NPB_3	-0,766	-0,614	**0,839**
	NPB_4	-0,787	-0,712	**0,851**
	NPB_5	-0,774	-0,770	**0,858**
	NPB_6	-0,703	-0,597	**0,785**
	NPB_7	-0,716	-0,718	**0,752**
	NPB_8	-0,795	-0,670	**0,861**
	NPB_9	-0,774	-0,629	**0,833**
	NPB_10	-0,749	-0,729	**0,804**
	NPB_11	-0,743	-0,738	**0,858**
	NPB_12	-0,796	-0,671	**0,815**
	NPB_13	-0,818	-0,728	**0,844**
	NPB_14	-0,781	-0,721	**0,860**
	NPB_15	-0,779	-0,754	**0,840**
	NPB_16	-0,774	-0,676	**0,821**
	NPB_17	-0,791	-0,821	**0,838**
	NPB_18	-0,746	-0,622	**0,811**
	NPB_19	-0,799	-0,715	**0,851**
	NPB_20	-0,754	-0,612	**0,843**

Source: Primary data processed (2025)

Based on the results of the cross-loading data listed in **Table 5** above, several things can be concluded, among others: the cross-loading value on each indicator from other constructs is superior to the indicators on the construct or latent variables on other indicator blocks. Thus, a statement can be drawn that all indicators in this study show good discriminant validity in each indicator.

Composite reliability and Cronbach's alpha

As a guideline, the Composite Reliability value should be more than 0.7, and Cronbach's Alpha value should also be more than 0.7 (Ghozali & Latan, 2015). A research instrument is considered reliable if Cronbach's Alpha value > 0.7, although a value of 0.6 is still acceptable (Ghozali & Latan, 2015).

Table 6. Reliability Test Results

Variable	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Information
Ergonomic Behavioral Awareness	0,963	0,963	0,967	Reliable
Health Belief Model	0,965	0,966	0,969	Reliable
Incidence of Low Back Pain	0,976	0,977	0,978	Reliable

Based on the data contained in **Table 6,** it can be concluded that all research variables have a composite reliability value > 0.7. This shows that all research variables show a high level of reliability, because the composite reliability value exceeds 0.7.

Structural Model Analysis (Inner Model)
R-Square

To measure the model fit, we can use the R-squared value. R-squared is an indicator that can describe how much influence independent variables have on dependent variables, and whether the influence is significant. **Table 10** shows the results of the R-squared value.

Table 7. R-Square

Variable	R-square	R-square Adjusted
Health Belief Model (Z)	0,641	0,639
Incidence of Low Back Pain (Y)	0,883	0,881

The results of data processing in **Table 7** above show that the Health Belief Model variable has an R-squared value of 0.641, which is equivalent to 64.1%. This means that around 64.1% of ergonomic behavioral awareness (X) affects the Health Belief Model variable. Meanwhile, the variable incidence of low back pain had an R-squared value of 0.883, or 88.3%. This indicates that the ergonomic behavioral awareness variable (X) is 88.3% related to the incidence of low back pain. In contrast, the other variables are influenced by different variables in this study.

Hypothesis testing (bootstrapping)

The results of the hypothesis test research are acceptable if the p-values are less than 0.05. This study uses the SmartPLS 4 program for hypothesis testing through bootstrapping and Sobel testing. Here are the results of the hypothesis test:

Table 8. Hypothesis Test Results

Hypothesis	Original Sample	Sample Mean	Standard Deviation	T statistics	p values
Ergonomic behavioral awareness → Incidence of low back pain	-0,715	-0,706	0,068	10,457	<0,001
Ergonomic behavioral awareness → Health belief model	0,801	0,807	0,029	27,680	<0,001
Health belief model → Incidence of low back pain	-0,264	-0,273	0,068	3,860	<0,001

Ergonomic behavioral awareness → Health belief model Incidence of low back pain	-0,211	-0,220	0,058	3,636	<0,001

Based on **Table 8**, all hypotheses in this study are proven to be statistically significant, shown by *p-values* that are below 0.05. Awareness of ergonomic behavior had a significant negative effect on the incidence of low back pain (β = -0.715; p <0,001), which means that the higher the awareness of ergonomics, the lower the incidence of pain. In addition, ergonomic awareness also had a significant positive effect on the Health Belief Model (β = 0.801; p <0,001), and the Health Belief Model had a significant negative impact on the incidence of low back pain (β = -0.264; p <0,001). Furthermore, there was a significant indirect influence between ergonomic awareness and back pain through the Health Belief Model as a mediating variable (β = -0.211; p <0,001). These findings suggest that the higher the awareness of ergonomics, the stronger the perception of the Health Belief Model, which together can lower the risk of low back pain in pregnant women.

Discussion

The effect of ergonomic behavioral awareness on the incidence of low back pain in pregnant women

The bootstrapping hypothesis test shows that ergonomic behavioral awareness significantly and negatively influences the incidence of low back pain (LBP) in pregnant women (coefficient = -0.715, p < 0.001). This means that higher ergonomic awareness is associated with a lower likelihood of experiencing LBP. Posture changes, fetal weight gain, and non-ergonomic activities commonly cause pregnancy-related back pain.

This finding aligns with Muhammad et al. (2022), who found a significant association between ergonomic behavior and reduced back pain (p < 0.05), and with Hadi & Hasmar (2021), who reported that correct sitting posture alleviates LBP. Similarly, Bryndal et al. (2020) emphasized multiple contributing factors, including sleeping and sitting positions, lack of exercise, and younger maternal age. However, despite this, many pregnant women remain unaware of the importance of ergonomics for musculoskeletal health.

The study strengthens the evidence that raising ergonomic awareness can reduce incorrect body positioning that contributes to LBP. Analdi et al. (2024) reported positive outcomes from ergonomic interventions, including improved posture and reduced pain. Likewise, Pekçetin et al. (2019) noted that ongoing ergonomics education—especially via telecommunication—was more effective than a single session. Therefore, midwives and clinicians should incorporate consistent ergonomic counseling into prenatal care. In low-resource settings, this can be feasibly delivered by trained community health workers or nurses using simplified visual guides.

The effect of ergonomic behavioral awareness on the health belief model in pregnant women

The analysis found that ergonomic behavioral awareness has a strong positive effect on the Health Belief Model (HBM) components among pregnant women (coefficient = 0.801, p < 0.001). This implies that as awareness increases, so does the strength of their health beliefs, such as perceived risks, benefits, and self-efficacy.

The components of the health belief model, namely perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy, play a major role in behavior in pregnant women (Fransiska et al., 2022). In

this case, pregnant women who understand the importance of correct posture, avoiding overload, and stretching tend to have higher perceived susceptibility and perceived severity of the possible adverse effects of unergonomic behavior. Furthermore, ergonomic awareness also increases pregnant women's confidence about the perceived benefits of implementing healthy behaviors, as well as helping them to identify and overcome perceived barriers in making behavior changes. For example, pregnant women who are aware of the importance of ergonomics will be better able to see the benefits of sitting in the correct position and stretching regularly, as well as looking for solutions when experiencing physical or time constraints. This awareness also strengthens their self-efficacy or self-confidence to be able to maintain posture and body activity correctly during pregnancy.

Ergonomic awareness can positively influence health behaviors. Some studies suggest that barriers such as fear of infection during the COVID-19 pandemic can inhibit adherence to health recommendations, suggesting a complex interaction between awareness and actual behavior (Nisa & Rahmanindar, 2023). Educational interventions based on HBM are effective in raising awareness and encouraging preventive behaviors (Movahed et al., 2022), such as maintaining ergonomic behavior during pregnancy. These findings show the importance of integrating ergonomics education in prenatal care programs. When pregnant women have a high level of ergonomic awareness, their perceptions of health risks, the benefits of preventive measures, and self-efficacy increase, which further supports the strengthening of the health belief model (HBM). Therefore, interventions that emphasize the importance of ergonomic behaviors are not only physically beneficial but also capable of forming a stronger preventive mindset in the face of health risks during pregnancy.

The effect of the health belief model on the incidence of low back pain in pregnant women

HBM significantly and negatively affects the incidence of LBP in pregnant women (coefficient = -0.264, $p < 0.001$), confirming its role in preventive behavior. Women who perceive higher risk, severity, and benefits of healthy behavior, and who overcome barriers, tend to experience less back pain.

Akbar (2022) supports this by linking perceived threat with preventive actions. Pregnant women who understand the seriousness of LBP are more likely to adopt positive behaviors, such as proper posture and physical activity. These perceptions, coupled with cues from healthcare workers or peers, can lead to consistent health-promoting actions.

This highlights the necessity of strengthening health beliefs to encourage behavior that mitigates LBP. HBM-based counseling, including practical strategies and motivational support, should be delivered by midwives or counselors during routine prenatal care. Even in low-resource settings, group education or mobile health messaging can be effective.

Mediating a health belief model in the relationship between ergonomic behavioral awareness and the incidence of low back pain in pregnant women

The mediation analysis confirmed that HBM significantly mediates the relationship between ergonomic awareness and LBP (coefficient = -0.211, $p < 0.001$). This shows that ergonomic awareness affects LBP both directly and indirectly through its influence on health beliefs.

The role of HBM mediation illustrates that pregnant women who have ergonomic awareness do not necessarily automatically experience a decrease in the incidence of back pain, unless this awareness is

accompanied by an internal belief in the risks, benefits, obstacles, and self-efficacy of acting. This means that awareness of ergonomic behavior becomes more effective in preventing low back pain if pregnant women also have strong health beliefs. HBM bridges the shift from knowledge to real, sustainable action.

The Health Belief Model (HBM) acts as a mediating variable in the relationship between ergonomic behavioral awareness and the incidence of low back pain in pregnant women because HBM describes the psychological processes that bridge between awareness and real action. Even if a person has knowledge and understanding of the importance of ergonomic behavior, it does not necessarily mean that they will immediately apply it in their daily life. In this context, HBM is present to influence how individuals assess risk (perceived susceptibility), severity of the condition (perceived severity), benefits of preventive measures (perceived benefits), obstacles that may be faced (perceived barriers), and readiness and confidence to act (self-efficacy) (Widyastuti et al., 2023).

In other words, awareness of ergonomic behavior is only an initial trigger. In contrast, the decision to practice ergonomic behavior depends on how strong the individual's beliefs and perceptions of the benefits and urgency of the behavior are. HBM forms a frame of mind for pregnant women in interpreting this awareness, thus encouraging them to act consistently (Lestari et al., 2023). In the absence of strong conviction as described in the HBM model, ergonomic awareness may not be strong enough to prevent low back pain from occurring.

HBM is important as a mediator because it is able to convert awareness into internal motivation that encourages behavior change. When HBM is positively formed in pregnant women, then understanding of the importance of proper posture and physical activity during pregnancy is more likely to translate into real action, which ultimately contributes to lowering the risk of low back pain. Therefore, it is important that health interventions during pregnancy not only provide education about ergonomics but also reinforce the cognitive and psychological aspects covered by HBM. This approach will increase the effectiveness of ergonomics education in reducing the risk of low back pain. Through HBM as a mediator, the process of behavior change becomes more structured and comprehensive, from understanding beliefs to real preventive measures.

While all tested pathways showed significant results, this study does not account for other potential influencing factors such as psychological stress, cultural beliefs, or family support. Future studies should explore potential conflicting or non-significant paths in different populations. In low-resource settings, incorporating ergonomics and HBM into existing antenatal care workflows is feasible. Community health workers or nurses can be trained to deliver short, structured educational modules. Mobile applications and group counseling sessions may further increase reach and cost-efficiency

Relevance to Clinical Practice

The findings of this study highlight key clinical applications for reducing the incidence of lower back pain among pregnant women through ergonomic behavioral awareness and the Health Belief Model (HBM), offering insights to enhance antenatal care (ANC) protocols and promote proactive, patient-centered strategies. Shifting from reactive to preventive care, the study emphasizes integrating ergonomic education and HBM-based counseling early in pregnancy, ideally beginning in the second trimester, to reduce discomfort and long-term complications. Using HBM constructs such as perceived

susceptibility, severity, benefits, and self-efficacy, healthcare providers can identify at-risk pregnant women and offer tailored education on safe posture, physical activity, and ergonomic habits. Practical implementation during ANC visits may include posture screenings and brief counseling sessions supported by visual aids or handouts. The study also recommends updating maternal care protocols and training midwives in ergonomics and HBM-based communication, supported by standardized scripts and educational tools. Preventing lower back pain can reduce the need for medication or physical therapy, enhancing maternal comfort, ANC adherence, and service efficiency. At the policy level, these findings can inform community and national health campaigns and educational curricula, advocating ergonomic awareness and behavior change as integral to maternal health.

In conclusion, the study confirms that ergonomic behavioral awareness, when mediated by the HBM, significantly lowers back pain incidence, reinforcing the role of personal beliefs in health behavior adoption. Integrating ergonomic education and health psychology into ANC, equipping providers with both technical and counseling skills, and implementing these strategies at the Puskesmas level through structured modules and standardized tools are essential steps. Ultimately, empowering pregnant women through a combination of ergonomic training and psychological reinforcement supports both cognitive understanding and behavioral commitment, contributing to healthier, more comfortable pregnancies.

Conclusion

This study concludes that ergonomic behavioral awareness significantly contributes to reducing the incidence of lower back pain among pregnant women. Furthermore, this effect is amplified when mediated by the Health Belief Model (HBM), which highlights the importance of individual beliefs regarding risk, benefits, barriers, and self-efficacy in adopting ergonomic behaviors. Pregnant women's perceptions and understanding of health, therefore, play a vital role in encouraging consistent preventive actions.

Integrating ergonomic education and health psychology into antenatal care (ANC) protocols is essential. Midwives and obstetricians should be equipped to deliver not only technical guidance on posture and daily activity but also counseling strategies grounded in the HBM framework. This includes increasing awareness of the risks of back pain, emphasizing the benefits of ergonomic behavior, addressing perceived barriers, and fostering confidence in a pregnant woman's ability to maintain healthy movement patterns.

To ensure broader impact, these interventions should be formally incorporated into policy at the community health center (*Puskesmas*) level. Developing structured modules and standardized counseling tools can aid in implementing these strategies across various healthcare settings, especially in primary care.

Ultimately, this study underscores the dual importance of education and belief in promoting maternal health. Empowering pregnant women through a combination of ergonomic training and psychological reinforcement fosters both cognitive understanding and behavioral commitment, leading to healthier and more comfortable pregnancies.

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CrediT Authorship Contributions Statement

Saifudin Zuhri: Conceptualization, Methodology, Supervision, Writing -

Original Draft, Investigation, Resources, Funding Acquisition.
Sri Suwarni: Software, Validation, Formal Analysis, Writing - Review & Editing, Data Curation, Project Administration

Conflicts Of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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