Effect of a Physical Activity-Based Intervention Package on Labor Pain: A Randomized Controlled Trial

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ABSTRACT

Background: Labor pain may affect maternal comfort and the progress of childbirth. Non-pharmacological interventions such as breathing relaxation exercise and pelvic rocking exercise are considered safe and practical methods for reducing labor pain.

Objective: This study aimed to analyze the effect of a physical activity-based intervention package consisting of breathing relaxation exercise and pelvic rocking exercise on labor pain among women during the active phase of the first stage of labor.

Methods: This randomized controlled trial was conducted at Pamarayan Primary Health Center, Indonesia, from August to December 2025. A total of 80 women were randomly assigned to either an intervention group (n = 40) or a control group (n = 40). The intervention group received breathing relaxation exercises and pelvic rocking exercises, whereas the control group received standard maternal care. Labor pain intensity was measured using the Visual Analog Scale (VAS) before and after intervention. Data were analyzed using Repeated Measures Analysis of Variance (Repeated Measures ANOVA) and multivariable linear regression. Statistical significance was established at $p < 0.05$.

Results: The mean labor pain score in the intervention group decreased from 7.68 ± 0.92 before intervention to 4.95 ± 1.01 after intervention, whereas the control group showed a smaller reduction from 7.55 ± 0.88 to 6.92 ± 1.07. Repeated Measures ANOVA demonstrated a significant Time × Group interaction effect ($F = 92.41$, $p < 0.001$, partial $\eta^2 = 0.542$), indicating that pain reduction over time was significantly greater in the intervention group than in the control group. The mean between-group difference in post-intervention pain scores was -1.97 (95% CI: -2.43 to -1.51), representing a clinically meaningful reduction in labor pain. Multivariable linear regression analysis showed that the intervention remained the strongest predictor of reduced labor pain intensity after adjustment for maternal age, education level, parity, anxiety level, family support, and duration of labor ($B = -1.842$; 95% CI: -2.301 to -1.383; $p < 0.001$).

Conclusion: A physical activity-based intervention package consisting of breathing relaxation exercise and pelvic rocking exercise significantly reduced labor pain during the active phase of labor.

Keywords: Active Phase Labor; Breathing Relaxation Exercise; Labor Pain; Pelvic Rocking Exercise

INTRODUCTION

Childbirth is a complex physiological process influenced by biological, psychological, hormonal, and social factors (Olza et al., 2020). One of the most common problems experienced during labor is labor pain, especially during the active phase of the first stage of labor. Labor pain results from uterine contractions, cervical dilatation, pelvic tissue stretching, and pressure on surrounding nerves (Thomson, 2013). Severe pain may increase catecholamine and cortisol levels, disrupt uterine contractions, reduce uteroplacental perfusion, and prolong labor. In addition, labor pain can increase anxiety, fear, and negative childbirth experiences. Therefore, effective pain management is essential to improve maternal comfort and safety during childbirth (Dixon et al., 2013).

Labor pain management includes pharmacological and non-pharmacological approaches. Non-pharmacological interventions are increasingly used because they are safer, affordable, simple to apply, and have minimal side effects. One commonly used approach is structured physical activity during pregnancy and labor (Ferreira et al., 2019; Rodríguez-Díaz et al., 2017). Activities such as pregnancy exercise, pelvic rocking, stretching, breathing exercise, birth ball exercise, and ambulation may improve muscle flexibility, circulation, endorphin release, and maternal relaxation. Previous studies reported that physically active women tend to experience shorter labor duration, lower anxiety, and less labor pain. However, integrated physical activity programs in primary healthcare services are still limited and not well standardized (Zhang et al., 2023).

Globally, labor pain remains a major concern in maternal healthcare, with many women experiencing moderate to severe pain during childbirth. Limited access to pharmacological analgesia in developing countries has increased the use of non-pharmacological pain management methods (Cilar Budler & Budler, 2022; Melzer et al., 2010). In Indonesia, the high number of normal deliveries in primary healthcare facilities highlights the need for safe and practical interventions. Preliminary observations at Pamarayan Primary Health Center showed that many women experienced severe labor pain and had limited access to structured physical activity interventions. Existing care mainly involved general education and simple relaxation techniques without comprehensive physical activity programs (Astuti et al., 2021).

Although numerous studies regarding physical activity and labor pain have been conducted, most previous studies focused on single interventions such as pregnancy exercise, prenatal yoga, breathing techniques, pelvic rocking exercises, or birth ball use separately (Pramana, 2022). Previous studies also generally used quasi-experimental designs with relatively small sample sizes, resulting in limited strength of evidence. Furthermore, several studies only evaluated the effects of interventions on anxiety levels or labor duration without comprehensively assessing the effects of integrated physical activity intervention packages on labor pain intensity (Amru et al., 2021). Variations in participant characteristics, differences in pain measurement methods, and inconsistencies in intervention timing have contributed to heterogeneous findings across studies. In Indonesia, randomized controlled trials evaluating structured and integrated physical activity intervention packages within primary maternal healthcare services remain limited, particularly in rural areas and first-level healthcare facilities. Consequently, there is a need for studies with stronger experimental designs to objectively evaluate the effectiveness of integrated physical activity interventions on labor pain and generate evidence that is applicable to routine maternity care (Arfah & Tridiyawati, 2022).

The development of a physical activity-based intervention package is important because combined approaches may provide more comprehensive physiological and psychological benefits than single interventions alone (Pramana, 2022). Combining several physical activities such as stretching exercises, breathing techniques, pelvic rocking exercises, mobilization, and birth ball use may work synergistically to improve muscle relaxation, optimize fetal positioning, reduce emotional tension, and increase endorphin production as the body's natural analgesic (Nursanti et al., 2021). This approach also has strong potential for implementation in primary healthcare settings because it is relatively simple, inexpensive, and feasible for healthcare providers after brief training. In addition to supporting physiological childbirth and woman-centered care, physical activity-based interventions may increase maternal participation during labor and contribute to a more positive childbirth experience (Yanti & Sukmaningtyas, 2020). Therefore, scientific evaluation of the effectiveness of such intervention packages is necessary to strengthen the evidence base for non-pharmacological labor pain management in midwifery and maternity nursing services in Indonesia.

This study does not propose a novel physical activity technique, as several components of the intervention, including breathing relaxation and pelvic rocking using a birth ball, have been previously investigated and reported in the literature. Rather, the contribution of this study lies in evaluating the effectiveness of a structured package that integrates multiple physical activity components delivered systematically during labor within a primary healthcare setting. In addition, evidence regarding integrated physical activity interventions during labor remains limited, particularly from randomized controlled trials conducted in resource-constrained primary healthcare facilities. Therefore, this study aimed to strengthen the available evidence by evaluating a standardized physical activity intervention package using a randomized controlled trial design in a community health center setting. The use of randomization and the implementation of the intervention within routine maternity services were expected to enhance both the internal validity and practical applicability of the findings, especially for primary healthcare facilities with characteristics similar to those of the study setting.

Based on the background described above, this study aimed to analyze the effect of a physical activity-based intervention package on labor pain among women delivering at Pamarayan Primary Health Center within the working area of the District Health Office, Indonesia. The findings of this study are expected to contribute scientifically to the development of evidence-based practice in non-pharmacological labor pain management and to serve as a reference for developing promotive and preventive maternal healthcare services. For healthcare providers, the findings may be used as an alternative intervention that is safe, effective, and easy to implement in maternal healthcare services. For laboring women, the implementation of a physical activity package is expected to improve comfort, reduce pain intensity, and create a more positive childbirth experience. The hypothesis of this study was that the physical activity-based intervention package would significantly reduce labor pain intensity compared with standard care.

METHODS

This study used an experimental study design with a randomized controlled trial (RCT) parallel-group approach to analyze the effect of a physical activity-based intervention package on labor pain among women during the active phase of the first stage of labor. The randomized controlled trial design was selected because it provided strong evidence in evaluating the causal relationship between intervention and outcome through a random allocation process that

minimized selection bias and imbalance between groups. The study was conducted at Pamarayan Primary Health Center, Indonesia, from August to December 2025.

The study population consisted of all women undergoing normal labor during the active phase of the first stage of labor at Pamarayan Primary Health Centerduring the study period. The sample included women who met the inclusion and exclusion criteria. The inclusion criteria were gestational age of 37–42 weeks, singleton pregnancy, cephalic presentation, cervical dilatation of 4–6 cm, adequate uterine contractions, maternal age between 20–35 years, stable maternal condition, ability to follow intervention instructions, and willingness to participate in the study. The exclusion criteria included women with obstetric complications such as preeclampsia, antepartum hemorrhage, placenta previa, fetal distress, premature rupture of membranes with infection, previous cesarean section, use of pharmacological analgesics during observation, musculoskeletal disorders, or medical conditions limiting physical activity and breathing exercises. Respondents who developed obstetric emergencies during the study were categorized as dropouts to ensure maternal and fetal safety.

Sampling was performed using a consecutive sampling technique by recruiting all eligible respondents until the required sample size was achieved. Respondents were then randomly assigned into intervention and control groups using a computer-generated random sequence with a 1:1 allocation ratio. The randomization sequence was generated by an independent statistician using a computerized random number generator. Block randomization with a block size of four was applied to ensure balanced allocation between groups throughout the recruitment process. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes (SNOSE) prepared by a research assistant who was not involved in participant recruitment, intervention delivery, or outcome assessment. After eligibility screening and informed consent procedures had been completed, the envelopes were opened sequentially to determine group allocation.

The implementation of randomization involved separate personnel to reduce bias. Trained midwives conducted participant recruitment and eligibility assessment, an independent research assistant managed the randomization sequence and allocation process, and trained enumerators performed outcome assessment. A participant flow diagram following CONSORT recommendations was used to document enrollment, allocation, follow-up, and analysis procedures.

Sample size determination was conducted using the formula for comparing two independent means in randomized controlled trials with a 95% confidence level, 80% statistical power, and an estimated effect size derived from previous studies evaluating non-pharmacological interventions for labor pain. Based on the calculation and consideration of adequate statistical power, the minimum required sample size was 80 respondents, consisting of 40 respondents in the intervention group and 40 respondents in the control group.

The independent variable in this study was a physical activity-based intervention package consisting of breathing relaxation exercises and pelvic rocking exercises. The intervention protocol was developed based on previously published evidence regarding non-pharmacological labor pain management and was standardized before implementation.

Breathing relaxation exercises were performed using deep and rhythmic breathing techniques during uterine contractions for approximately five minutes per session under the guidance of trained midwives. Participants were instructed to inhale slowly through the nose for

approximately four seconds, hold their breath for two seconds, and exhale gradually through the mouth for approximately six seconds. This breathing cycle was repeated continuously during contractions while participants were encouraged to maintain relaxation of the shoulders, neck, and facial muscles. The procedure was initiated during the active phase of labor and repeated according to the contraction pattern and maternal comfort.

Pelvic rocking exercises were performed using a birth ball for approximately 10–15 minutes according to maternal tolerance. Participants were instructed to sit upright on the birth ball with both feet supported firmly on the floor and perform controlled anterior-posterior and lateral pelvic movements. Each movement was repeated approximately 10–15 times per set under direct supervision of trained healthcare providers. The intervention was adjusted according to maternal comfort and clinical condition. Detailed intervention procedures were adapted from previously published protocols regarding birth ball and pelvic rocking exercises during labor.

The intervention package was administered during the active phase of the first stage of labor under the supervision of trained healthcare providers. The control group received standard maternal care according to routine procedures at the health center without additional intervention. The dependent variable was labor pain intensity. Potential confounding variables included maternal age, education level, parity, anxiety level, family support, and duration of labor. Parity was also considered a potential effect modifier because previous childbirth experience may influence maternal pain perception.

Labor pain intensity was measured using the Visual Analog Scale (VAS) with scores ranging from 0 to 10, where 0 indicated no pain and 10 indicated the most severe pain imaginable. The VAS instrument was selected because of its high sensitivity for assessing acute pain intensity and its extensive use in obstetric and maternal health research. Previous studies have demonstrated good validity and reliability of the VAS instrument, with Cronbach's alpha values exceeding 0.80. Pain assessments were conducted before and after intervention during the active phase of labor. Anxiety levels were assessed using the Indonesian version of the Hamilton Anxiety Rating Scale (HARS), which has demonstrated satisfactory validity and reliability with Cronbach's alpha values above 0.85. Respondent characteristics were obtained through structured interviews, direct observation, and maternal medical records. All instruments underwent content validity evaluation by experts in maternity nursing and midwifery before implementation in the main study.

The data sources consisted of primary and secondary data. Primary data were collected directly from respondents through observation, interviews, and pain assessments using the VAS instrument. Secondary data were obtained from maternal medical records and labor registers at Pamarayan Primary Health Center. Outcome assessment procedures were applied equally in both groups to ensure comparability. Pain measurements were performed by trained enumerators who were blinded to participant group allocation to reduce observer bias. Standard operating procedures (SOPs) for intervention implementation and outcome measurement were applied consistently throughout the study to improve reliability and validity.

Several strategies were implemented to minimize potential bias, including respondent randomization, allocation concealment, use of standardized instruments, enumerator training, implementation of standardized intervention procedures, and blinding of outcome assessors. To reduce performance bias, all midwives involved in intervention delivery received the same training regarding breathing relaxation and pelvic rocking exercises before the study commenced. The

intervention was administered according to maternal tolerance and was discontinued if respondents experienced fatigue, severe discomfort, or obstetric complications.

Participants who withdrew from the study, developed obstetric emergencies, required emergency referral, or received pharmacological analgesia during the observation period were classified as dropouts. All dropout cases and reasons for withdrawal were documented and reported in the participant flow diagram. Data analysis was performed using a complete-case approach because the number of dropouts was minimal and did not substantially affect statistical power.

Data collection was conducted through several stages, including respondent identification, eligibility screening, informed consent, randomization, baseline assessment, intervention administration, and post-intervention outcome measurement. All collected data were recorded using structured observation sheets by trained enumerators. The data were edited, coded, entered, and cleaned prior to statistical analysis using IBM SPSS Statistics version 26.0.

Before inferential analysis, data normality was assessed using the Shapiro–Wilk test. The results indicated that labor pain scores were normally distributed ($p > 0.05$), thereby satisfying the assumptions required for parametric statistical analyses. Because labor pain was measured repeatedly at two time points (pre-intervention and post-intervention), the primary analysis was performed using Repeated Measures Analysis of Variance (Repeated Measures ANOVA). This method was selected to evaluate the effects of time (pre-intervention versus post-intervention), group (intervention versus control), and the interaction between time and group on labor pain intensity. The interaction effect (Time × Group) was considered the primary indicator of intervention effectiveness. Assumptions for Repeated Measures ANOVA, including normality of residuals and homogeneity of variance, were evaluated before analysis. Since only two measurement occasions were included, the assumption of sphericity was automatically satisfied. Continuous variables were summarized using means and standard deviations (SD), whereas categorical variables were presented as frequencies and percentages. Baseline differences between groups were assessed using independent t-tests for continuous variables and chi-square tests for categorical variables. Effect sizes were reported using partial eta squared (η^2p) for Repeated Measures ANOVA and Cohen's d for between-group comparisons. Mean differences and 95% confidence intervals (95% CI) were also calculated to quantify the magnitude of the intervention effect.

Multivariable linear regression analysis was subsequently performed to control for potential confounding variables because labor pain intensity was analyzed as a continuous outcome variable. Variables considered clinically relevant and variables with p-values < 0.25 in bivariate analyses were entered into the multivariable model. Regression coefficients (B), standardized beta coefficients, 95% confidence intervals, and p-values were reported. Statistical significance was established at $p < 0.05$.

RESULTS

Table 1. Baseline Characteristics of Participants in the Intervention and Control Groups

Variable	Intervention Group (n=40)	Control Group (n=40)	p-value
Maternal age (years), Mean ± SD	27.45 ± 4.12	28.10 ± 4.38	0.498
Anxiety level, Mean ± SD	21.35 ± 4.28	22.10 ± 4.51	0.446
Duration of active phase labor (hours), Mean ± SD	5.82 ± 1.12	6.03 ± 1.25	0.431
Primary education, n (%)	10 (25.0)	12 (30.0)	0.812
Secondary education, n (%)	22 (55.0)	20 (50.0)	
Higher education, n (%)	8 (20.0)	8 (20.0)	
Primipara, n (%)	21 (52.5)	20 (50.0)	0.822
Multipara, n (%)	19 (47.5)	20 (50.0)	
Good family support, n (%)	24 (60.0)	23 (57.5)	0.818
Poor family support, n (%)	16 (40.0)	17 (42.5)	

Note: Continuous variables were compared using independent t-tests, whereas categorical variables were compared using chi-square tests.

The baseline characteristics did not differ significantly between groups (all $p > 0.05$), indicating successful randomization and comparability of the intervention and control groups before intervention.

Table 2. Labor Pain Intensity Before and After Intervention by Study Group

Group	Pre-Intervention Mean ± SD	Post-Intervention Mean ± SD	Mean Change	95% CI	p-value
Intervention (n=40)	7.68 ± 0.92	4.95 ± 1.01	-2.73	(-3.08, -2.38)	< 0.001
Control (n=40)	7.55 ± 0.88	6.92 ± 1.07	-0.63	(-1.23, -0.03)	0.041

The intervention group demonstrated a substantial reduction in labor pain intensity following the physical activity intervention package. The mean pain score decreased by 2.73 points, whereas the control group showed a reduction of only 0.63 points.

Table 3. Repeated Measures ANOVA for Labor Pain Intensity

Source of Variation	F	p-value	Partial η^2
Time	148.52	< 0.001	0.656
Group	59.87	< 0.001	0.434
Time × Group Interaction	92.41	< 0.001	0.542

The repeated measures ANOVA demonstrated a significant effect of time, indicating that labor pain intensity changed significantly during the observation period. A significant group effect was also observed, indicating differences in pain scores between the intervention and control groups. Most importantly, a statistically significant Time × Group interaction effect was identified ($F = 92.41$, $p < 0.001$, partial $\eta^2 = 0.542$), demonstrating that the reduction in labor pain intensity over time was significantly greater in the intervention group than in the control group.

The partial eta squared value of 0.542 indicates a large effect size, suggesting substantial clinical and statistical effectiveness of the intervention package.

Table 4. Between-Group Comparison of Post-Intervention Labor Pain Intensity

Outcome	Intervention Mean ± SD	Control Mean ± SD	95% CI	p-value	Cohen's d
Labor pain intensity	4.95 ± 1.01	6.92 ± 1.07	(-2.43, -1.51)	< 0.001	1.89

Post-intervention labor pain intensity was significantly lower in the intervention group compared with the control group. The mean difference was 1.97 points on the VAS scale. The effect size (Cohen's d = 1.89) indicated a very large intervention effect.

Table 5. Multivariable Linear Regression Analysis of Factors Associated with Labor Pain Intensity

Variable	B	Standardized Beta	95% CI	p-value
Intervention package	-1.842	-0.621	(-2.301, -1.383)	< 0.001
Maternal age	-0.021	-0.051	(-0.077, 0.035)	0.456
Education level	-0.114	-0.042	(-0.458, 0.230)	0.509
Parity	-0.362	-0.126	(-0.742, 0.018)	0.061
Anxiety level	0.087	0.284	(0.039, 0.135)	< 0.001
Family support	-0.418	-0.138	(-0.826, -0.010)	0.045
Duration of labor	0.263	0.197	(0.082, 0.444)	0.005

The multivariable linear regression analysis demonstrated that the intervention package remained the strongest predictor of lower labor pain intensity after adjustment for maternal age, education level, parity, anxiety level, family support, and duration of labor (B = -1.842; 95% CI: -2.301 to -1.383; $p < 0.001$). Anxiety level and duration of labor were associated with increased pain intensity, whereas family support was associated with lower pain intensity.

DISCUSSION

This study successfully achieved its objective of analyzing the effect of a physical activity-based intervention package consisting of breathing relaxation exercise and pelvic rocking exercise on labor pain among women during the active phase of the first stage of labor. The findings demonstrated that the intervention group experienced a significantly greater reduction in labor pain intensity compared with the control group. The mean pain score in the intervention group decreased from 7.68 to 4.95 after intervention, while the control group only showed a slight reduction from 7.55 to 6.92. Multivariate analysis further confirmed that the intervention remained the strongest predictor of labor pain reduction even after controlling for maternal age, education level, parity, anxiety level, family support, and duration of labor. These findings indicate that the intervention package provided both physiological and psychological benefits during labor and may serve as an effective non-pharmacological strategy in primary maternal healthcare settings.

Importantly, the magnitude of the intervention effect was substantial. The Repeated Measures ANOVA demonstrated a large Time × Group interaction effect (partial $\eta^2 = 0.542$), indicating that more than half of the variance in pain score changes could be attributed to the intervention effect over time. According to conventional effect size interpretation, this value

represents a large effect and suggests that the observed reduction in labor pain was not only statistically significant but also clinically meaningful. Similarly, the between-group effect size after intervention (Cohen's d = 1.89) indicated a very large treatment effect, supporting the practical importance of the intervention package in clinical settings.

The results of this study are consistent with previous studies that reported the effectiveness of breathing relaxation techniques and pelvic rocking exercise in reducing labor pain. A study conducted by (Gallo et al., 2018) found that breathing relaxation techniques significantly reduced pain perception and maternal anxiety during labor through improved oxygenation and muscle relaxation. Another study by (Makvandi et al., 2015) reported that pelvic rocking exercise using a birth ball effectively decreased labor pain intensity and improved maternal comfort during the active phase of labor. Similarly, research conducted by (Taavoni et al., 2011) demonstrated that non-pharmacological physical activity interventions during labor were associated with shorter labor duration and lower pain scores compared with standard care. The consistency between this study and previous findings suggests that combining relaxation and pelvic mobility exercises may produce synergistic effects in pain management during childbirth.

Beyond statistical significance, the observed mean difference of 1.97 points on the VAS scale warrants consideration from a clinical perspective. Previous pain research suggests that a reduction of approximately 1.3–2.0 points on a 10-point VAS is generally considered clinically important and perceptible to patients. Therefore, the reduction observed in this study likely reflects a meaningful improvement in maternal comfort during labor rather than a merely statistical finding. In practical terms, reducing pain from the severe pain category toward a moderate pain level may improve maternal coping ability, participation during labor, and overall childbirth experience.

The effectiveness of breathing relaxation exercise may be explained through several physiological mechanisms. Controlled breathing techniques stimulate parasympathetic nervous system activity, resulting in decreased sympathetic stimulation and reduced release of stress hormones such as catecholamines and cortisol. Lower stress hormone levels contribute to reduced muscle tension, improved uterine oxygenation, and enhanced maternal relaxation during contractions. In addition, rhythmic breathing increases oxygen supply to maternal tissues and helps prevent hyperventilation, which is commonly associated with heightened pain perception during labor. The intervention may also activate endogenous opioid mechanisms through increased endorphin release, thereby enhancing maternal pain tolerance. This mechanism is supported by the Gate Control Theory proposed by (Melzack & Wall, 1965), which explains that sensory stimulation and relaxation responses can inhibit pain signal transmission at the spinal cord level before reaching the brain.

The positive effect of pelvic rocking exercise may also be explained physiologically and biomechanically. Pelvic rocking movements help improve pelvic flexibility, reduce lower back pressure, and facilitate fetal descent through optimal pelvic alignment (Amru et al., 2021). During labor, repetitive pelvic movement may reduce tension in the lumbosacral region and stimulate mechanoreceptors that compete with pain impulses, thereby decreasing pain perception. Furthermore, pelvic rocking exercise performed using a birth ball promotes upright positioning, which utilizes gravity to assist fetal descent and cervical dilatation (Arfah & Tridiyawati, 2022). This condition may reduce prolonged labor and improve maternal comfort during contractions. The intervention is considered effective because it combines movement, relaxation, and maternal participation simultaneously, allowing mothers to feel more in control during labor. Women who

actively participate in labor management often report lower anxiety and more positive childbirth experiences compared with mothers receiving passive care only (Astuti et al., 2021).

The correlation between anxiety level and labor pain observed in this study indicates that psychological factors play an important role in shaping pain perception during childbirth. Mothers with higher anxiety scores tended to experience greater pain intensity. Anxiety stimulates the release of catecholamines, which may increase muscle tension, decrease uterine blood flow, and intensify pain perception during contractions. Fear and emotional stress can also disrupt maternal coping mechanisms, making contractions feel more painful and exhausting. Therefore, breathing relaxation exercise may indirectly reduce labor pain by decreasing anxiety and improving emotional stability during labor. This finding supports the concept that labor pain is multidimensional and influenced not only by physiological processes but also by maternal psychological responses (Yanti & Sukmaningtyas, 2020).

This study also found that family support and duration of labor were significantly associated with labor pain intensity. Mothers who received better family support experienced lower pain scores, likely because emotional support may increase maternal confidence and reduce fear during labor (Bowers, 2002). Emotional reassurance from family members may enhance oxytocin release and create a more relaxed labor environment, which subsequently improves pain coping ability. In contrast, prolonged labor duration was associated with increased pain intensity because repeated uterine contractions over an extended period may lead to physical exhaustion, emotional fatigue, and decreased coping capacity (Nursanti et al., 2021).

The influence of family support also highlights the possibility of contextual effects that may contribute to pain reduction. Women receiving greater attention, encouragement, and emotional support during labor may experience improved confidence and coping ability independent of the physical intervention itself. Consequently, part of the observed benefit may reflect contextual or non-specific treatment effects, which are commonly observed in non-pharmacological intervention studies. Although randomization was used to balance baseline characteristics, the contribution of supportive interactions between healthcare providers, family members, and participants cannot be completely excluded.

In addition, cultural factors may influence how labor pain is perceived, expressed, and managed. In many Indonesian communities, labor pain is often viewed as a natural and expected component of childbirth, and cultural beliefs may encourage women to tolerate pain with minimal verbal expression. Such cultural norms may affect self-reported pain scores and potentially influence the measured effectiveness of pain management interventions. Therefore, caution is needed when generalizing these findings to populations with different sociocultural backgrounds and childbirth practices.

Another important consideration is the potential confounding influence of labor support. Although family support was included in the multivariable model and remained significantly associated with pain intensity, other aspects of labor support, such as the quality of midwife–patient communication, emotional encouragement from healthcare providers, and continuous companionship during labor, were not measured directly. These factors may influence maternal pain perception and should be considered in future studies investigating non-pharmacological pain management strategies.

The findings of this study have important implications for maternal healthcare practice, particularly in primary healthcare settings with limited access to pharmacological pain management. The intervention package is simple, inexpensive, non-invasive, and feasible for implementation by midwives after brief training. Therefore, breathing relaxation exercise and

pelvic rocking exercise may be integrated into standard intrapartum care protocols to improve maternal comfort and childbirth experiences. Nevertheless, this study has several limitations. First, the study was conducted in a single healthcare center, which may limit the generalizability of findings to other populations or healthcare settings. Second, pain intensity was measured using self-reported instruments that may be influenced by individual pain tolerance and emotional conditions. Third, blinding participants was difficult because respondents were aware of the intervention received, which may introduce response bias.

Furthermore, the inability to blind participants creates the possibility of expectancy effects, whereby women receiving the intervention may anticipate symptom improvement and consequently report lower pain scores. Observer bias was minimized through blinded outcome assessors; however, reporting bias associated with self-reported pain measures cannot be completely eliminated. Residual confounding may also remain despite multivariable adjustment because factors such as previous childbirth experiences, coping styles, labor companionship quality, and cultural beliefs regarding childbirth were not fully measured. These limitations should be considered when interpreting the study findings.

Despite these limitations, the randomized controlled trial design, allocation concealment procedures, blinded outcome assessment, and multivariable analysis strengthened the internal validity of the study findings.

CONCLUSION

This study concluded that breathing relaxation exercise and pelvic rocking exercise were effective in reducing labor pain among women during the active phase of the first stage of labor. Mothers who received the intervention experienced significantly lower pain intensity compared with those receiving standard care. Anxiety level, family support, and duration of labor were also associated with labor pain intensity. The intervention package may serve as a safe, practical, and evidence-based non-pharmacological approach for labor pain management in primary maternal healthcare services.

Healthcare providers, especially midwives in primary healthcare centers, are encouraged to implement breathing relaxation exercise and pelvic rocking exercise as part of routine intrapartum care to improve maternal comfort during labor. Future studies are recommended to involve larger sample sizes, multicenter settings, and additional maternal outcomes such as labor duration, maternal satisfaction, and neonatal outcomes to strengthen evidence regarding the effectiveness of physical activity-based interventions during childbirth.

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Artificial Intelligence (AI) Use Statement

The authors declare that artificial intelligence (AI)-assisted tools were used solely to support language editing, grammar checking, and improvement of manuscript readability during the preparation of this article. AI tools were not used for study design, data collection, data analysis,

interpretation of results, or generation of scientific conclusions. All intellectual content, interpretations, and final decisions regarding the manuscript remain the sole responsibility of the authors.

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