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The Effectiveness of Core Stability Exercise Toward the Beta-Endorphin Hormon Level of Postpartum Mothers

Efektivitas Core Stability Exercise terhadap Level Hormon Beta-Endorfin pada Ibu Pasca Persalinan

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ABSTRACT

Background: A decrease in beta-endorphin hormone levels is experienced by postpartum mothers on the 4th day. Beta-endorphin hormone plays an important role as an analgesic, in breast milk production, and in preventing postpartum depression.

Objective: This research was aimed to determine the effectiveness of core stability exercise on beta-endorphin hormone levels in postpartum mothers.

Methods: A pretest and posttest controlled group design was utilized in this research. Forty-two postpartum mothers at Halmahera and Ngesrep Health Centers, Semarang were involved as respondents. The respondents were divided equally into 2 groups using simple random sampling: the experimental group (core stability exercise) and the control group (postpartum exercise). The effects on beta-endorphin hormone levels were then observed before and after the intervention while anxiety scores were controlled. Analysis was performed using independent T-test and MANCOVA.

Results: The mean increase in beta-endorphin hormone levels in the experimental group was 140 ng/ml, while in the control group it was 43.1 ng/ml. Core stability exercise was found to be more effective in increasing beta-endorphin hormone levels after controlling for anxiety compared to postpartum exercise, with a p-value of 0.023.

Conclusion: Core stability exercise is effective in increasing beta-endorphin hormone levels in postpartum mothers. This research can be used as a guideline for midwives to implement core stability exercise when providing midwifery care to postpartum mothers.

Keywords: beta-endorphin; core stability exercise; postpartum

ABSTRAK

Latar Belakang: *Ibu pasca persalinan mengalami penurunan level hormon beta-endorfin pada hari ke-4. Hormon beta-endorfin berperan penting sebagai analgesik, produksi ASI, dan mencegah terjadinya depresi pasca persalinan.*

Tujuan: *Penelitian bertujuan untuk mengetahui efektivitas core stability exercise terhadap level hormon beta-endorfin pada ibu pasca persalinan.*

Metode: *Desain penelitian menggunakan pretest and posttest controlled group design. Melibatkan 42 responden yaitu ibu pasca persalinan di Puskesmas Halmahera dan Ngesrep, Semarang. Responden dibagi menjadi 2 kelompok sama rata dengan simple random sampling yaitu : kelompok eksperimen (core stability exercise) dan kelompok kontrol (senam nifas). Kemudian akan dilihat pengaruhnya sebelum dan sesudah intervensi terhadap level hormon beta-endorfin dengan mengendalikan skor kecemasan. Analisis menggunakan independent T test dan MANCOVA.*

Hasil *Rerata kenaikan level hormon beta-endorfin pada kelompok eksperimen yaitu 140 ng/ml, sedangkan pada kelompok kontrol adalah 43.1 ng/ml. Core stability excercise lebih efektif untuk meningkatkan level hormon beta-endorfin setelah mengendalikan kecemasan dibandingkan dengan senam nifas dengan nilai p 0,023.*

Kesimpulan: *Core stability exercise efektif meningkatkan level hormon beta-endorfin pada ibu pasca persalinan. Penelitian ini sebagai pedoman bidan untuk menerapkan core stability exercise saat memberikan asuhan kebidanan pada ibu pasca persalinan.*

Kata Kunci: *beta-endorfin; core stability exercise; pasca persalinan*

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INTRODUCTION

The beta-endorphin hormone decreases on day 4 in postpartum women, which provides an analgesic effect by binding to μ-opioids. This interaction prevents the release of Gamma-aminobutyric Acid (GABA), inhibits neurotransmitter activity, and stimulates the production of dopamine, known as the happiness hormone (Litwack 2022). The analgesic effect prevents postpartum mothers from feeling afterpains or pain due to the process of uterine involution (Karimah, Supriyana, Sumarni, et al. 2022), pain due to perineal wound sutures (Karimah, Khafidhoh, Hardjanti, et al. 2019), pain due to cesarean section sutures, and pain due to breastfeeding the baby for the first time (Kartal, Kaya, Yazici, et al. 2022).

The beta-endorphin hormone secreted into the bloodstream stimulates the let-down reflex by increasing the secretion of prolactin and oxytocin hormones by the anterior pituitary, which supports the process of producing and releasing breast milk (Lestari, Rahmawati, Windarti, et al. 2019). The exclusive breastfeeding rate in Indonesia in 2022 (67.96%) has decreased compared to 2021 (69.7%). The causes of mothers not exclusively breastfeeding are complex, including employment, poor milk production, limited knowledge of the importance of breast milk for babies, lack of early initiation of breastfeeding (IMD), and insufficient husband support (Salamah & Prasetya 2019). Breast milk is a living fluid rich in nutrients for babies and can strengthen the baby's immune system (WHO 2023).

Beta-endorphins are important in preventing postpartum depression by improving mood, resulting in improved physical condition. The global prevalence of postpartum depression each year is approximately 10-15% or 500,000 people (Guintivano, Manuck & Meltzer-Brody 2018). The prevalence of postpartum depression in Indonesia in 2021 was 27% (I-NAMHS 2022). Postpartum depression can reduce breast milk production through an increase in the hormone cortisol (stress hormone), which suppresses the secretion of prolactin and oxytocin hormones (Ahmadinezhad, Karimi, Abdollahi, et al. 2024), and can lead postpartum mothers to harm themselves and their babies.

The beta-endorphin hormone is a neuropeptide composed of 31 amino acids produced in the body by the hypothalamus and pituitary when a person feels comfortable. Postpartum mothers who receive emotional, physical, and psychological support from their husbands will feel comfortable and experience reduced stress, then their bodies will respond by increasing levels of beta-endorphins (Lowdermilk, Cashion, Alden, et al. 2023). Additionally, engaging in enjoyable activities can increase beta-endorphin levels, such as pursuing hobbies, consuming favorite foods, cuddling the baby, receiving massage, and exercising. Beta-endorphins are released when the body experiences pain, discomfort, depression, negative mood, decreased appetite, and during breastfeeding. These represent some of the benefits of beta-endorphins to the body (Litwack 2022).

The beta-endorphin hormone plays a crucial role for postpartum and breastfeeding mothers and can be stimulated through exercise. The type of exercise recommended for postpartum mothers is postpartum exercise. Pelvic floor muscle exercises, also known as postpartum exercises, are proven to strengthen the pelvic floor muscles after childbirth and reduce incontinence symptoms (KEMENKES 2018).

Postpartum exercises can increase blood circulation, improve postpartum posture, and strengthen the back, pelvic floor, and abdominal muscles. However, puerperal exercises cannot activate the transversus abdominis, erector spinae, and oblique muscles needed to improve spinal stability (Yuliarti 2010). Therefore, core stability exercise has been shown to reduce pain intensity in patients with chronic non-specific low back pain (Zheng, Liu, Yin, *et al.* 2024).

Postpartum mothers transition into their new role as caregivers for their newborn babies, spending significant time breastfeeding babies, bathing babies, and changing baby clothes that are wet from urine or feces. This is very time-consuming; therefore, care or intervention for postpartum mothers is carried out through home visits or homecare. Core stability exercise can be performed in a group class or individually (Karimah, Afriannisyah, Ropitasari, et al. 2024).

Core stability exercise is an exercise that activates the 'core' muscles, namely the transversus abdominis and multifidus. Both muscles are continuously modulated by the central nervous system and provide feedback regarding joint position. The transversus abdominis muscle begins to contract 30 milliseconds before limb movement occurs, while the multifidus muscle contracts within 110 milliseconds. In individuals with low back pain, this neuromuscular response is delayed. As a result, the transversus abdominis and multifidus muscles have difficulty forming spinal stability before movement (Karimah, Afriannisyah, Ropitasari, et al. 2024).

Core stability exercises aim to create stability in the proximal body parts to allow optimal distal movement. This continuous movement pattern helps protect the distal joints as the body moves (Norris 2023). Body stability is maintained through interactions between three subsystems: the nervous subsystem (including the central and peripheral nervous systems), the passive subsystem (which includes bones, ligaments, and joints), and the active subsystem (involving muscles and tendons). These three systems work synergistically to control spinal movement and stability (Wang, Zheng, Yu, et al. 2012).

To date, there has been no research that specifically evaluates the effectiveness of Core stability exercise for postpartum mothers. Therefore, this study aims to determine the effectiveness of core stability exercise on beta-endorphin hormone levels in postpartum mothers. This research is expected to provide guidelines for midwives to apply core stability exercise when providing midwifery care to postpartum mothers.

MATERIALS AND METHODS

A. Research Design

A pure experimental design with pretest and posttest controlled group was employed in this study. Participants were randomly allocated into two groups: the experimental group received core stability exercise intervention, while the control group performed standard puerperal exercises. Each participant engaged in the assigned intervention three times weekly for 45-minute sessions over a one-month period.

Core stability exercise and postpartum exercise served as the independent variables, with beta-endorphin hormone level as the dependent variable. Anxiety was identified as a confounding variable. This research was conducted between February and March 2020 at Halmahera and Ngesrep Health Centers in Semarang City, Indonesia.

B. Population and Sample

The target population comprised all postpartum mothers attending Halmahera and Ngesrep Health Centers in Semarang City. Based on outcome probability calculations, a sample size of 42 participants was determined and equally divided between the two groups. Inclusion criteria were: postpartum women within 0-3 months, aged 20-35 years, history of vaginal delivery, and body mass index < 27 kg/m². Exclusion criteria included: consumption of analgesic medications, presence of other medical conditions, and unwillingness to participate..

Simple random sampling was utilized by having participants select lottery numbers randomly. Two lottery options were provided: number 1 (experimental group) and number 2 (control group). Participants were categorized according to their selected lottery number.

C. Data Collection Procedure

This study received ethical approval from the Bioethics Commission for Medical/Health Research, Faculty of Medicine, Sultan Agung Islamic University Semarang (Ethical Clearance number: 023/I/2020/Bioethics Commission). All participants provided informed consent prior to enrollment.

Beta-endorphin hormone levels and anxiety scores were measured before intervention (pretest). Participants then followed their assigned exercise regimen—core stability exercise (experimental group) or postpartum exercise (control group)—for one month. Post-intervention measurements (posttest) were obtained from both groups upon completion of the program.

D. Research Instrumens

For both pretest and posttest measurements, 1 cc saliva samples were collected from participants. The posttest sample was taken after the 12th (final) session. Samples were transported to the Diponegoro University GAKY Laboratory for storage until analysis. Beta-endorphin hormone levels were assessed using the Enzyme-Linked Immunosorbent Assay (ELISA) method. Anxiety was evaluated using the validated Perinatal Anxiety Screening Scale (PASS) questionnaire, a 31-item instrument designed to detect various anxiety symptoms during pregnancy and postpartum with high sensitivity and versatile application.

E. Data Analysis

Univariate analysis was performed to describe participants' characteristics (age, parity, and anxiety score), independent variables (core stability exercise and postpartum exercise), and the dependent variable (beta-endorphin hormone level). Bivariate analysis determined the effects of both exercise regimens on beta-endorphin levels. Prior to bivariate testing, data normality was assessed using the Shapiro-Wilk test, as the sample size was less than 50. Results indicated that differences between pretest and posttest beta-endorphin levels and anxiety scores were normally distributed (p-value > 0.05) (Table 1). Consequently, parametric analysis using the independent t-test was conducted.

Table 1. Results of Normality Testing

No.	Variables	Group	n	Mean	Value of p^a	Data Distribution
1	Beta-endorphin hormone levels	Experiment	21	3,36	0,667	Normal
		Control	21	8,89	0,760	Normal
2	Anxiety score	Experiment	21	9,40	0,691	Normal
		Control	21	6,42	0,952	Normal

[a]Shapiro-Wilk: Test of normality, level of significance sig>0.05*

Multivariate analysis was performed using the MANCOVA test to control for confounding factors that function as covariates. The anxiety variable qualified as a covariate based on Pearson correlation testing with the dependent variable. All data were analyzed using SPSS version 22.0.

RESULT AND DISCUSSION

A. Research Results

The characteristics of respondents in this study were analyzed using univariate methods, which included the mean, minimum value, and maximum value of age, parity and anxiety. Prior to the intervention, a homogeneity test of characteristics was conducted to ensure similarity of variance between groups by applying the Lavene test.

Healthcare professionals, particularly midwives, can promote core stability exercise as an evidence-based intervention when providing high-quality midwifery care to postpartum mothers. Future research should consider using additional biomarkers, such as cortisol hormone levels, to obtain more accurate measurements of anxiety scores and minimize subjective assessment biases.

Table 2. Respondent Characteristics

No.	Characteristics	Experiment			Control			Value of p^a	Value of p^b
		Average	Min	Max	Average	Min	Max		
1	Age	24,16	19	36	26,11	19	39	0,557[a]	0,970
2	Anxiety	25,16	16	40	28,42	10	28	0,419[a]	0,185

[a]*Levene Test: Homogeneity of variances, *level of sig>0.05*
[b]*Independent T Test, level of sig>0.05*

Table 2 indicates that participants in the experimental group had a mean age of 24 years and an anxiety score of 25.16, while the control group had a mean age of 26 years and an anxiety score of 28.42. Statistical analysis revealed no significant differences in age and anxiety scores between groups (*p* value > 0.05), confirming homogeneity.

Table 3. Parity Status of Respondents

No.	Characteristics		Experimental Group		Control Group	
			f	%	f	%
1	Parity	Primiparous	1	5	0	0
		Multiparous	20	95	21	100

As shown in Table 3, the majority of participants were multiparous in both the experimental (95%) and control (100%) groups. Table 4 demonstrates that the mean baseline (pretest) beta-endorphin level was 86.26 ng/ml in the experimental group compared to 182 ng/ml in the control group. Homogeneity testing confirmed no significant difference in baseline beta-endorphin levels between groups (p value > 0.05).

Table 4. Homogeneity Test Results of Mean Beta-Endorphin Levels Before Intervention

No.	Variables	Group	Mean
1	Beta-endorphin level	Experiment	86,26
		Control	182
		P-value	0,101[a]

[a]*Levene Test: Homogeneity of variances*
**level of sig >0.05*

As presented in Table 5, the calculated T-value was 4.87. The p-value for the gain score in beta-endorphin levels between experimental and control groups was 0.004 (< 0.05), resulting in acceptance of the alternative hypothesis (H1). This indicates a statistically significant difference in beta-endorphin levels between pretest and posttest measurements across the experimental and control groups.

Table 5. Beta-endorphin Hormone Level Score Gain

No.	Group		Average	Value p^a	Value of p^b	Delta Mean
1	Experimental	*Pre test*	1,2	0.021[a]	0.004[b]	7,01
		Post test	1.9			
2	Control	*Pre test*	1.6	0.790[a]		4,8
		Post test	1.6			

[a]*Paired sample T test, *level of significance sig < 0.05*
[b]*Independent T test, *level of significance sig < 0.05*

Table 6. Correlation Analysis of Anxiety Score Gain with Beta-Endorphin Hormone Levels

No.	Variables	Value of p^a	Pearson Correlation[b]
1	Anxiety-hormone beta-endorphins	0,0001[a]	0,882[b]

[a]*Pearson Correlation Test * level of sig < 0.05*
[b]*Pearson Correlation * level of sig > r table* 0.320

Table 6 presents the results of Pearson correlation analysis. The significant relationship between anxiety variables and beta-endorphin hormone levels is demonstrated by a p-value of 0.0001 (< 0.05), indicating a strong correlation between these variables. The calculated r-value of 0.882 exceeds the r-table value of 0.320 (r-calculated > r-table), confirming a significant relationship between anxiety variables and beta-endorphin hormone levels.

Table 7 demonstrates the difference in beta-endorphin level gain between the experimental and control groups after controlling for anxiety as a covariate. The p-value for Roy's Largest Root test was 0.023 (< 0.05), indicating a significant effect of the different interventions between the experimental and control groups on beta-endorphin hormone levels after controlling for postpartum maternal anxiety.

The Multivariate Analysis of Covariance (Tests of Between-Subjects Effects) revealed that the covariate variable of anxiety significantly affected beta-endorphin hormone levels (p = 0.007, < 0.05), confirming the influence of anxiety as a covariate on beta-endorphin hormone levels.

Table 7. Difference in Gain Score of Beta-Endorphin Hormone Levels with Anxiety as Covariate

No.	Variables	Group	Average	*P-value*		
				Roy's Largest Root	Group	Covariance Anxiety
1	Beta-endorphin level	Experiment	140	0,023[a]	0,749[b]	0,007[b]
		Control	43,1			

[a]*MANCOVA, level of sig <0.05*
[b]*MANCOVA: Tests of Between-Subjects Effects, level of sig<0.05*

As shown in Table 7, the mean increase in beta-endorphin hormone levels was substantially higher in the experimental group (140 ng/ml) compared to the control group (43.1 ng/ml). This indicates that the core stability exercise intervention had a greater effect on increasing beta-endorphin hormone levels compared to standard postpartum exercises.

Based on these findings, the MANCOVA analysis confirms that core stability exercise is effective for increasing beta-endorphin levels in postpartum mothers, even after controlling for anxiety as a covariate.

B. Discussion

1. Respondent Characteristics

The mean age of participants was 24 years in the experimental group and 26 years in the control group, falling within the healthy reproductive range (20-35 years). This age range is particularly relevant to beta-endorphin hormone function, which plays a significant role in the reproductive system. At healthy reproductive ages, beta-endorphin levels typically remain in optimal condition. Most participants in both groups were multiparous (Seshadri, Morris, Serhal, et al. 2021; Chronopoulou, Raperport, Serhal, et al. 2021).

Parity, defined as the total number of live births a woman has experienced, is considered safest for both mother and infant when between 2-3. Parity status of 1 (primiparous) or greater than 3 presents increased risks. The parity distribution in this study was therefore considered predominantly safe (Yusuf 2022). It is noteworthy that parity status can influence postpartum beta-endorphin levels, with primiparous mothers typically exhibiting higher levels due to increased stress and pain responses associated with first-time labor (Karimah, Afriannisyah, Ropitasari, et al. 2024).

Mean anxiety scores were 25.16 in the experimental group and 28.42 in the control group, categorizing participants as experiencing mild to moderate anxiety (Barone, Cuniberti & Perna 2022).

2. **Gain Score Analysis of Beta-endorphin Hormone Levels**

Beta-endorphins are endogenous peptides secreted by the pituitary gland in response to stress or pain stimuli. These peptides bind to opioid receptors on neurons, inhibiting neurotransmitter release and consequently disrupting pain signal transmission to the brain. Physical exercise has been demonstrated to stimulate beta-endorphin release approximately 30 minutes after initiation of activity (Lowdermilk, Cashion, Alden, et al. 2023).

The anterior pituitary gland serves as both a storage and synthesis site for beta-endorphins, which are produced in substantial quantities. These hormones demonstrate immune-stimulating properties, stress-suppressing effects, analgesic action, and anti-inflammatory capabilities. Beta-endorphins function similarly to endogenous morphine, providing holistic preventive benefits without adverse physiological effects (Suri, Sharma & Saini 2017).

In this investigation, beta-endorphin levels were assessed via ELISA methodology using morning saliva samples. Hormones enter saliva through the vasculature surrounding salivary glands. Saliva has gained significant traction as a diagnostic medium over the past decade due to several advantages compared to serum sampling. These advantages include non-invasive collection (preventing tissue damage), ability for self-sampling without specialized training, relatively lower examination costs, and reduced participant anxiety associated with venipuncture procedures (Pfaffe, White, Beyerlein, et al. 2011).

Our findings revealed statistically significant differences in beta-endorphin levels between experimental and control groups. The mean increase in beta-endorphin concentration was 7.0142 ng/ml in the experimental group compared to 4.8189 ng/ml in the control group.

Therefore, participants who received core stability exercise intervention demonstrated greater increases in beta-endorphin levels compared to those who received standard postpartum exercise.

The significant elevation in beta-endorphin levels following core stability exercise aligns with previous research indicating that exercise constitutes a viable preventive or adjunctive treatment for improving mental wellbeing by alleviating anxiety, depression, pain, and stress symptoms (Mikkelsen, Stojanovska, Polenakovic, et al. 2017). Furthermore, physical exercise has been demonstrated to simultaneously increase beta-endorphin production while decreasing cortisol levels (Hildebrandt et al., 2014; Robinson and Balasundaram, 2018; Yadav et al., 2012).

3. Effectiveness of Core Stability Exercise and Postpartum Gymnastics on Beta-endorphin Hormone Levels

After controlling for anxiety as a covariate, our analysis revealed a direct effect between core stability exercise and postpartum exercise on beta-endorphin hormone levels ($p=0.023$). Based on MANCOVA test results, we conclude that core stability exercise intervention demonstrates superior efficacy in elevating beta-endorphin levels compared to standard postpartum exercises, even after controlling for anxiety.

We observed that as beta-endorphin levels increased following core stability exercise, anxiety scores concurrently decreased. This finding corresponds with research by Mohammed Emran (2017), which demonstrated that kinesiotape application combined with postural correction exercises constitutes a more effective therapeutic approach compared to exercise alone for postpartum mothers experiencing back pain. This conclusion was supported by documented reductions in pain intensity measured via Visual Analog Scale (VAS) among participants (Mohamed, El-Shamy & Hamed 2018).

Our findings align with previous research indicating that physical interventions effectively reduce back pain in postpartum women. Physical activity programs based on the BASNEF (Beliefs, Attitudes, Subjective Norms, and Enabling Factors) model have demonstrated effectiveness in promoting physical activity during the postpartum period. Consequently, implementation of physical exercise programs accompanied by educational components is recommended for all postpartum mothers (Bashirian et al., 2020; Thabet and Alshehri, 2019).

During pregnancy, abdominal muscles undergo progressive stretching as gestational age advances. This results in decreased muscle tone, which becomes particularly pronounced during the postpartum period. Consequently, the abdominal wall weakens and abdominal muscle strength diminishes. Standard postpartum exercises primarily target the abdominal and pelvic floor muscles (Rahmaniar, Halik, Purnamasari, et al 2019).

Core stability exercise encompasses a broader anatomical region, extending from the abdominal trunk to the inferior torso. The muscle groups engaged during these exercises include: the Gluteus Muscle Group (pelvic muscles, medial hip, and hamstrings), Hip Muscle Group (superior hip and pelvis), Abdominal Muscle Group (transversus abdominis, multifidus, anterior and lateral abdominal muscles, and obliques), Spine Muscle Group (paraspinal musculature), and the diaphragm (Kibler, Press & Sciascia 2006).

Core stability exercise was initially developed for athletic performance enhancement, focusing on strengthening specific muscle groups. However, its application has increasingly expanded to postpartum rehabilitation because the targeted muscle groups significantly influence postpartum recovery processes (Dipietro, Evenson, Bloodgood, et al. 2019), (Rahmaniar, Halik, Purnamasari et al 2019).

This study confirms that core stability exercise effectively increases beta-endorphin levels. The core stability exercise protocol implemented in this investigation comprised a systematic series of movements designed to strengthen the abdominal muscles, diaphragm, pelvic muscles, L1-L5 vertebral spine, and hamstrings. Beyond physical exercise, our intervention included educational components explaining the functional purpose of each movement sequence. This approach enhanced participants' understanding of exercise rationale and function. Additionally, postpartum counseling was provided, which increased maternal knowledge and motivation for optimal postpartum recovery.

Postpartum mothers who engage in core stability exercise experience increased hypothalamic-pituitary-adrenal (HPA) axis activation within adaptive physiological parameters. HPA axis stimulation promotes the release of endogenous peptides, including beta-endorphins, from the anterior pituitary gland into systemic circulation. This physiological response to mild exercise-induced stress generates natural euphoric and analgesic effects.

Furthermore, the rhythmic muscle contractions performed during core stability exercise stimulate mechanosensory receptors and proprioceptors, which transmit afferent signals to the spinal cord and brain. These neural impulses are subsequently relayed to the limbic system and hypothalamus—regions critically involved in emotional regulation and endogenous hormone secretion. Consequently, beta-endorphin secretion increases, contributing to reduced back pain intensity and disability levels in postpartum women (Xue, Sun, Zhu, et al. 2020).

Elevated beta-endorphin levels induce sensations of pleasure, relaxation, and contentment while reducing anxiety and enhancing immune function in postpartum mothers.

CONCLUSION

The findings of this study demonstrate that core stability exercise is more effective than standard postpartum exercises for increasing beta-endorphin hormone levels after controlling for anxiety as a covariate. These results provide valuable evidence-based guidance for midwives to implement core stability exercise in postpartum care protocols. Healthcare professionals, particularly midwives, should consider incorporating core stability exercise as a high-quality intervention when providing comprehensive midwifery care to postpartum mothers. This approach may enhance both physical recovery and psychological well-being during the postpartum period. Future research should consider utilizing cortisol as a biomarker to obtain more objective measurements of anxiety, thereby enhancing the accuracy of assessment and minimizing the subjectivity inherent in self-reported anxiety measures.

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REFERENCES

Ahmadinezhad, G.S., Karimi, F.Z., Abdollahi, M. and NaviPour, E. (2024). Association between Postpartum Depression and Breastfeeding Self-Efficacy in Mothers: A Systematic Review and Meta-Analysis. *BMC Pregnancy and Childbirth*. 24 (273). Available at: https://doi.org/10.1186/s12884-024-06465-4

Barone, Y., Cuniberti, F. and Perna, G. (2022). *Anxiety Disorders. In: Key Topics in Perinatal Mental Health* . Springer. p. Cham

Bashirian, S., Ouji, Z., Afshari, M., Barati, M., et al. (2020). Effect of an Educational Intervention Based on the BASNEF Model on Promoting Physical Activity Among Postpartum Women. *International Quarterly of Community Health Education*. 40 (2): 151–158. Available at: https://doi.org/10.1177/0272684X19858897

Chronopoulou, E., Raperport, C., Serhal, P., Saab, W., et al. (2021) Preconception Tests at Advanced Maternal Age. *Best Practice and Research: Clinical Obstetrics and Gynaecology*. 7028–50.

Dipietro, L., Evenson, K.R., Bloodgood, B., Sprow, K., et al. (2019). Benefits of Physical Activity during Pregnancy and Postpartum: An Umbrella Review. *Medicine and Science in Sports and Exercise*. 51 (6): 1292–1302. Available at: https://doi.org/10.1249/MSS.0000000000001941

Guintivano, J., Manuck, T. and Meltzer-Brody, S. (2018). Predictors of Postpartum Depression: A Comprehensive Review of the Last Decade of Evidence *Clinical Obstetrics and Gynecology*. 61 (3): 591–603. Available at: https://doi.org/10.1097/GRF.0000000000000368

Hildebrandt, T., Shope, S., Varangis, E., Klein, D., et al. (2014). Exercise reinforcement, stress, and β-endorphins: An initial examination of exercise in anabolic-androgenic steroid dependence. *Drug and Alcohol Dependence*. 139(1): 86–92. Available at: https://doi.org/10.1016/j.drugalcdep.2014.03.008

I-NAMHS (2022) *National Adolescent Mental Health Survey*. Universitas Gadjah Mada. Yogyakarta

Karimah, N., Afriannisyah, E., Ropitasari and Fatsena, R.A. (2024). Home Core Stability Exercise Reduces The Intensity Of Pain And The Level Of Lower Back Disability In Postpartum Mothers. *African Journal OF Biomedical Research*. 27 (4s): 6099–6110. Available at: https://doi.org/10.53555/AJBR.v27i4S.4738

Karimah, N., Khafidhoh, N., Hardjanti, T. and Hakim, R. (2019). The Period of Perineal Wound Healing in Postpartum Mothers Between The Decoction Water Treatments of Bihanong Leaves with Red Betel Leaves. *GHMJ (Global Health Management Journal)*. 3 (3): 107–116. Available at: https://doi.org/10.35898/ghmj-33454

Karimah, N., Supriyana, Sumarni, S. and Sunarto. (2022). The Effectiveness of Hot Herbal Compress in Accelerate Uterine Involution and Recovery of Afterpains on the Postpartum Mothers. *ENDLESS: Journal of Futures Studies*. 5 (1): 1–18. Available at: http://dx.doi.org/10.54783/endlessjournal.v5i1.235

Kartal, Y.A., Kaya, L., Yazici, S., Engin, B., et al. (2022). Effects of Skin-To-Skin Contact on Afterpain and Postpartum Hemorrhage: A Randomized Controlled Trial. *Nursing and Health Sciences*. 24 (2): 479–486. Available at: https://doi.org/10.1111/nhs.12945

KEMENKES. (2018). *Hasil Utama Riskesdas Tentang Prevalensi Balita Pendek di Indonesia 2018*. Kemenkes. Jakarta

Kibler, W. Ben, Press, J. and Sciascia, A. (2006). The Role of Core Stability in Athletic Function. *Sport Medicine.* 36 (3): 189–198. Available at: https://doi.org/10.2165/00007256-200636030-00001

Lestari, I., Rahmawati, I., Windarti, E. and Hariyono. (2019). Speos (Stimulation of Endorphin, Oxytocin and Suggestive): Intervention to Improvement of Breastfeeding Production. *Medico-Legal Update*. 19 (1): 210–215. Available at: https://doi.org/10.5958/0974-1283.2019.00042.2

Litwack, G. (2022). *Hormones*. Elsevier. United Kingdom

Lowdermilk, D.L., Cashion, K., Alden, K.R., Olshansky, E., et al. (2023). *Maternity and Women's Health Care*. Elsevier Health Sciences. Missouri

Mikkelsen, K., Stojanovska, L., Polenakovic, M., Bosevski, M., et al. (2017). Exercise and mental health. *Maturitas*. 106 (September): 48–56. Available at: https://doi.org/10.1016/j.maturitas.2017.09.003

Mohamed, E.A., El-Shamy, F.F. and Hamed, H. (2018). Efficacy of kinesiotape on functional disability of women with postnatal back pain: A randomized controlled trial. *Journal of Back and Musculoskeletal Rehabilitation*. 31 (1): 205–210. Available at: https://doi.org/10.3233/BMR-170827

Norris, C.M. (2023). *Back Rehabilitation: Core Stability Re-examined: Third Edition*. Taylor and Francis. United Kingdom

Pfaffe, T., White, J.C., Beyerlein, P., Kostner, K., et al. (2011). Diagnostic Potential of Saliva : Current State and Future Applications. *Clinical Chemistry*. 57 (5): 675–687. Available at: https://doi.org/10.1373/clinchem.2010.153767.

Rahmaniar, A.S.P., Halik, A.A., Purnamasari, N. (2019). Pengaruh

Senam Nifas terhadap Intensitas Nyeri Perineum dan Kecemasan Ibu Postpartum di RSIA Pertiwi Makassar. *UMI medical journal*. 4 (2): 11–19. Available at: https://doi.org/10.33096/umj.v4i2.64

Robinson, H.S. and Balasundaram, A.P. (2018). Effectiveness of physical therapy interventions for pregnancy-related pelvic girdle pain (PEDro synthesis). *British Journal of Sports Medicine*. 52 (18): 1215–1216. Available at: https://doi.org/10.1136/bjsports-2017-098287.

Salamah, U. and Prasetya, P.H. (2019). Faktor - Faktor yang Mempengaruhi Ibu dalam Kegagalan Pemberian ASI Eksklusif. *Jurnal Kebidanan*. 5 (3): 199–204.

Seshadri, S., Morris, G., Serhal, P. and Sab, W. (2021). Assisted Conception in Women of Advanced Maternal Age. *Best Practice and Research: Clinical Obstetrics and Gynaecology*. 70(1): 10–20. Available at: https://doi.org/10.1016/j.bpobgyn.2020.06.012

Suri, M., Sharma, R. and Saini, N. (2017) Neuro Physiological Correlation Between Yoga, Pain and Endorphins. *Interantional Journal of Adapted Physical Education & Yoga*. 2 (9): 18–32

Thabet, A.A. and Alshehri, M.A. (2019). Efficacy of Deep Core Stability Exercise Program in Postpartum Women with Diastasis Recti Abdominis : A Randomised Controlled Trial. *Journal of Musculoskeletal and Neuronal Interactions*. 19 (1): 62–68.

Wang, X., Zheng, J., Yu, Z., Bi, X., et al. (2012). A Meta Analysis of Core Stability Exercise versus General Exercise for Chronic Low Back Pain. *Plose One*. [Online] 7 (12): 1–7. Available at: https://doi.org/10.1371/journal.pone.0052082

WHO. (2023). *Bersama - sama Dukung Ibu Sukses Menyusui dan Bekerja*. WHO. Jakarta. Available at: https://www.who.int/indonesia/news/events/world-breastfeeding-week/2023#:~:text=Cakupan%20ASI%20ekslusif%20Indonesia%20pada%202022%20tercatat%20hanya,dukungan%20lebih%20intensif%20agar%20cakupan%20ini%20bisa%20meningkat. (Accessed: 10 May 2024).

Xue, L., Sun, J., Zhu, J., Ding, Y., et al. (2020) The Patterns of Exercise-Induced β-Endorphin Expression in the Central Nervous System of Rats. *Neuropeptides*. 82 (102048). Available at: doi: https://doi.org/10.1016/j.npep.2020.102048

Yadav, R.K., Magan, D., Mehta, N., Sharma, R., et al. (2012) Efficacy of a short-term yoga-based lifestyle intervention in reducing stress and inflammation: Preliminary results. *Journal of Alternative and Complementary Medicine*. 18 (7): 662–667. Available at: https://doi.org/10.1089/acm.2011.0265

Yuliarti, N. (2010) *Panduan Lengkap Olahraga bagi Wanita Hamil & Menyusui*. Penerbit ANDI. Yogyakarta

Yusuf, N.N. (2022) *Keberhasilan Persalinan dengan Augmentasi terhadap Kadar Kortisol*. Penerbit NEM. Pidie

Zheng, F., Liu, S., Yin, Q., Zheng, Y., et al. (2024) Long-Term Impact of Self-Compassion Training with Core Stability Exercise on Patients with Nonspecific Chronic Low Back Pain: A Randomized Controlled Trial. *Journal of Psychosomatic Research*. 181. (111678). Available at: https://doi.org/10.1016/j.jpsychores.2024.111678