B-ICON Proceeding

CORTISOL LEVELS IN THIRD-TRIMESTER PREGNANT WOMEN

Wenny Indah Purnama Eka Sari[1*], Kurniyati[1], Yusniarita[2], Ida Mardalena[2]

[1]Department of Midwifery, Poltekkes Kemenkes Bengkulu, Bengkulu, Indonesia
[2]Department of Nursing, Poltekkes Kemenkes Yogyakarta, Yogyakarta, Indonesia

*Correspondent : wenny@poltekkesbengkulu.ac.id

Abstract

Pregnancy leads to significant physiological changes, including adaptations in the endocrine system that support fetal development and prepare the body for childbirth. Cortisol levels naturally rise during pregnancy, primarily due to increased estrogen. However, psychological stress and heightened HPA axis activity can further elevate maternal cortisol beyond normal physiological levels. This descriptive study aimed to descript cortisol levels in the third trimester among pregnant women at Rejang Lebong District in 2025. Thirty participants were selected through simple random sampling. Data were collected using questionnaires and afternoon saliva samples (0.5-1 cc), and analyzed using percentage distributions. Most respondents were aged 20-35 (86.7%), over half were primigravida (63.3%), and 66.7% were employed. The average afternoon cortisol level was 0.18, exceeding the reference value of 0.15. While increased cortisol is a normal adaptation in pregnancy, levels above the physiological range may result from factors such as stress, anxiety, depression, or poor sleep, potentially affecting maternal and fetal health. It is essential for healthcare providers, particularly midwives, to offer comprehensive antenatal care, encompassing stress and anxiety monitoring, as well as education, counseling, and psychosocial support.

Keywords: Anxiety, Cortisol level, Pregnancy, Midwife

Presented at The 5th Bengkulu International Conference on Health (B-ICON), Bengkulu-Indonesia, October 28-29th, 2025

Published: December 31st, 2025

e-ISSN : 2986-027X

INTRODUCTION

Pregnancy induces complex physiological adaptations in the maternal body to support fetal development, prepare for childbirth, and maintain metabolic equilibrium between mother and fetus (Pillay et al., 2016). These adaptations notably affect the endocrine system. Significant increases in hormones such as oestrogen, progesterone, human chorionic gonadotropin (hCG), prolactin, and thyroid hormones occur during pregnancy. These hormonal changes influence glucose metabolism, adrenal activity, thyroid function, and pituitary gland regulation (Morton & Teasdale, 2022).

The Hypothalamic-Pituitary-Adrenal (HPA) Axis, the primary neuroendocrine system regulating stress responses, metabolism, emotional regulation, and immune function, undergoes substantial modification during pregnancy. The HPA Axis primarily controls glucocorticoid production,

particularly cortisol, which is essential for maternal homeostasis and fetal development. Maternal cortisol levels progressively increase throughout pregnancy, peaking in the third trimester at concentrations two to four times higher than in non-pregnant women. This physiological adaptation ensures sufficient energy and nutrient supply to the fetus by inducing maternal insulin resistance and increasing circulating glucose (Kassotaki et al., 2021).

Physiological increases in cortisol during pregnancy are influenced by elevated estrogen, which raises cortisol-binding globulin (CBG), and by placental production of corticotropin-releasing hormone (CRH). In addition to these normal changes, psychological stress and excessive HPA axis activation can result in abnormally high maternal cortisol levels. Elevated awakening salivary cortisol reflects the HPA axis circadian pattern and can impact placental function, fetal growth, and timing of delivery. Maternal salivary cortisol measured upon waking during mid-pregnancy is a significant biomarker for predicting preterm birth and low birth weight (LBW). Salivary cortisol assessment offers a non-invasive approach for early identification of pregnant women at risk for obstetric complications (Vlenterie et al., 2022).

During pregnancy, the placenta produces substantial quantities of corticotropin-releasing hormone (CRH), which enters maternal circulation and stimulates adrenal cortisol secretion. Cortisol facilitates the provision of energy substrates such as glucose and suppresses excessive maternal immune responses to the fetus. This mechanism maintains elevated maternal cortisol levels throughout gestation. Both cortisol and pre-eclampsia (PE) are associated with gestational age at birth (Johnston et al., 2020).

Chronic stress elevates maternal cortisol levels, leading to vasoconstriction and reduced blood and oxygen delivery to the fetus. This compromised supply can adversely affect fetal growth and development (Selfiana et al., 2023). Empirical evidence demonstrates that elevated maternal cortisol negatively influences fetal development (B. R. Gonzalez et al., 2018).

Maternal anxiety activates the HPA axis, increasing production of stress hormones such as cortisol. Elevated cortisol levels can impair placental function, uteroplacental blood flow, and fetal growth. Higher anxiety correlates with increased cortisol concentrations. Both anxiety scores and cortisol levels serve as predictors of birth weight, alongside maternal anthropometric measures (Fan et al., 2018). Chronic psychological stress and sustained HPA axis activity, as indicated by hair cortisol concentration, can predict pregnancy duration in early-onset pre-eclampsia cases (Esch et al., 2023).

Based on the 2023 Rejang Lebong District Health Profile, the main cause of neonatal mortality is complications in low birth weight (LBW) and premature babies, accounting for 63% of cases. The high mortality rate due to prematurity is a determinant caused by anxiety/stress in pregnant women, leading to hypertension and pre-eclampsia. Maternal mortality in Rejang Lebong District increased in 2023 compared to 2022, with the leading cause of death being hypertension in pregnancy (Dinkes, 2024).

This study aims to descript cortisol levels in the third trimester among pregnant women at Rejang Lebong District in 2025.

METHODS

This descriptive study was conducted from June to August 2025 and involved pregnant women in their third trimester from Rejang Lebong District, Bengkulu Province. Data were collected simultaneously at a single point in time. The sample of 30 respondents was selected using simple random sampling, based on Solvin's formula.

A questionnaire was used to collect data on respondent characteristics and cortisol levels. Saliva samples, ranging from 0.5 to 1 cc, were collected in the afternoon. Data were analyzed using percentages to describe each variable. The study received approval from the Research Ethics Committee of the Bengkulu Ministry of Health Polytechnic (No. KEPK.BKL/430/05/2025)

RESULTS AND DISCUSSION

The characteristics of the subjects in this study is presented in the following table:

Table 1 Characteristics of Respondents

	Characteristics	Frequency	
		N	%
1	Age		
	Age < 20 and > 35	4	13.3
	Age 20-35 years	26	86.7
2	Parity		
	Primigravida	19	63.3
	Multigravida	11	36.7
3	Occupation		
	Working	20	66.7
	Not working	10	33.3

Table 1 shows that more than almost all respondents were aged 20-35 years (86.7%), more than half of the respondents were primigravida (63.3%), and more than half were employed (66.7%).

Description of cortisol level is presented in the following table:

Table 2 Description of cortisol level

Variable	Mean	Min-Max	SD
Cortisol Levels	0.18	0.07 – 0.64	0.10

Table 2 shows that the average afternoon cortisol level for third-trimester pregnant women at the Rejang Lebong District is 0.18, which exceeds the reference value (≤ 0.15).

During pregnancy, cortisol levels in mothers increase progressively as part of physiological adaptation. Compared to non-pregnant conditions, total cortisol levels can increase up to 3–4 times towards the end of pregnancy (third trimester) (Peterson et al., 2020). In the first trimester, cortisol begins to increase from basal levels, but remains within a range close to that of non-pregnant women. In the second trimester, there is a more pronounced increase, averaging about 30–50% higher than in the first trimester. Cortisol levels peak, reaching about three to four times the normal level, playing a crucial role in the maturation of fetal organs, particularly the lungs, and in preparing for the birth process (Bleker et al., 2017).

Increased cortisol levels in pregnant women occur due to several mechanisms, including the placenta secreting corticotropin-releasing hormone (pCRH), which progressively increases with gestational age. pCRH stimulates the mother's hypothalamic–pituitary–adrenal (HPA) axis, increasing ACTH and cortisol production. High estrogen levels during pregnancy increase CBG levels, thereby increasing total cortisol. The 11β-HSD2 enzyme in the placenta converts active cortisol into inactive cortisone, thereby protecting the fetus from excessive exposure. However, the activity of this enzyme is limited, so some cortisol still reaches the fetus. The daily rhythm (high in the morning, low at night) persists, but with overall higher levels throughout all stages of pregnancy (Chourpiliadi & Paparodis, 2023).

Risk factors and causes that affect cortisol levels in pregnant women include maternal age, psychological stress levels, nutritional status, comorbidities such as anxiety or depression, and the pregnancy itself. Pregnant women with chronic stress, high-risk pregnancies, or exposure to adverse environmental conditions tend to have higher cortisol levels. Excessive cortisol elevation can have negative effects, such as increasing the risk of preterm birth or affecting the baby's birth weight. Therefore, understanding the physiological changes in cortisol levels during pregnancy and the factors

that influence them is crucial for maintaining the health of both the mother and the fetus (Miranda et al., 2025).

High cortisol levels in pregnant women are a poor predictor of fetal *outcome*. Maternal cortisol levels are more strongly associated with adverse outcomes in infants, including IUGR, low birth weight, lower gestational age, neurocognitive development (such as attention), and a decrease in protective microbiota populations (such as Lactobacillus, Slackia, and Actinobaculum). The findings of Gonzalez *et al. (*2022) indicate that prenatal cortisol levels, as a biological indicator, have stronger predictive validity for infant outcomes, including fetal growth, birth weight, cognitive development, and gut microbiota status (R. A. C. Gonzalez et al., 2022)

Furthermore, one significant risk factor for elevated cortisol is maternal anxiety. Anxiety in pregnant women affects an increase in cortisol levels. Heuvel *et al* (2018) revealed the mechanism underlying the relationship between maternal psychological stress and cortisol and sought mechanisms other than the HPA axis. A relationship exists between maternal psychological stress and salivary cortisol levels during pregnancy. Mothers with higher anxiety levels show higher cortisol levels (Heuvel et al., 2018)

Extending the discussion on stress, it is evident that stress can affect the maternal hormonal system, particularly causing dysfunction in the HPA axis. Stress activates the sympathetic nervous system, triggering various physiological responses in the human body. In general, the body recovers from stressful situations by normalising physiological responses. However, prolonged periods of stress can lead to pathological conditions such as fatigue or depression. Stress in mothers during pregnancy is often associated with premature birth, low birth weight, and hypertension in pregnancy. Uncontrolled hypertension in pregnancy, if not treated immediately, can develop into pre-eclampsia. PJT is one of the complications of pre-eclampsia (Saleha et al., 2019) .

Changes in cortisol during pregnancy, influenced by stress, can affect fetal growth. Cortisol is released when the pituitary gland, stimulated by hypothalamic stress signals, produces ACTH. Normally, cortisol is released in small amounts, but stressful conditions cause a significant increase. This elevated cortisol is no longer able to effectively inhibit CRH and ACTH secretion.

Cortisol is essential for embryonic and fetal development. Excessive maternal cortisol crossing the placenta can alter the fetal programming of the HPA axis, disrupting the proper regulation of cortisol production and affecting fetal development, which can result in low birth weight and impaired brain development (B. R. Gonzalez et al., 2018).

During pregnancy, maternal cortisol levels increase physiologically, and some of these levels cross the placenta; however, 11β-HSD2 modulates fetal exposure. Elevated mid- and late-pregnancy cortisol levels are associated with increased risk of SGA (small-for-gestational-age), particularly in female fetuses (Vlenterie et al., 2022) .

CONCLUSION

Alterations in cortisol levels during pregnancy represent a typical physiological adaptation. Cortisol is essential for glucose metabolism, immune regulation, and fetal development. However, empirical evidence demonstrates that cortisol concentrations may exceed normal physiological ranges in response to psychological stress, anxiety, depression, inadequate sleep quality, limited social support, and frequent exposure to environmental stressors. Elevated cortisol levels are associated with adverse maternal and fetal health outcomes, including increased risk of preterm birth, low birth weight, and emotional regulation disorders in offspring.

Health professionals, especially midwives, should provide comprehensive care throughout pregnancy. Monitoring stress and anxiety, delivering education, counseling, and psychosocial support constitute essential components of antenatal care. The association between elevated cortisol and anxiety in pregnant women requires careful consideration, as unmanaged anxiety may exacerbate physiological disturbances. Integrating physical, psychological, social, and emotional support is anticipated to help maintain cortisol homeostasis and promote optimal maternal and fetal health.

ACKNOWLEDGEMENTS

Thank you to the Bengkulu Ministry of Health Polytechnic, the Head of the Rejang Lebong District Health Office, the enumerators, and the respondents involved in this research.

DECLARATION OF INTEREST STATEMENT

The authors declare that they have no conflict of interests.

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