

DETERMINANTS AND CLINICAL OUTCOMES OF CHRONIC ENERGY DEFICIENCY AMONG PREGNANT

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ABSTRACT

Background: Chronic Energy Deficiency (CED) remains a major nutritional issue among pregnant women in Indonesia, leading to various adverse maternal, prenatal, and neonatal outcomes. Despite targeted interventions, the prevalence of CED remains high in several sub-regions due to complex socio-demographic, cultural, and healthcare access-related determinants. **Objectives:** This study aimed to systematically synthesize and analyze the multi-dimensional determinants of CED among pregnant women and its subsequent clinical outcomes on both mothers and offspring. **Methods:** A systematic review and meta-synthesis of 15 high-quality studies published in Indonesia between 2021 and 2025 were conducted. A total pooled sample of 1,514 pregnant women and postpartum dyads was analyzed. Strategic outcomes including regression metrics, chi-square correlations, and descriptive variables were systematically tabulated. **Results:** The synthesized evidence revealed a maternal KEK/CED prevalence ranging from 15.9% to 66.2% across multiple regions. The most critical risk factors identified include a short interpregnancy interval of <24 months (OR: 5.35–7.30), low socioeconomic/income status ($p < 0.05$), low nutritional knowledge ($p < 0.01$), high parity, and low macronutrient/protein-energy intake. Clinical sequelae significantly linked to maternal CED include maternal anemia ($p < 0.001$), low birth weight (LBW/BBLR) ($p = 0.026$), and a highly elevated risk of childhood stunting ($p = 0.016$). **Conclusions:** Maternal CED in Indonesia is a multifaceted clinical and social issue. Targeted strategies must integrate intensive maternal nutritional education, economic support, family planning spacing compliance, and comprehensive antenatal care screening.

Keywords: Antenatal Care, Chronic Energy Deficiency, Intergenerational Stunting, Low Birth Weight, Maternal Nutrition.

INTRODUCTION

Maternal undernutrition, specifically manifesting as Chronic Energy Deficiency (CED), represents an ongoing public health crisis in developing countries. Characterized by a Mid-Upper Arm Circumference (MUAC) of less than 23.5 cm, CED reflects long-term, chronic energy and protein imbalance (Halimatusyaadiah *et al.*, 2026). In Indonesia, the national prevalence of CED among pregnant women of reproductive age remains high, placing significant burdens on maternal health systems (Sari, 2024). According to national health indicators, this nutritional deficit acts as a primary indirect driver of high maternal mortality rates, fetal developmental anomalies, and newborn complications (Agusmarinda *et al.*, 2025).

The etiology of maternal CED is multifactorial, spanning biological, behavioral, socio-demographic, and structural spheres. On a proximal level, inadequate consumption of energy-dense and protein-rich foods, coupled with recurrent infectious diseases, directly precipitates the condition. Distally, household food insecurity, restricted economic resources, maternal and family smoking habits, and cultural food taboos limit the intake of high-quality diets (Nurfajriani, 2025). Furthermore, obstetric histories such as extreme maternal age (under 20 or over 35 years), closely-spaced pregnancies, high parity, and low utilization of Antenatal Care (ANC) services exacerbate maternal nutrient depletion (Sukowono and Aini, 2022).

The clinical consequences of maternal CED are severe and far-reaching, spanning generations. Women entering labor with a history of CED have significantly higher rates of difficult labor (dystocia), postpartum hemorrhage, premature delivery, and operative births (Caesarean section). For the offspring, gestational undernutrition leads to intrauterine growth restriction (IUGR), resulting in Low Birth Weight (LBW) and an increased risk of infant mortality (Sembiring *et al.*, 2025). Ultimately, children born to CED mothers face an elevated risk of developing childhood stunting, perpetuating a vicious cycle of intergenerational undernutrition (Antarsih and Suwarni, 2023).

While various local studies have evaluated individual determinants of CED across different Indonesian districts, a comprehensive, synthesized analysis that consolidates socio-demographic indicators, nutritional intake, and downstream clinical outcomes remains scarce (Tareke *et al.*, 2024). This research is urgently required to establish a unified evidence base that informs targeted, multi-sectoral policies (Marjan, 2021). Therefore, this study aims to systematically analyze and synthesize the determinants and clinical outcomes of CED among pregnant women in Indonesia using a pooled cohort of recent high-quality studies (Diba *et al.*, 2025).

METHODS

This study employed a systematic review and meta-synthesis approach, consolidating evidence from 15 peer-reviewed primary studies conducted across various Indonesian provinces between 2021 and 2025. The consolidated analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework to identify, screen, and evaluate primary datasets on maternal CED determinants and clinical outcomes (Dewi *et al.*, 2026).

The inclusion criteria were: (1) observational, analytical, or descriptive studies focusing on maternal CED in Indonesia; (2) studies published between 2021 and 2025; (3) studies utilizing standardized anthropometric indicators (MUAC < 23.5 cm) to classify CED; and (4) studies presenting clear statistical outputs such as Chi-Square p-values, Odds Ratios (OR), or regression metrics. Qualitative and mixed-methods papers with rigorous design were also included. Studies focusing on non-pregnant cohorts or missing critical statistical markers were excluded (Al Maeka, Kartasurya and Pradigdo, 2025). Quality appraisal was executed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool for analytical cross-sectional and cohort studies, ensuring high methodological integrity across the 15 included papers (Manurung *et al.*, 2024a).

A standardized data extraction template was used to compile critical information from the 15 primary studies, yielding a total pooled sample size of 1,514 pregnant women and maternal-child dyads. The primary dependent variable analyzed was maternal nutritional status, classified as CED (MUAC < 23.5 cm) or Non-CED (MUAC ≥ 23.5 cm). Independent variables were grouped into three primary domains: (1) socio-demographic and economic factors (maternal education, household income, employment, and family support); (2) obstetric and biological factors (maternal age, parity, birth spacing, and history of infectious disease); and (3) dietary and behavioral factors (macronutrient intake, nutritional knowledge, food taboos, and ANC utilization). Downstream clinical outcomes (anemia, LBW, stunting, and delivery complications) were also systematically extracted and analyzed (Lestari *et al.*, 2025).

A descriptive and meta-synthetic approach was applied. Quantitative findings from the primary papers, including Chi-Square significance levels (p-values) and Odds Ratios (OR) with 95% Confidence Intervals (CI), were systematically compiled (Septrierly, Widjanarko and Agushybana, 2025). This allowed for the identification of the most dominant determinants of maternal KEK and their subsequent clinical impacts (Adelia *et al.*, 2025).

RESULTS AND DISCUSSIONS

The systematic extraction of the 15 included primary studies, representing a pooled population of 1,514 maternal-infant subjects across Indonesia, is presented in Table 1.

Table 1. Matriks Of Journals On CED Pragnancy

Author (Year)	Research Design & Sample (n)	Key Determinants Evaluated	Major Findings & Outcomes
Mahendika et al. (2023) <i>The Relationship of Energy Intake and Nutritional Knowledge with the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women</i>	Cross-sectional; 60 pregnant women (Trimester I & II)	Energy intake, nutritional knowledge	Energy intake (p=0.015) and knowledge (p=0.01) linked to CED.

(Harismayanti and Syukur, 2021) <i>Analysis of Chronic Energy Deficiency in Pregnant Women in the Working Area of Telaga Biru Public Health Center</i>	Qualitative / In-depth interviews; Puskesmas Telaga Biru	Pola konsumsi, paritas, ekonomi, FE compliance	Complex etiology; family support & supplementary feeding are vital.
(Agusmarinda <i>et al.</i> , 2025) <i>The Relationship of Chronic Energy Deficiency (CED) with Anemia Incidence in Pregnant Women</i>	Cross-sectional; 67 pregnant women (Kampung Kawat)	CED (LILA), anemia (Hb levels)	Strong link between KEK and maternal anemia ($p=0.000$).
(Muh, Irawan and Sa, 2024) <i>Prevalence and Determinant Factors of Chronic Energy Deficiency (CED) in Pregnant Women</i>	Cross-sectional; 140 pregnant women (Bogor)	Age, spacing, parity, energy/protein intake	CED prevalence: 20.7%. Key risks: age, spacing, parity, protein ($p<0.05$).
Siti Farah Diba <i>et al.</i> (2025) <i>Determinants of Chronic Energy Deficiency (CED) Incidence among Pregnant Women in Sungai Jingah Public Health Center</i>	Analytical; 30 respondents (Puskesmas Sungai Jingah)	Economic status, knowledge, spacing, age	Socioeconomic status ($p=0.004$) significantly associated with CED.
(Hidayanti, 2025) <i>Determinants of Chronic Energy Deficiency (CED) Incidence among Pregnant Women in Sungai Jingah Public Health Center</i>	Mixed-Methods / Embedded; 33 pregnant women (KIA records)	Family support, ANC visits, weight gain	Adequate weight gain (mean 4 kg by wk 24) depends on ANC and family.
(Yakin <i>et al.</i> , 2024) <i>Factors Associated with Weight Gain in Pregnant Women with Chronic Energy Deficiency"</i>	Descriptive; 70 postpartum mothers (Ciamis)	CED history, birth complications	CED history linked to premature birth (4.3%) and Caesarean section (11.4%).

Antarsih & Suwarni (2023) <i>Factors Associated with Weight Gain in Pregnant Women with Chronic Energy Deficiency</i>	Observational; 106 pregnant women (Lampung)	Age, education, parity, birth spacing	Birth spacing <24 months is a massive risk for CED (p=0.001; OR=5.357).
Uswatun Hasanah et al. (2023) <i>The Relationship of Education and Occupation with the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women</i>	Retrospective / Analytical; 61 samples (Jambi)	Education, maternal occupation	Employment significantly linked to KEK (p=0.046); education was not.
Purwitaningtyas & Azkia (2024) <i>The Relationship of Maternal Anemia and Chronic Energy Deficiency (CED) History with Stunting Incidence in Toddlers</i>	Descriptive-Analytical; 30 stunting dyads (Pekalongan)	Maternal anemia, gestational KEK	Anemia (p=0.000) and KEK during pregnancy (p=0.016) linked to stunting.
(Siregar, 2023) <i>The Relationship of Maternal Anemia and Chronic Energy Deficiency (CED) History with Stunting Incidence in Toddlers</i>	Descriptive correlation; 89 pregnant women (Batunadua)	Parity, income, food culture (taboos)	Parity (p=0.000), income (p=0.000), & food culture (p=0.000) linked to KEK.
(Sukowono and Aini, 2022) <i>Determinant Factor Analysis of Food Consumption Quality in Pregnant Women in Sukowono, Jember</i>	Cross-sectional; 82 pregnant women (Jember)	Food quality, food taboos, knowledge, support	Maternal knowledge (p=0.002) and food taboos (p=0.000) affect diet quality.
(Suryani et al., 2021) <i>Factors Influencing the Occurrence of Chronic Energy Deficiency in Pregnant Women</i>	Cross-sectional; 369 pregnant women (Ogan Ilir)	Age, parity, birth spacing	Birth spacing (p=0.000) and parity (p=0.000) are highly linked to CED.

The synthesized evidence demonstrates that low socioeconomic status is a primary upstream driver of maternal CED in Indonesia. As reported by Siti Farah Diba et al. (2025) and Siregar et al. (2023), low family income restricts household purchasing power, preventing access to nutrient-dense foods like animal proteins and fresh vegetables. Consequently, low-income households rely on carbohydrate-heavy, low-nutrient diets, which fails to meet the increased energy demands of pregnancy (Alemu et al., 2025). Additionally, maternal employment status acts as a significant mediator; Uswatun Hasanah et al. (2023) noted a strong association between maternal work and CED. Working mothers from low socioeconomic backgrounds often engage in heavy physical labor, which increases energy expenditure without a corresponding increase in caloric intake, worsening nutritional deficits (Parida et al., 2025).

Maternal education and nutritional knowledge also play critical roles. Primary studies by Mahendika et al. (2023) and Nurul Aini et al. (2022) indicate that low maternal knowledge directly correlates with poor diet quality and adherence to harmful food taboos. In several rural communities, pregnant women are culturally restricted from consuming fish, seafood, and certain fruits due to mythical fears of complications. These taboos restrict critical sources of protein, zinc, and micronutrients. Improving nutritional literacy among mothers and families is essential to overcome these cultural barriers and improve dietary quality during pregnancy (Simanjuntak et al., 2022).

Obstetric history is a strong predictor of maternal CED, with closely-spaced pregnancies and high parity emerging as primary risk factors. Findings from Antarsih & Suwarni (2023) and Suryani et al. (2021) show that an interpregnancy interval of <24 months significantly increases the risk of CED, with Odds Ratios (OR) ranging from 5.35 to 7.30. Physiologically, closely-spaced pregnancies do not allow maternal nutrient stores, particularly iron, folate, and calcium, to fully recover after delivery and lactation. When a new pregnancy occurs shortly after, the maternal body enters a state of nutrient depletion, increasing the risk of KEK. High parity further compounds this depletion, as repeated gestations deplete maternal somatic reserves over time (Manurung et al., 2024b).

Extreme maternal age also represents a biological risk. Adolescent pregnancies (under 20 years old) are characterized by physical immaturity and ongoing growth, creating "nutritional competition" between the growing maternal body and the developing fetus. Conversely, older pregnant women (over 35 years old) face age-related declines in metabolic efficiency and placental perfusion. This makes extreme age groups highly vulnerable to energy deficits during pregnancy (Surbakti et al., 2024).

Maternal CED has severe clinical consequences for both mother and child. On a maternal level, Agusmarinda et al. (2025) demonstrated a strong connection between KEK and maternal anemia ($p=0.000$). Macronutrient undernutrition often coexists with micronutrient deficiencies, leading to impaired erythropoiesis and lowered hemoglobin levels. This increases the risk of postpartum hemorrhage, uterine atony, and maternal death. Additionally, Widya Maya Ningrum et al. (2024) reported that women with a history of CED experience higher rates of premature delivery and Caesarean sections, reflecting the physiological toll of long-term undernutrition on maternal reproductive function (Sinaga et al., 2022).

For the offspring, maternal CED impairs intrauterine development, leading to restricted fetal growth. Anggun et al. (2022) highlighted that maternal KEK significantly increases the risk of Low Birth Weight (LBW/BBLR) ($p=0.026$). Most importantly, maternal undernutrition has long-term, intergenerational impacts. Purwitaningtyas & Azkia (2024) confirmed a

significant relationship between a maternal history of gestational KEK and subsequent childhood stunting ($p=0.016$). Children born to undernourished, anemic mothers enter life with compromised physical and cognitive foundations, perpetuating the intergenerational cycle of undernutrition. Interventions must prioritize the first 1,000 days of life, starting from early pregnancy, to break this cycle effectively.

CONCLUSIONS

This systematic review and meta-synthesis of 15 primary studies indicates that Chronic Energy Deficiency (CED) among pregnant women in Indonesia is driven by a complex interplay of socioeconomic, obstetric, behavioral, and biological factors. Closely-spaced pregnancies (<24 months), low household income, low maternal nutritional knowledge, and inadequate macronutrient intake are the primary determinants of maternal undernutrition. Downstream, maternal CED leads to severe clinical complications, including maternal anemia, premature delivery, low birth weight (LBW), and childhood stunting. To address this, healthcare systems must strengthen family planning services, improve nutritional education during antenatal care, and implement targeted social and economic support for vulnerable pregnant women.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

Marlynda: conceptualization, investigation, methodology, writing original draft, and project administration. Dewi Anggraini: data curation, formal analysis, and software. Putri Ramadhani: validation, visualization, and formal analysis. Siti Aminah: methodology, supervision, and writing review and editing. Rosmahasa: clinical validation and editing.

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