



Multifactorial Predictors of Chronic Energy Deficiency (CED) in Pregnant Women: A Literature Review

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Abstract: Chronic Energy Deficiency (CED) in pregnant women is a critical public health issue in Indonesia, associated with severe consequences such as maternal anemia, hemorrhage, low birth weight, stunting, and perinatal mortality. This literature review analyzed 15 scientific articles sourced from Google Scholar, PubMed, and ResearchGate, to identify factors associated. The analysis identified that CED is influenced by direct factors (inadequate nutritional intake, infectious diseases) and indirect factors (extreme maternal age, low education and knowledge, economic constraints, high parity, short birth intervals, food taboos, and irregular antenatal care). While dominant factors varied regionally, maternal economic status, education, dietary patterns, and pre-pregnancy nutritional status were consistently identified as key determinants. In conclusion effective prevention requires comprehensive, context-specific, and multisectoral strategies, including enhanced nutrition education, strengthening household food security, increasing antenatal care coverage, and promoting optimal birth spacing. These interventions are crucial to reduce CED prevalence and improve maternal and child health outcomes.

Keywords: Energy Deficiency, Pregnant Women, Risk Factors, Nutrition, Prevention

INTRODUCTION

Maternal health serves as a crucial benchmark for evaluating the success of national health initiatives and the overall quality of human resources. The nutritional condition of a woman during pregnancy has a decisive influence on fetal growth and survival. Nonetheless, maternal malnutrition remains a persistent public health challenge in many regions across the globe (Wati et al., 2024). According to the World Health Organization, malnutrition refers to an imbalance between nutrient intake and the body's energy needs, encompassing both undernutrition and overnutrition. One of the most widespread chronic malnutrition problems in developing countries is Chronic Energy Deficiency (CED), caused by prolonged inadequate energy intake (Mukkadas et al., 2021).

Globally, malnutrition continues to affect millions of women of reproductive age. WHO reports that many women in this group experience anemia, leading to fatigue, weakness, and shortness of breath—conditions that diminish productivity and contribute to pregnancy complications, preterm births, and impaired child development (Hasan et al., 2022).

Approximately 30.7% of women aged 15–49 years worldwide suffer from anemia, showing that the global target of reducing anemia by 50% by 2030 remains out of reach (Alem et al., 2023). Similarly, UNICEF estimated that over one billion adolescent girls and women experience undernutrition, micronutrient deficiencies, or anemia, which worsens gender inequality by reducing learning capacity, work productivity, and maternal health outcomes. This highlights that malnutrition among women is not solely a nutritional issue but also a broader socioeconomic challenge with long-lasting consequences for human development (Owais et al., 2021).

Within the context of pregnancy, CED remains a predominant nutritional problem in low- and middle-income countries, including Indonesia. It is characterized by diminished energy reserves resulting from insufficient dietary intake to meet the increased metabolic demands of pregnancy. Persistent energy deficiency disrupts metabolism, weakens immunity, and heightens the risk of obstetric complications, leading to outcomes such as low birth weight (LBW), premature birth, and growth retardation in children (Lassi et al., 2020). Furthermore, CED perpetuates the intergenerational cycle of malnutrition, as children born to CED mothers are more likely to suffer from undernutrition in later stages of growth (González-Fernández et al., 2024).

In Indonesia, CED remains a major public health concern. The Indonesian Health Survey (SKI, 2023) reported a prevalence of 16.3% among pregnant women and 20.6% among non-pregnant women (Nofitasari et al., 2021). Although these numbers indicate improvement compared to previous years, regional disparities remain evident. Provinces in eastern Indonesia, such as Highland Papua (44.3%), South Papua (28.6%), and Southwest Papua (26.7%), record the highest rates, while Bali (8.6%) and East Nusa Tenggara (8.0%) have the lowest (Kumar et al., 2023; Laksono et al., 2023). These differences reflect unequal access to nutritious foods, maternal healthcare, and nutrition education (Andriani et al., 2023).

Research on chronic energy deficiency (CED) and related maternal health outcomes reveals multiple interconnected determinants across individual, socioeconomic, and healthcare factors. It is found by Wati et al., that extreme maternal age, low educational attainment, short pregnancy intervals, infrequent antenatal care (ANC), and low protein intake significantly increased CED risk among Indonesian pregnant women (Wati et al., 2024). Similarly, Kuntari et al. identified age, education, and supplementary feeding as key CED determinants in young rural pregnant women (Kuntari et al., 2024). Chilot et al. also demonstrated that protein intake interactions with family size substantially influence CED risk, with large families having inadequate protein intake showing 21 times higher risk (Chilot et al., 2023). Furthermore, healthcare access emerges as crucial, with studies showing suboptimal ANC utilization in high maternal mortality countries at 55.66% (Dusingizimana et al., 2023). In addition, distance to healthcare facilities, education level, and socioeconomic status significantly predict adequate ANC visits (Adem et al., 2023). Food insecurity during COVID-19 affected 51% of pregnant women and mothers, with ethnicity, education, income, and employment as primary determinants (Azevedo et al., 2023).

Despite numerous studies addressing CED prevalence and determinants, comprehensive reviews that integrate these multifactorial predictors remain scarce, particularly in Indonesia. Hence, the objective of this article is to critically synthesize empirical findings on the multifactorial determinants of CED among pregnant women and to identify key variables that can inform evidence-based maternal nutrition interventions. The insights from this review aim to support the formulation of national strategies for preventing CED and enhancing maternal nutrition resilience in Indonesia.

METHOD

This study employed a narrative literature review approach to systematically gather, examine, and synthesize findings from previous research related to the determinants of Chronic

Energy Deficiency (CED) among pregnant women. The narrative approach was chosen because it allows for a more flexible and comprehensive analysis of diverse studies, enabling the identification of both conceptual patterns and contextual variations in how CED is defined and measured. Data sources were obtained from a wide range of national and international journals to ensure a broad perspective on the issue. The search process was conducted through Google Scholar, PubMed, and ResearchGate using relevant keywords such as chronic energy deficiency, KEK, influencing factors, and pregnant women. To ensure the inclusion of recent and high-quality studies, only articles published between 2020 and 2025 in either English or Indonesian were considered. Articles that did not directly address CED in pregnant women or failed to provide an operational definition of the condition were excluded from the analysis.

A total of 15 relevant articles met the inclusion criteria and were analyzed narratively to explore both direct and indirect factors influencing CED. The included studies used various operational indicators, most commonly the Mid-Upper Arm Circumference (MUAC) of less than 23.5 cm, while some utilized a pre-pregnancy Body Mass Index (BMI) below 18.5 kg/m². The narrative synthesis focused on identifying recurring determinants such as socioeconomic status, education level, dietary diversity, maternal health, and antenatal care utilization. Through this analytical process, the review not only summarized existing empirical findings but also highlighted the interconnectedness of biological, behavioral, and environmental factors shaping maternal nutritional outcomes. This integrative perspective provides a strong foundation for understanding CED as a multifactorial issue and informs future research and policy interventions aimed at improving maternal nutrition.

RESULTS AND DISCUSSION

Result

The literature search was carried out across multiple electronic databases, including Google Scholar, PubMed, and ResearchGate, by systematically screening articles relevant to the topic of factors influencing Chronic Energy Deficiency (CED) among pregnant women. Each selected article underwent an in-depth review to ensure it met the established inclusion criteria. Eligible studies were those published between 2020 and 2025, written in either English or Indonesian, and specifically focused on identifying the determinants associated with CED in pregnant women.

Following this selection procedure, 15 scientific articles were identified as the most relevant and representative for this study. These publications were analyzed narratively to explore various contributing factors to CED, such as socioeconomic background, education level, nutritional awareness, and maternal health status. Overall, the review revealed that although numerous studies have investigated CED among pregnant women, relatively few offered a comprehensive assessment of its multifactorial nature. Thus, the 15 selected studies formed the core foundation. A summary of the selection process is presented in Table 1.

Table 1. Summary of Selected Articles

Author(s) & Year	Title	Journal	Key Findings
(Fauziah & Febriyanti, 2023)	Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women at Sukoharjo Health Center, Pringsewu District (Faktor-Faktor yang Berhubungan dengan Kurang Energi Kronik (KEK) pada Ibu Hamil di UPT Puskesmas Rawat Inap Sukoharjo Kabupaten Pringsewu Tahun 2020)	Jurnal Maternitas Aisyah (JAMAN AISYAH), 1(3)	Education, dietary patterns, and food taboos were associated with CED.
(Putra & Dewi, 2020)	Risk Factors of Chronic Energy Deficiency (CED) in Pregnant Women in Cikembar, Sukabumi	ARTERI: Jurnal Ilmu Kesehatan, 1(4)	Maternal knowledge and household food security were significant; food

Author(s) & Year	Title	Journal	Key Findings
	District (Faktor Risiko Kurang Energi Kronis (KEK) pada Ibu Hamil di Cikembar Kabupaten Sukabumi)		security was the strongest factor.
(Marjan et al., 2021)	Determinant Factors of Chronic Energy Deficiency (CED) in Pregnant Women in Gunung Sindur, Bogor (Analisis Determinan Faktor yang Berhubungan dengan Kejadian Kurang Energi Kronik (KEK) pada Ibu Hamil di Wilayah Gunung Sindur, Bogor)	Jurnal Kesehatan Terpadu, 12(1)	Age, parity, nutritional knowledge, energy, and protein intake were associated; energy intake was dominant.
(Adesty et al., 2025)	Factors Influencing the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women (Faktor yang Mempengaruhi Terjadinya Kekurangan Energi Kronik pada Ibu Hamil)	Surya Medika, 16(2)	Education, maternal knowledge, family income, dietary patterns, and pre-pregnancy BMI were related to CED.
(Nur'aini et al., 2021)	Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women at Tegal Gundil Health Center, Bogor (Faktor-Faktor yang Berhubungan dengan Kejadian Kurang Energi Kronis (KEK) pada Ibu Hamil di Wilayah Kerja Puskesmas Tegal Gundil Bogor Tahun 2020)	Promotor, 4(3)	Age, nutritional knowledge, and antenatal care visits were related to CED.
(Novelia et al., 2021)	Factors Related to Chronic Energy Deficiency (CED) Among Pregnant Women (Factors Related to Chronic Energy Deficiency Among Pregnant Women)	Nursing and Health Sciences Journal (NHSJ), 1(3)	Maternal knowledge, medical history, and parity were significantly related to CED.
(Akbarini & Siswina, 2022)	Factors Affecting the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women (Factors Affecting the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women)	Science Midwifery, 10(5)	Birth spacing and household income were significantly associated with CED.
(Nuri et al., 2022)	Relationship Between Maternal Age and Chronic Energy Deficiency (CED) in Pregnant Women in Metro, Lampung (Hubungan Usia Ibu dengan Kejadian KEK pada Ibu Hamil di Wilayah Kerja Puskesmas Ganjar Agung Kecamatan Metro Barat Kota Metro)	Jurnal Wacana Kesehatan, 7(1)	Maternal age <20 or >35 years increased the risk of CED.
(Rita Fauzia et al., 2024)	Factors Associated with the Incidence of Chronic Energy Deficiency in Pregnant Women at the UPTD Public Health Center of Sungai Raya, East Aceh, in 2024	Medical Laboratory Journal, Vol. 3 No. 1 (2025): March	Maternal knowledge, family income, and ANC visits were related; ANC frequency was dominant.
(Oktavita, 2023)	Risk Factors of Chronic Energy Deficiency (CED) among pregnant women in Surabaya (Faktor Risiko Kekurangan Energi Kronis (KEK) pada Ibu Hamil di Puskesmas Gunung Anyar Surabaya)	Jurnal Inovasi Penelitian	Low education, low income, poor nutritional knowledge, and inadequate energy and protein intake were risk factors.
(Wati et al., 2024)	Determinants of Chronic Energy Deficiency (CED) in Pregnant Women: A Cross-Sectional Study in Banyumas, Indonesia (Determinants	Narra Journal, 4(1)	Extreme age, low education, short birth intervals, low ANC frequency, and

Author(s) & Year	Title	Journal	Key Findings
	of Chronic Energy Deficiency (CED) Incidence in Pregnant Women: A Cross-sectional Study in Banyumas, Indonesia)		insufficient protein intake were associated with CED.
(Sulistianingrum et al., 2024)	Analysis of Factors Related to the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women (Analysis of Factors Related to the Incident of Chronic Energy Deficiency (CED) in Pregnant Women)	JKM (Jurnal Kebidanan Malahayati)	High parity (>2 children) was the most related factor; also nutritional status and infection history.
(Harna et al., 2024)	Prevalence and Determinant Factors of Chronic Energy Deficiency (CED) in Pregnant Women (Prevalence and Determinant Factors of Chronic Energy Deficiency (CED) in Pregnant Women)	AcTion: Aceh Nutrition Journal, 9(1)	CED was associated with age, parity, birth spacing, infection history, knowledge, and energy/protein intake.
(Jenni, 2025)	Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women in Sibolga, North Sumatra (Faktor-Faktor yang Berhubungan dengan Kejadian Kekurangan Energi Kronik (KEK) pada Ibu Hamil Puskesmas Aek Parombunan Kota Sibolga Tahun 2024)	CENDEKIA, 2(1)	Education, income, and parity were associated; income was dominant.
(Leony Lorenza et al., 2025)	Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women in the Working Area of the Putri Ayu Public Health Center, Jambi City	Jurnal Riset Rumpun Ilmu Kedokteran: Vol. 4 No. 1,: April :	Knowledge and income were significantly associated with CED.

Discussion

Main findings from previous research

Maternal nutritional status plays a vital role in determining both maternal health and fetal growth and development. Chronic Energy Deficiency (CED) among pregnant women contributes not only to complications during pregnancy but also to long-term effects on child health and human resource quality. Multiple studies have shown that CED significantly increases the risk of low birth weight (LBW), stunting, miscarriage, as well as maternal and perinatal mortality (Zewude et al., 2024). Based on literature analysis, CED is influenced by both direct and indirect factors. Direct factors include inadequate energy and protein intake and the presence of infectious diseases, while indirect factors encompass extreme maternal age, low education and limited nutritional knowledge, insufficient household income, high parity, short birth spacing, and cultural food taboos (Khammarnia et al., 2024).

Maternal age has consistently been identified as a major determinant. Pregnancies occurring before 20 years of age are linked to biological immaturity and limited physiological capacity to meet nutritional demands, whereas pregnancies beyond 35 years are associated with decreased metabolic efficiency, thereby increasing vulnerability to CED (Purwanto et al., 2020). Women at these extreme reproductive ages are reported to have up to three times higher risk of CED compared to those in the optimal reproductive range (Auranissa et al., 2024). Socioeconomic status is another critical determinant, as low household income reduces access to diverse and nutritious foods, especially animal proteins, fruits, and vegetables. Studies from Bengkulu and Sibolga found that economic hardship remains the most influential factor contributing to CED (Fitria et al., 2025). highlighting the persistent cycle of household malnutrition that cannot be resolved without social support and policy intervention. Similarly,

limited education and poor nutritional knowledge reduce women's understanding of balanced diets and result in lower dietary diversity and poor antenatal care (ANC) compliance (Kuntari et al., 2024).

Obstetric factors such as short birth intervals and high parity further worsen maternal nutrition. Birth intervals shorter than 24 months hinder the recovery of maternal energy and nutrient reserves, while repeated pregnancies accelerate physiological depletion (Aprianti et al., 2021; Sihite, 2025). Cultural practices and traditional food taboos also play a role in dietary restriction; for instance, a study in Lampung found that prohibitions against certain foods during pregnancy increased CED risk (Rukmono, 2019). Moreover, chronic infections such as diarrhea, respiratory infections, and parasitic infestations aggravate nutritional deficiencies by impairing nutrient absorption and raising energy expenditure (Wahyuni, 2021; Suherman, 2019).

Regional comparisons indicate that the determinants of CED vary across Indonesia. Research conducted in Java (Bogor, Banyumas, Gunung Sindur) highlighted inadequate energy-protein intake and inconsistent ANC visits as dominant factors, suggesting that even areas with stronger health systems face behavioral and nutritional challenges. In contrast, studies in eastern regions like Papua and Sulawesi identified economic hardship, food insecurity, and geographical constraints as primary causes. These differences demonstrate that CED is a context-dependent condition requiring regionally tailored interventions.

The implications of these findings for public health are significant. First, improving ANC quality through enhanced nutrition counseling focusing on dietary diversity, animal protein intake, and micronutrient supplementation (iron, folic acid, and calcium) is essential. Second, providing high-energy and high-protein food supplements to high-risk pregnant women should be prioritized in regions with elevated CED rates. Third, family planning programs encouraging at least 24-month birth intervals must be reinforced to support maternal recovery. Fourth, culturally sensitive, community-based education is necessary to address food taboos unsupported by science. Finally, strengthening household food security through the promotion of local food utilization, social protection initiatives, and cross-sectoral collaboration between health, education, and agriculture sectors should be central to national maternal nutrition policies.

Chronic Energy Deficiency (CED) in pregnant women

Chronic Energy Deficiency (CED) in pregnant women is a complex condition influenced by multiple interacting factors. Biologically, pregnancy increases nutritional demands as the body supports fetal growth and maternal physiological changes. Inadequate caloric and protein intake, combined with pre-existing malnutrition or infections, can exacerbate the risk of CED (Wiyono & Priyo Harjatmo, 2019). Hormonal fluctuations and metabolic adaptations during pregnancy further complicate nutrient utilization, making it difficult for women with limited dietary intake to maintain energy balance. Thus, biological vulnerabilities play a fundamental role in shaping susceptibility to CED, especially in low-resource settings where food security is fragile (Aiman et al., 2025).

From a socioeconomic perspective, poverty, low education levels, and limited access to healthcare are major determinants of maternal nutrition. Women from low-income households often face barriers to obtaining diverse and nutrient-rich foods, leading to poor dietary quality and insufficient energy intake (Alberta, 2024). Additionally, low educational attainment may reduce awareness of nutritional requirements during pregnancy, resulting in suboptimal food choices. Cultural norms and gender inequality may also limit women's autonomy in household food allocation, further increasing their risk of CED. Therefore, socioeconomic disadvantage creates structural barriers that perpetuate inadequate maternal nutrition and poor health outcomes (Janaki & Prabakar, 2025).

Behavioral and environmental factors also significantly contribute to the prevalence of CED among pregnant women. poor health-seeking behaviors, limited dietary diversity, and heavy workloads can deplete energy reserves and impair maternal well-being. In rural areas, environmental challenges such as poor sanitation, infectious disease exposure, and limited access to clean water compound nutritional deficiencies (Septierly et al., 2025). Furthermore, agricultural dependency and seasonal food shortages can lead to cyclical patterns of undernutrition. Collectively, these biological, socioeconomic, behavioral, and environmental dimensions interact in complex ways, emphasizing the need for holistic and context-specific strategies to prevent and manage CED in pregnant women (Purwanto et al., 2020).

Understanding Multifactorial Predictors is Essential for Developing Effective Maternal Nutrition Intervention

Understanding the multifactorial predictors of Chronic Energy Deficiency (CED) in pregnant women is vital for designing effective and sustainable maternal nutrition interventions. Since CED arises from the interplay of biological, socioeconomic, and environmental determinants, recognizing these interconnections allows for a more comprehensive approach to prevention (Harna et al., 2024). For instance, while nutritional supplementation may address biological deficiencies, it must be complemented by interventions that tackle the root socioeconomic and behavioral causes of inadequate dietary intake. Thus, a multidimensional understanding of CED ensures that interventions are not only curative but also preventive, addressing both immediate and underlying causes of maternal undernutrition (Nuri et al., 2022).

Identifying the key risk factors and their interrelationships further enables policymakers to formulate evidence-based strategies that are contextually relevant. Public health programs can be tailored to specific populations by integrating local data on income levels, education, and health behaviors (Siwi Hety & Rufaida, 2025). For example, in communities where poverty and food insecurity are predominant, policies that promote food fortification, agricultural support, and maternal cash assistance can be prioritized. Likewise, educational initiatives that improve nutritional literacy among women of reproductive age can enhance their ability to make informed dietary choices. Evidence-based planning ensures that interventions are efficient, equitable, and aligned with the actual needs of target populations (Nur'aini et al., 2021).

Moreover, understanding these predictors has long-term implications for breaking the cycle of intergenerational malnutrition. Maternal CED not only affects the health of the mother, but also leads, stunted growth, and developmental delays in children (Azevedo et al., 2023). By addressing the multifactorial nature of CED, public health strategies can promote healthier pregnancies, improve birth outcomes, and enhance child survival and growth. Consequently, a holistic approach to maternal nutrition grounded in a clear understanding of its multifaceted predictors serves as a cornerstone for achieving broader goals of health equity, poverty reduction, and sustainable development (Dusingizimana et al., 2023).

CONCLUSION

This literature review concludes that Chronic Energy Deficiency (CED) in pregnant women is a multifactorial condition resulting from the complex interaction of biological, socioeconomic, behavioral, and environmental determinants. The review reveals that inadequate dietary intake, frequent infections, extreme maternal age, low education, and poor socioeconomic status are consistently identified as the primary risk factors contributing to CED. Furthermore, cultural beliefs and food taboos exacerbate these vulnerabilities by limiting the diversity and adequacy of maternal diets. These findings affirm that CED cannot be attributed to a single cause but rather emerges from interconnected systemic and individual-level influences that shape maternal health outcomes across diverse regions.

The implications of these findings emphasize the importance of adopting an integrated and context-specific approach to maternal nutrition. Interventions should go beyond food supplementation and include strategies that address poverty reduction, nutritional education, healthcare access, and cultural behavior change. Strengthening antenatal care services with nutrition counseling, promoting adequate birth spacing, and supporting community-based nutrition education can collectively enhance maternal energy balance and reduce the prevalence of CED. Furthermore, policy-level actions that link health, education, agriculture, and social protection sectors are necessary to build a supportive environment that enables women to achieve optimal nutrition throughout pregnancy.

In a broader context, tackling CED is not only crucial for maternal health but also for breaking the cycle of intergenerational undernutrition. Addressing its root causes can improve birth outcomes, reduce stunting rates, and enhance long-term human capital development. Therefore, understanding and mitigating the multifactorial predictors of CED must remain a central focus of public health efforts in Indonesia and other developing nations. By implementing holistic, evidence-based interventions, governments and stakeholders can move toward achieving Sustainable Development Goals related to health, nutrition, and gender equality.

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