

Energy, Protein Intake, and Chronic Energy Deficiency in Pregnant Women: A Critical Review

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ABSTRACT

Introduction: The prevalence of pregnant women with Chronic Energy Deficiency (CED) is 14.8%, which is still above the threshold for public health problems for pregnant women at risk of CED. CED is a nutritional problem caused by lack of food intake for a long time, a matter of years. Nutritional intake is a direct cause of malnutrition. **Objective:** This research aims to review and critique articles that examine the relationship between energy, protein intake and CED in pregnant women, which includes technical studies of writing and research materials. **Methods:** The design of the research was a critical review of 10 articles related to the relation between energy, protein intake and CED in pregnant women from a database of 7 articles of nationally reputable journals and 3 articles of international reputable journals in the last 10 years. **Results:** Based on the results of a review of 10 articles, the prevalence of CED in pregnant women ranged from 9.0–44.4%, with energy intake in the less category ranging from 36.7 to 97.6%, while protein intake in the less category ranged from 29.0–73.7%. There is a relation between energy, protein intake and CED as many as 8 articles and 4 articles, respectively. And the results of the multivariate test on 4 articles of energy intake had the most dominant effect on the risk of CED. **Conclusion:** The results of this critical review indicate that energy and protein intake are related to the incidence of CED in pregnant women, so it is necessary to follow up on planning and implementing programs to prevent and overcome the incidence of CED in pregnant women.

Keywords: Energy, Protein Intake, CED, Pregnant Women

1. INTRODUCTION

Pregnant women are one of the most vulnerable population groups due to their higher nutritional needs [1]. According to the World Health Organization (WHO) in 2010 the threshold for public health problems for pregnant women with the risk of Chronic Energy Deficiency (CED) is <5%, while the results of the Nutritional Status Assessment in Indonesia (2017) show a rate of 14.8% for the prevalence of pregnant women with CED. This shows that Indonesia still has moderate category of public health problems (10-19%) for the problem of pregnant women at risk of CED [2]. CED in pregnant women as measured by mid-upper arm circumference (MUAC) was reported in the Indonesian Ministry of Health (2014) that there is an increasing of CED prevalence between 2010 and 2013. Almost one in four pregnant women (24.2%) had a low MUAC (<23.5 cm) in 2013 and this was almost unchanged in 2016, but then decreased in 2018 to 17.3% [3].

CED is a nutritional problem caused by lack of food intake for a long time, a matter of years. Lack of energy intake from macronutrients (carbohydrates, protein and fat) as well as micronutrients, especially vitamin A, vitamin D, folic acid, iron, zinc, calcium and iodine as well as other micronutrients [2]. According to United Nations International Children's Emergency Fund (UNICEF), malnutrition is caused by direct and indirect causes. Which includes direct causes are less nutritional intake and infection. Meanwhile, indirect causes include the lack of food availability at home and poor parenting as well as poor health and environmental services [4].

The results of research conducted by Petrika et al. [5] found that pregnant women with low energy intake were more in the CED risk group (50.0%), while for low protein intake the proportion was more in the CED risk group (72.2%). Likewise, research conducted by Mahmudah and Sigit [6] found that 36.7% of those whose energy intake was classified as less suffered from

CED while those with good nutritional status were 6.7% suffered from CED, for protein intake it was known that 43.5% were classified as less suffering. while 9.1% of those with good nutritional status suffer from CED.

Based on research conducted by researchers related to energy and protein intake with the incidence of CED in pregnant women, it is still a health problem in Indonesia. The prevalence of CED is still above the health problem threshold according to the WHO category. In the search for articles, 250 journals related to the incidence of CED were found, most of which used a *cross-sectional* and *case-control* research design. This critical review aimed to identify and analyse relevant articles to evaluate specific research question about energy protein intakes and CED, substantive aspects, theoretical approach, methodology, findings, discussion and recommendation. In this study, the researchers wanted to focus on 10 articles that are closest to the relationship between energy and protein intake and the incidence of CED in pregnant women to be studied and criticized regarding the technical writing and theoretical basic according to the topic.

2. METHODS

In this study, the design used was a critical review of 10 articles that were closest to the relationship between energy and protein intake with the incidence of CED in pregnant women from a nationally reputable database of 7 articles and 3 articles of international repute in the last 10 years. The 10 articles selected from 250 articles with the criteria that we justified based on the characteristics of critical review design, so in this article we did not present the diagram of articles selection (that should be present in systematic review or meta-analysis design). The criteria of the article that feasible to review: provided *full text* in Indonesian or English with the subjects in the study being pregnant women who experienced CED or were at risk for CED, and the research design used was *cross sectional* and *case control*. In this study, the researchers searched for articles using the keywords used including "ibu hamil", "kekurangan energi kronis", "nutrition intake", "pregnant women".

3. RESULTS

3.1 Clarity of CED

Chronic Energy Deficiency (CED) is one of the nutritional problems that occur in pregnant women. CED is a condition of the mother when she experiences chronic food shortages that result in maternal health problems with signs or symptoms, including a weak body and pale face [7]. CED will have an impact on the mother, fetus, and birth outcomes. The impact of CED on pregnant women is anemia, bleeding,

maternal weight does not increase normally, infection with infectious diseases and indirect causes of maternal death. The impact on infants is birth weight, perinatal mortality, perinatal health conditions, and infant growth after birth [8].

Mid-upper Arm Circumference (MUAC) defined as an anthropometric measurement which is used to assess nutritional status and determine eligibility for nutrition support especially among pregnant women [9]. The proportion of women of childbearing age and pregnant women at risk of CED is seen based on the MUAC indicator, to describe the risk of CED in pregnant women, the average MUAC <23.5 cm is used [7]. MUAC measurement is an alternative that is easier than body mass index (BMI) in identifying chronic energy deficiency events and more importantly, MUAC is only used for initial screening in pregnant women and cannot be used as a tool for monitoring nutritional status during pregnancy [10].

3.2 Mechanism of relationship between energy, protein intake and CED

Chronic energy deficiency (CED) is caused by direct factors and indirect factors. The direct factor is the intake of food sources of energy and protein and infectious diseases. Indirect factors include age, parity, level of education, knowledge, occupation, family income, food expenditure, food availability and frequency of presence of ANC [11]. Fundamentally, CED is the result of an energy imbalance in which the energy intake is lower than the body's needs. As a result, CED produces low body weight and fatty deposits [12].

Pregnancy causes an increase in energy metabolism, so the need for energy and other nutrients increases. During pregnancy, extra energy is required of 340-450 calories per day in the second and third trimesters [13] [14]. A full-term pregnancy needs around 80,000 kcal energy intake for maternal and fetal metabolism, as well as for fetal and placental growth [15]. The additional energy sources of pregnant women are usually contributed by macronutrients such as carbohydrates, protein, and fat [16]. The additional protein intake for Indonesian Requirement Dietary Allowance (RDA) needs to be added by 20 grams per day. The increasing protein intake in pregnant women needed for the growth of mother's and fetal tissue and placenta [17]. MUAC is a description of the condition of muscle tissue and fat layers under the skin that are not affected by body fluids. The MUAC measurement is intended to determine whether pregnant women suffer from CED. The MUAC threshold for CED risk was 23.5 cm. If the size is less than 23.5 cm, it means that the woman has a risk of CED [4].

This *critical review* examines and criticizes the relationship between energy and protein intake with the incidence of CED in pregnant women from 10

articles. The following is a summary of the results of the article.

Table 1. Summary the results of the relationship between energy, protein intake and CED in pregnant women

No.	Author/ Year	Subject	Characteristics	Results
1.	Petrika et al., 2014 [5].	201 pregnant women in Sedayu District, Bantul, Yogyakarta	a) Prevalence of pregnant women at risk of CED 17.9%, while not at risk of CED 82.1% b) The proportion of energy intake level is sufficient 70.7%, while the level of protein intake is low 58.7%	The results showed that there was a statistically significant relationship between the level of energy intake and the risk of CED (p=0.006; OR=2.8; 95% CI:1,3-6.1)
2.	Erwinawati et al., 2018 [18].	117 pregnant women who attend the pregnant women class in the Lubuk Muda Health Center Work Area, Siak Kecil District, Bengkalis Regency	The prevalence of the nutritional status of pregnant women is less 44.4%, while the normal nutritional status is 55.6%.	The results showed that there was no significant relationship between energy intake and the incidence of CED (p=0.825).
3.	Rachmawati et al., 2019 [19].	200 pregnant women in 25 Public Health Center, Gunungkidul Regency	a) The prevalence of pregnant women with CED is 25.0%, while not with CED is 75.0%. b) The proportion of food intake is less 28.5%, while the food intake is sufficient 71.5%	The results of this study indicate that there is a statistically significant relationship between chronic energy deficiency and food intake (energy and protein) (p<0.001; OR=6.01; 95% CI:7.74 to -1.28).
4.	Mahmudah and Sigit, 2015 [6].	45 pregnant women in the second and third trimesters in the Bergas Public Health Center, Semarang Regency	a) Prevalence of pregnant women with CED 26.67% b) A total of 66.67% of pregnant women have low energy intake and 51.11% of pregnant women have less protein intake	The results of statistical test analysis showed that there was a relationship between energy intake (p=0.038) and protein intake (p=0.017) with the nutritional status of pregnant women.
5.	Oktriyani et al., 2014 [20].	201 pregnant women in Sedayu District, Bantul, Yogyakarta	a) Prevalence of pregnant women at risk of CED 17.9%, while not at risk of CED 82.1% b) Most pregnant women have adequate energy intake (70.6%) and low levels of protein intake (58.7%)	The level of energy intake has a statistically significant relationship to the dependent variable (p=0.03; OR=3.37; 95% CI:1.50-7.57)
6.	Mutalazimah et al., 2020 [21].	164 pregnant women in the second and third trimesters in the Kemusu 2 Community Health Center, Boyolali District	a) The prevalence of pregnant women with MUAC <23.5 cm is 17.1% b) The percentage of pregnant women with very high energy deficiency (97.6%), protein deficiency	Pearson's Product moment test showed that there was a relationship between energy intake and MUAC (p=0.0215, r=0.181), and between protein intake and MUAC (p=0.001, r=0.319) in pregnant women.

No.	Author/ Year	Subject	Characteristics	Results
			(73.2%), carbohydrate deficiency (100%), and fat deficiency (90.2%)	
7.	Lestari, 2019 [22].	399 pregnant women at the Mataram Regional Health Center	a) The prevalence of CED in pregnant women is 9.0%, while not CED is 91.0% b) Some pregnant women have appropriate food intake categories 59.4% and 40.6% not appropriate	The results showed that the most dominant variable that had a relationship with the incidence of CED in pregnant women was food intake (p = 0.000, OR = 4.321)
8.	Lestari et al., 2019 [23].	30 pregnant women in the Karang Taliwang, Pajeruk, and Karang Pule Community Health Centers	a) The prevalence of pregnant women experiencing CED is 20.3% and not experiencing CED is 79.7% b) Pregnant women with food intake in the appropriate category as much as 71%, while in the inappropriate category as much as 29%	There is a significant relationship between intake foods with chronic energy deficiency in mothers pregnant in Mataram City in 2020 (p=0,000; OR=0,300)
9.	Madanijah et al., 2016 [24].	200 pre-pregnant women in the age group of 20-40 years and 203 pregnant women with gestational age between 13 and <28 weeks in Bogor Regency	All of 12.5% of pre-pregnant women and 18.3% of pregnant women experienced CED based on MUAC (<23.5)	The study results are in accordance with the MUAC measurement, >1 in 10 women initiate pregnancy with CED. In 24% of pre-pregnant women and 44% of pregnant women found inadequate energy and protein intake
10.	Nurdin et al., 2018 [25].	616 pregnant women in Jenepono Regency	The prevalence of CED in general reached 21.3%	The results of statistical tests by adjusting the variables of low carbohydrate and protein intake, between the two there were no statistically significant variables as determinants of CED in pregnant women (p> 0.05)

Based on the results of the technical study of writing on 10 articles, it was found that in general the characteristics of the abstract in 8 articles had presented a summary of the research which included the background, objectives, methods, results, and conclusions, while in the 2 articles each had not presented the objectives and conclusions of the research. The introduction in the article contains a theoretical basis that describes the research objectives. The theoretical basis in 10 articles has been able to describe the research objectives. The balance of theory in each article is systematically arranged with credible library sources in accordance with the research hypothesis. The theoretical basis in 9 articles has

specifically conveyed theories and mechanisms regarding nutritional intake with the incidence of CED in pregnant women that are relevant to the study. The 8 articles have also been supported by reference data and previous research to strengthen the assumptions about the causes of CED in pregnant women.

In the study of aspects of research methods, 6 articles have reviewed the mechanism of research methods which include the type and research design, sampling technique and process, inclusion and exclusion criteria, data collection methods, and has also been equipped with ethical approval. The study of aspects of research results in 10 articles is generally presented clearly and consistently in accordance with the

objectives of the research. In presenting the results, it is complemented by presenting tables or graphs and explained in sufficient detail. The presentation of the results fully represents the results of the research. The discussion in each article is interpreted specifically and systematically. Each article is good because the discussion has represented the theory reviewed by the researcher in the introduction and then added with other supporting theories. In addition, the discussion of each article has also been equipped with similar interventions from several previous research articles as comparisons.

Based on the study of the aspects of the conclusion of the article, 7 of them have presented the conclusions of their research supported by the results so that they are good. In addition, these 7 articles have also conveyed the efforts that need to be made related to the results of the research. In contrast to 1 article which only presented the conclusions, while in the other 2 articles the researcher presented the conclusions only in the abstract section of the article.

3.3 Relationship between energy and protein intake with CED

The results of the study, which were presented in 10 articles, showed that the prevalence of CED in pregnant women ranged from 9–44.4%. The highest percentage is found in research articles Erwinawati, et al. [18] with a percentage of 44.4%, and the lowest is in the research article Lestari [22] with a percentage of 9%, while in other studies it is in the range of 17–21%. The results of sample intake in ten articles of energy intake with the category of less with the highest percentage in research articles Mutalazimah et al. [21] with a percentage of 97.6%, and the lowest was in the research article Mahmudah and Sigit [6] with a percentage of 36.7%. As for protein intake, the results from all studies in the article stated that protein intake was in the less category with the highest results in the research article Mutalazimah et al. [21] of 73.7%, besides the results of this study also found carbohydrate deficiency (100%) and fat deficiency (90.2%). And protein intake is less with the lowest percentage in the Lestari's et al. [23] research with a percentage of 29%.

The results of statistical tests stated that there was a significant relationship between energy and protein intake and the incidence of CED with 8 articles and 4 articles, respectively. Among them in the research article Petrika et al. [5] with research results stating that there is a statistically significant relationship between the level of energy intake and the risk of CED ($p=0.006$; $OR=2.8$; $95\% CI:1.3-6.1$). In the research article Rachmawati et al. [19], the results of this study showed that there was a statistically significant relationship between chronic energy deficiency and food intake (energy and protein) ($p<0.001$; $OR=6.01$; $95\% CI:7.74-1.28$). The research of Mahmudah and Sigit [6] results

of statistical test analysis showing that there is a relationship between energy intake ($p=0.038$) and protein intake ($p=0.017$) with the nutritional status of pregnant women. The level of energy intake has a statistically significant relationship with the nutritional status of pregnant women with CED ($p=0.03$; $OR=3.37$; $95\% CI:1.50-7.57$) [20]. In the study of Mutalazimah et al. [21] the results of the Pearson's product moment test showed that there was a relationship between energy intake and MUAC ($p=0.0215$, $r=0.181$), and between protein intake and MUAC ($p=0.001$, $r=0.319$) in pregnant women. From the results of Lestari's research [22], the most dominant variable that has a relationship with the incidence of CED in pregnant women is food intake ($p=0.000$, $OR=4.321$). The results of statistical tests showed that there was a significant relationship between food intake and chronic energy deficiency in pregnant women ($p=0.000$; $OR=0.300$) [23]. And on the research results Madanijah et al. [24] study according to MUAC measurement, >1 in 10 women initiate pregnancy with CED. In 24% of pre-pregnant women and 44% of pregnant women found inadequate energy and protein intake.

In 2 articles, it was found that intake of energy and protein was not associated with the incidence of CED in pregnant women, namely in the study of Nurdin et al. [25] conducted in Jenepono Regency stated that if the results of statistical tests by adjusting the variables of low carbohydrate and protein intake, there were no statistically significant variables as determinants of CED in pregnant women ($p>0.05$), as well as the results of Erwinawati's et al. research [18] conducted at the Lubuk Muda Health Center, Siak Kecil District, Bengkalis Regency, stated that the results of the study showed that there was no significant relationship between energy intake and the incidence of CED ($p=0.825$).

4. DISCUSSION

Based on the results of the study, 10 articles showed the percentage of the prevalence of CED in pregnant women with a range of 9–44.4%. Apart from these 10 articles, it was found that the percentage prevalence of CED incidence was higher, which was 50% Azizah and Adriani's research [26]. Meanwhile, from the literature study, Desyibelew et al. [27] among pregnant women in Africa in 23 articles found 23.5% maternal malnutrition rate with a threshold set of 10% for declaring maternal malnutrition a health problem. Thus, from the research findings, the prevalence of CED in pregnant women still exceeds the health threshold for pregnant women from the WHO where Indonesia is included in the moderate category of public health problems with a percentage range of 10-19% [2].

The results of the study from 8 articles showed the percentage of energy intake in the less category with a

range of 36.7–97.6%, while protein intake in the less category with a range of 29–73.7%. In another study, it was also found that the food intake of pregnant women in the less category was 34.7%, the sufficient category was 54.7%, and the more category was 10.6% [28]. According to UNICEF, malnutrition is a direct cause of malnutrition. Which includes direct causes are less nutritional intake and infection. Meanwhile, indirect causes include the lack of food availability at home and poor parenting as well as poor health and environmental services [4].

From the results of statistical tests, it was stated that there was a significant relationship between energy and protein intake and the incidence of CED, respectively, as many as 8 articles and 4 articles. The emergence of CED in pregnant women is caused because in the long term energy intake (carbohydrates and fat) is not sufficient for the body's needs [29]. The three types of macronutrients in the form of carbohydrates, fats, and proteins produce energy for the body through metabolic processes (burning). The main sources of energy are carbohydrates and fats, while proteins are mainly used as building blocks. Only when the consumption of carbohydrates and fats is less to meet energy needs, protein is used [30]. This is in line with research conducted by Alza [31], where the conclusion from the results of his research is that there is a relationship between energy intake and the risk of CED in pregnant women ($p=0.003$).

Specifically, the cause of CED is the result of an imbalance between intake to meet energy needs and expenditure. The nutritional status of pregnant women is influenced by imbalances in nutrient intake, having suffered from infectious diseases and socioeconomic conditions [32]. Research conducted by Novitasari et al. [33], regarding the factors related to the incidence of CED in pregnant women, the most dominant variable is nutritional intake. In general, the incidence of CED is not only influenced by energy and protein intake, but all nutrients can contribute to this incident, however. the magnitude of the effect of energy and protein intake as the strongest predictors of the incidence of CED.

In 2 articles, it was found that energy and protein intake were not associated with the incidence of CED in pregnant women. In line with the results of Azizah and Adriani's research [26], the results of statistical tests showed that the level of carbohydrate, protein and fat intakes had no significant relationship with the incidence of CED ($p=1.000$; $p=1.000$; $p=0.635$) respectively. This study found factors that were significantly related to the nutritional status of pregnant women, namely education ($p=0.002$), income ($p=0.002$) and knowledge ($p=0.013$) in pregnant women [34]. According to Fathonah [35] nutritional status during pregnancy is influenced by several things including socioeconomic conditions, birth spacing,

parity, age at first pregnancy, and level of physical work. The previous study also discovered that there were differences on energy and protein intakes among women of childbearing age (preconception age) 15-19 years old with CED and non-CED [36].

5. CONCLUSION

The results of this *critical review* indicate that energy and protein intake are associated with the incidence of CED in pregnant women, so it is necessary to follow up on planning and implementing programs to prevent and overcome the incidence of CED in pregnant women.

AUTHORS' CONTRIBUTIONS

All authors contributed significantly in the designed the study, performed analysis, interpreted the data, and drafted the manuscript and critically reviewed the manuscript. All authors approved and read the final manuscript.

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