RESEARCH ARTICLE

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Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women: An Analysis of the 2018 Indonesian Basic Health Survey (Riskesdas) Data for South Kalimantan Province

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Abstract:

Introduction: The condition of Chronic Energy Deficiency (CED) in pregnant women is characterized by the long-term presence of nutritional deficiencies. The objective of this study was to analyze the factors associated with CED in pregnant women in South Kalimantan Province.

Methods: The research design employed by the present study was cross-sectional, using secondary data from the 2018 Indonesian Basic Health Survey (Riskesdas). The population under study was all pregnant women in South Kalimantan Province. The total sampling technique was employed, and the sample size was determined to be 169 pregnant women. The instrument used for this study was the Indonesian Basic Health Survey (Riskesdas) from 2018 as mentioned. The data were subjected to analysis using two statistical methods: the chi-square test and multivariate test with logistic regression.

Results: The results showed a correlation between supplementary feeding (p-value 0.008) and BMI (p-value < 0.001) with CED. Conversely, age (p-value 0.327), area of residence (p-value 0.870), educational attainment (p-value 0.981), employment status (p-value 0.456), parity (p-value 0.576), and fruit and vegetable consumption (p-value 0.718) were found to be non-significant correlates of CED.

Discussion: The findings highlight the critical role of maternal nutritional status, particularly BMI and access to supplementary feeding, in the manifestation of CED among pregnant women. The observed absence of correlation between sociodemographic factors and CED suggests that biological and programmatic interventions may exert a more significant influence than structural variables in this context.

Conclusion: The present study concludes that supplementary feeding and body mass index (BMI) have a significant correlation with CED, with supplementary feeding being the most dominant risk factor.

Keywords: CED, Education, Parity, Supplementary feeding, BMI.

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1. INTRODUCTION

Pregnant women afflicted with chronic energy deficiency (CED) predominantly experience long-term deficiencies of nutrients, especially energy and protein. The condition of CED during pregnancy arises when the body's energy requirements exceed its energy intake, resulting an energy imbalance. This occurs because the mother and the developing fetus both require additional nutrients. According to the 2018 Indonesian Basic Health Survey (Riskesdas), 17.3% of pregnant women in Indonesia were affected by CED. In South Kalimantan Province, the rate was even slightly higher, at 19.45% [1]. According to the 2020 report from the Ministry of Health of the Republic of Indonesia, the prevalence of CED among pregnant women in South Kalimantan Province had decreased to 14%, ranking ninth highest in the country and exceeding the national average of 9.7%. According to the World Health Organization (WHO), a CED prevalence rate above 5% in pregnant women constitutes a public health concern [2]. The Ministry of Health of the Republic of Indonesia has classified CED as a public health issue if its prevalence exceeds 10%. This elaboration suggests that CED in pregnant women remains a significant public health issue in Indonesia and South Kalimantan Province in particular [1, 2].

Chronic energy deficiency (CED) in pregnant women can exert a significant adverse effect on maternal and fetal health. As a form of malnutrition, CED can have a major impact on maternal health during pregnancy [3], manifesting in anemia. Anemia in pregnant women has been associated with a variety of adverse outcomes, including decreased work productivity, a higher risk of infection, preterm birth, suboptimal neonatal outcomes, and even maternal mortality [4].

Pregnant women with CED face a higher risk of encountering difficulties and discomfort during childbirth, a consequence stemming from their low energy reserves [3]. A state of CED often gives rise to inadequate intake of essential nutrients, which can, in turn, precipitate further health complications [5]. Among the most salient of these complications is the occurrence of low birth weight (LBW) babies. A correlation has been demonstrated between LBW and an increased incidence of neonatal morbidity and mortality [6].

According to the Ministry of Health of the Republic of Indonesia (2015), chronic energy deficiency (CED) during pregnancy can result from multiple factors, including indirect, biological, and direct factors. The indirect factors encompass residential location, educational attainment, and occupation. A correlation has been demonstrated between lower educational attainment and higher rates of CED. Women receiving limited educational opportunities may possesses inadequate knowledge regarding proper nutrition and the importance of dietary diversity during pregnancy [7]. In addition, pregnant women who are homemakers face a higher risk of developing CED when compared to their employed counterparts. Employment engenders financial stability, which, in turn, can improve access to nutritious food [8]. Furthermore, the living environment and socioeconomic conditions of a region influence dietary habits and nutritional intake within the population [9]. According to the 2018 Indonesian Basic Health Survey (Riskesdas), 51.14% of pregnant women affected by CED in South Kalimantan Province reside in rural areas [1].

Pregnant women experiencing chronic energy deficiency (CED) encounter long-term nutritional inadequacies, particularly in the intake of energy and protein, which is a critical determinant of the condition. It has been demonstrated that pregnant women with low protein intake exhibit a significant propensity to develop CED. Prolonged energy and protein deficiency can result in adverse pregnancy outcomes due to the increased nutritional needs associated with gestation [5].

A number of direct factors, including dietary habits and overall nutritional status, have been demonstrated to influence chronic energy deficiency (CED) during pregnancy. Inadequate dietary intake and poor eating patterns may contribute to health complications, including CED and other forms of malnutrition. An imbalance in one's diet, for instance, the inadequate consumption of fresh vegetables and meat or fish, has the potential to disrupt the fulfillment of essential nutritional needs during pregnancy, which can result in CED. The prevention of CED among pregnant women can be achieved by ensuring adequate nutrition through the consumption of a varied diet containing sufficient calories and protein. Another strategy used to improve the nutritional status of pregnant women involves the provision of supplementary food [10].

In order to address the persistent nutritional challenges faced by pregnant women in Indonesia, several national strategies have been implemented. These include

the provision of supplementary food, nutrition education for expectant mothers, and enhancements to maternal healthcare services. The provision of supplementary food can be accomplished through the administration of fortified nutritional supplements, such as fortified biscuits that have been formulated with essential vitamins and minerals. These supplements are prioritized for pregnant women classified as having chronic energy deficiency (CED) in order to address their nutritional needs. Concurrently, the primary objective of nutrition education and improved maternal healthcare services is to promote maternal awareness of balanced nutrition and ensure improved access to healthcare services throughout pregnancy [11].

Despite numerous studies conducted on chronic energy deficiency (CED) among pregnant women in Indonesia, there has been no study specifically utilizing data from the 2018 Indonesian Basic Health Survey (Riskesdas) to examine factors associated with CED in pregnant women in South Kalimantan Province. A previous study by Hasrida Mustafa *et al.* investigated the key risk factors contributing to CED among pregnant women in Indonesia. However, this study did not specifically focus on data from South Kalimantan [12]. The 2018 Indonesian Basic Health Survey (Riskesdas) data offer a broad and comprehensive representation of the population, encompassing various aspects, such as body mass index (BMI), supplementary feeding, dietary patterns, and socio-demographic factors. This approach is essential for elucidating the factors contributing to CED in South Kalimantan, a region with distinct characteristics compared to other regions [1].

A study conducted in South Kalimantan by Nirma Yunita and Mahrita Ariyati in 2021 examined the relationship between diet and family income and the incidence of CED in pregnant women. The study revealed a significant correlation between dietary habits and family income and CED among pregnant women in the operational area of Kertak Hanyar Health Center. However, the study's utilization of local data from the operational area of a single health center might limit its ability to fully represent the broader population [15].

The present study utilized data from the 2018 Indonesian Basic Health Survey (Riskesdas) to provide a comprehensive analysis of the factors associated with CED in pregnant women in South Kalimantan Province. The analysis in the present study encompasses variables, such as educational attainment and employment status, in addition to supplementary feeding and BMI, which have been identified as significant predictors of CED. The utilization of more representative data is expected to address the existing information deficit and establish a robust basis for the development of more effective health interventions in South Kalimantan Province.

2. MATERIALS AND METHODS

2.1. Study Design and Type of Study

The study employed a cross-sectional design, drawing from a secondary data set from the 2018 Indonesian Basic Health Survey (Riskesdas). The sample for this study comprised women aged 10–54 years who were selected as respondents in the 2018 Riskesdas survey in South Kalimantan Province. The Indonesia Basic Health Survey (Riskesdas) of 2018 was a national survey conducted by the Health Research and Development Agency of the Ministry of Health of the Republic of Indonesia (Supplementary Material). It functions as a primary repository for public health data, providing a comprehensive overview of health status, health behaviors, and disease risk factors throughout Indonesia. The sampling method employed in the Riskesdas of 2018 was the Probabilistic Proportional to Size (PPS) method, which utilized linear systematic sampling with a two-stage stratified cluster sampling approach. The multilevel probability method ensures that the findings are representative and can be generalized [1].

The independent variables in the present study included age, area of residence, educational attainment, employment status, parity, fruit and vegetable consumption, supplementary feeding, and body mass index (BMI). The dependent variable of this study was the incidence of Chronic Energy Deficiency (CED) in pregnant women. The present study employed a total sampling method, thereby including all pregnant women who served as respondents in the 2018 Basic Health Survey (Riskesdas). The inclusion criteria for this study were as follows: pregnant women who underwent measurement of mid-upper arm circumference (MUAC) and height and weight measurements, and who were not in their first pregnancy. The exclusion criteria for this study were subjects without data from measurement of mid-upper arm circumference (MUAC). In the 2018 Riskesdas survey conducted in South Kalimantan Province, 222 pregnant women participated as respondents. Following the application of the inclusion criteria, it was determined that three pregnant women had not undergone MUAC measurement, one individual had not undergone height and weight measurement, and 49 pregnant women were in their first pregnancy. Therefore, the total sample of pregnant women who met the inclusion criteria was 169. A sample size calculation was not required, as the entire eligible population was included as study subjects. Lastly, the integrity of the results was ensured by avoiding selection bias.

The study's respondents were exclusively female, with the majority, 103 individuals (60.9%), falling within the non-risk age range of 20 to 35 years. The remaining 66 individuals (39.1%) were considered at risk due to their age, being either under 20 or over 35 years old.

2.2. Data Collection and Measurements

The initial phase of data processing involved a thorough examination of the raw data obtained from the 2018 Indonesian Basic Health Survey (Riskesdas). This process included a review of the variables to be analyzed. Additionally, exploratory data analysis was conducted to examine data distribution and determine the characteristics of the available dataset. A data cleaning

procedure was then performed to remove entries irrelevant to the analysis. Missing data were excluded from the final analysis. The next step was data transformation, which involved compiling or recoding variables, as explained below:

1. According to the Ministry of Health of the Republic of Indonesia, chronic energy deficiency (CED) is defined as an imbalance in nutritional intake (energy and protein intake) that persists over an extended period and is characterized, in part, by mid Upper Arm Circumference (MUAC) measurement of less than 23.5 cm [9] The incidence of CED in pregnant women was obtained from the calculation of MUAC from the 2018 Riskesdas Individual Questionnaire Block L with numbers 07a and 07b. The MUAC data were then classified into two categories: CED and non-CED.

2. The variable of age is defined by the age of married and pregnant female household members, which ranged from 10 to 54 years. This variable was based on the date, month, and year of birth. The 2018 Indonesian Basic Health Survey (Riskesdas) data for South Kalimantan Province are the source of this information. The data were classified into two categories: at risk (aged <20 years and >35 years) and not at risk (aged 20-35 years.)

3. The area of residence refers to the village or district in South Kalimantan Province where married and pregnant female household members aged 10–54 years resided, as indicated in the 2018 Indonesian Basic Health Survey (Riskesdas) Questionnaire, Block I (Introduction to Location), item number 5. The area of residence was classified into two categories: rural and urban.

4. The educational attainment variable refers to the highest level of formal education completed by married and pregnant female household members aged 10–54 years, as reported in the 2018 Indonesian Basic Health Survey (Riskesdas) Household Questionnaire, Block IV (Family Member Information), item number 11. This variable was categorized into two groups: low—indicating no formal education, completion of elementary school, or junior high school; and high—indicating completion of high school or higher education (university).

5. The employment status variable refers to whether married and pregnant female household members aged 10–54 years were employed, as reported in the 2018 Indonesian Basic Health Survey (Riskesdas), Household Questionnaire, Block IV (Family Member Information), item number 12. This variable was classified into two categories: employed and not employed.

6. The parity variable is defined as the total number of children ever born to married and pregnant female household members aged 10–54 years. This variable includes live births, stillbirths, and miscarriages, as reported in the 2018 Indonesian Basic Health Survey (Riskesdas) Individual Questionnaire, Block J, Number 02, Question B. The classification of this variable is as follows: individuals who have delivered three or more children are designated as "at risk," while those who have delivered fewer than three children are classified as "not at risk."

7. The fruit and vegetable consumption variable measures the population's behavior regarding the intake of fruits and vegetables. This behavior is determined by the frequency and quantity of fruits and vegetables consumed by household members on a weekly basis. The metric was calculated using data from the 2018 Indonesian Basic Health Survey (Riskesdas) Individual Questionnaire, Block G, numbers 08 and 011. The questionnaire used is a food frequency questionnaire (FFQ). Based on the calculation results, fruit and vegetable consumption was then classified as insufficient or sufficient.

8. The supplementary feeding variable refers to the provision of supplementary food items to pregnant women. These food items include biscuits from government programs, as well as non-government programs, powdered milk, liquid milk, raw food ingredients, and cooked food ingredients. The classification of supplementary feeding can be divided into two categories: not receiving supplementary food and receiving supplementary food.

9. The body mass index (BMI) variable represents the BMI of pregnant women. BMI was calculated using height and weight data from the 2018 Indonesian Basic Health Survey (Riskesdas) in South Kalimantan Province. This data was obtained from the Individual Questionnaire of Riskesdas 2018, Block L, number 01 (height) and number 02 (weight). BMI was then classified into two categories: at risk (BMI < 18.5 kg/m^2) and normal (BMI ≥ 18.5 kg/m^2).

2.3. Statistical Analysis

The data analysis was conducted from May to June of 2021 in Indonesia. Calculations were performed using weighted N. Univariate analysis was conducted to describe the frequency distribution of each variable. Subsequently, bivariate analysis was conducted to ascertain the relationship between each independent variable and the dependent variable using the chi-square test. Odds ratio (OR) was used in the data analysis to estimate the strength of the relationship between the independent variable and the dependent variable. Multivariate analysis was executed using multiple logistic regression to determine the most dominant relevant variables.

3. RESULT

3.1. Univariate Analysis

Table **1** shows that 15.2% of the pregnant women were identified as having chronic energy deficiency (CED), while the remaining 84.8% were not. Among the respondents, 30.4% were categorized as being at risk due to age, whereas 69.6% were not. Regarding the area of residence, 48.1% of the respondents lived in rural areas, while 51.9% lived in urban areas. The respondents' educational attainment was unevenly distributed, with 62.3% having low attainment and 37.7% having higher educational attainment. Employment status indicated that 68.9% of the respondents were not employed, whereas 31.1% were employed. Regarding parity, 21.7% of pregnant women were identified as at risk, while 78.3% were not.

The analysis of dietary habits indicated that 87.7% of respondents had insufficient consumption of fruits and vegetables, while only 12.3% demonstrated sufficient consumption. With regard to supplementary food, 84.8% of the sample did not receive supplementary food, while 15.2% did. Finally, according to BMI classification, 5.5% of respondents were identified as being at risk of CED, while 94.5% had a normal BMI, indicating they were not at risk of CED.

3.2. Bivariate Analysis

As illustrated in Table **2**, the incidence of chronic energy deficiency (CED) among pregnant women in the non-risk age group was higher (15.5%) compared to those in the risk age group (9.1%). The chi-square test results, with a p-value of 0.256 (greater than 0.05), indicate that the null hypothesis (H0) was accepted, suggesting that age is not significantly associated with the incidence of CED among pregnant women in South Kalimantan Province.

Table 1. Distribution and frequency of chronic energy deficiency (CED) in pregnant women in south kalimantan according to demographic and health-related characteristics.

Variables	Frequency	Percentage (%)
Chronic Energy Deficiency (CED) Status		
CED	22	15.2
Non-CED	147	84.4
Age		
At risk (age range of < 20 and > 35 years)	66	30.4
Not at risk (age range of 20−35 years)	103	69.6
Area of Residence		
Rural	101	48.1
Urban	68	51.9
Educational Attainment		
Low attainment (no schooling; completion of elementary school or an equivalent program; completion of junior high school or an equivalent program)	111	62.3
High attainment (completion of high school or an equivalent program; completion of a university degree or an equivalent program)	58	37.7
Employment Status		
Not employed	107	68.9
Employed	62	31.1
Parity		
At risk (delivering ≥ 3 children)	36	21.7
Not at risk (delivering < 3 children	133	78.3
Consumption of Fruits and Vegetables		
Insufficient	150	87.7
Sufficient	19	12.3
Supplementary Feeding		
Not receiving supplementary food	143	84.8
Receiving supplementary food	26	15.2
Body Mass Index (BMI)		
At risk (BMI <18.5 kg/m^2)	8	5.5
Normal (BMI ≥18.5 kg/m^2)	161	94.5
Total respondents	169	100

Source: Secondary data from the Indonesian Basic Health Survey (Riskesdas) (2018).

Table 2. Relationship between demographic and health-related characteristics and CED in pregnant women in south kalimantan province in 2018.

Variables	CED		Non-CED		p-value	OR	95% CI	
	n	%	n	%			Lower	Upper
Age								
At risk	6	9.1	60	90.9	0.327	0.544	0.201	1.47
Not at risk	16	15.5	87	84.5		Ref		
Area of Residence								
Rural	14	13.9	87	86.1	0.870	1.20	0.47	3.05
Urban	8	11.8	60	88.2		Ref		
Educational Attainment								
Low attainment	15	13.5	96	86.5	0.981	1.138	0.436	2.97
High attainment	7	12,1	51	87.9		Ref		
Employment Status								
Not employed	16	15	91	85	0.456	1.641	0.606	4.44
Employed	6	9.7	56	90.3		Ref		
Parity								
At risk	6	16.7	30	93.3	0.576	1.463	0.527	4.05
Not at risk	16	12	117	88		Ref		
Consumption of Fruits and Vegetables								
Insufficient	19	12.7	131	87.3	0.718	0.774	0.206	2.90
Sufficient	3	15.8	16	84.2		Ref		
Supplementary Feeding								
Not receiving supplementary food	14	9.8	129	90.2	0.008*	0.244	0.090	0.663
Receiving supplementary food	8	30.8	18	69.2		Ref		
Body Mass Index (BMI)								
At risk	16	75	2	25	<0.001*	27.188	5.059	146.1
Normal	6	9.9	145	90.1		Ref		

Source: Secondary data from the Indonesian Basic Health Survey (Riskesdas) (2018)
Note: *significant *p*-value

Pregnant women residing in rural areas showed a slightly higher prevalence of CED (13.9%) compared to those in urban areas (11.8%), with a difference of only 2.1%. This suggests a comparable prevalence of CED between rural and urban residents. The chi-square test for this comparison yielded a p-value of 0.870, which is also greater than 0.05, leading to the acceptance of H0. Thus, the area of residence is not significantly associated with CED in pregnant women in South Kalimantan Province. Moreover, the incidence of CED in pregnant women with low educational attainment (13.5%) surpassed that observed in pregnant women with high educational attainment (12.1%). The application of statistical tests using chi-square produced a p-value of 0.981, which is greater than 0.05. This result indicates that H0 was accepted, meaning that educational attainment was not related to CED in pregnant women in South Kalimantan Province.

The incidence of CED was found to be higher among pregnant women who were not employed (15.5%) compared to those who were employed (9.7%). Women who are not engaged in paid employment are not in possession of an income. The possession of income is indicative of the possession of purchasing power, including the power to purchase nutritional foodstuffs that fulfill the body's nutritional needs (10). The results of the statistical test with

chi-square obtained a p-value of 0.456 or higher than 0.05. This result indicates that H0 was accepted, meaning that employment status had no relationship with CED in pregnant women in South Kalimantan Province.

Furthermore, the incidence of CED was higher among pregnant women with risky parity (16.7%) compared to those with non-risk parity (12%). This finding is influenced by the study's inclusion of 27 pregnant women (16%) with parity 3, six women (3.6%) with parity 4, and three women (1.8%) with parity 5. The Fisher exact test yielded a p-value of 0.576, which is greater than 0.05, indicating that the null hypothesis (H0) was accepted. Therefore, no significant relationship was found between parity and CED among pregnant women in South Kalimantan Province.

Similarly, the incidence of CED was more common among pregnant women who consumed sufficient amounts of fruits and vegetables (15.8%) compared to those with insufficient consumption (12.7%). The Fisher exact test produced a p-value of 0.718, also greater than 0.05, signifying that the null hypothesis (H0) was accepted. This indicates no significant association between fruit and vegetable consumption and CED in pregnant women in South Kalimantan Province.

Moreover, CED manifested at a significantly higher frequency among pregnant women who received

supplementary food (30.8%) compared to those who did not receive supplementary food (9.8%). The Fisher exact test yielded a p-value of 0.008, which is less than 0.05, indicating that the null hypothesis (H0) was rejected. This means that supplementary feeding was significantly associated with CED in pregnant women in South Kalimantan Province. The odds ratio (OR) was 0.244, with a 95% confidence interval (CI) of 0.090–0.663.

Finally, the prevalence of chronic energy deficiency (CED) was significantly higher among pregnant women in the at-risk BMI category (75%) compared to those with normal BMI (9.9%). The Fisher exact test produced a p-value of less than 0.01, leading to rejection of the null hypothesis (H0) and confirming a significant relationship between BMI and CED in pregnant women in South Kalimantan Province. The odds ratio (OR) was 27.188.

3.3. Multivariate Analysis

The multivariate analysis incorporated two independent variables: supplementary feeding exhibiting a p-value 0.008 and BMI displaying a p-value of <0.001. These variables were selected based on their p-values, which were less than 0.25. The analysis of these variables was conducted using a logistic regression model with the Backward Wald method. The final multivariate test results, which showed the relationship between supplementary feeding, BMI, and CED in pregnant women in South Kalimantan Province, are presented in the Table **3** below.

Multivariate analysis in the present study employed the backward Wald model. The test procedure entailed a single step, and the final model was constructed directly. The two variables that were subjected to multivariate analysis were both included in the model. As illustrated in Table **3**, there is a demonstrable relationship between body mass index and supplementary feeding on the incidence of CED in pregnant women in South Kalimantan Province. The body mass index (BMI) variable emerged as the most significant predictor with the Exp (B) value of 24.43. The results of the analysis yielded a Nagelkerke R-Squared of 0.229, which means that the body mass index (BMI) and supplementary feeding jointly influenced CED in pregnant women by 22.9%, while the remaining 77.1% was influenced by other factors that were not analyzed.

4. DISCUSSION

Chronic Energy Deficiency (CED) manifests when there is a prolonged imbalance of energy and protein intake, thereby impeding the body's ability to receive sufficient nutrients. In pregnant women, the condition is characterized by a persistent lack of sufficient energy intake, as indicated by a mid-upper arm circumference (MUAC) of less than 23.5 centimeters. This condition arises due to a persistent lack of macronutrients (carbohydrates, proteins, and fats) and essential micronutrients, including vitamin A, vitamin D, folic acid, iron, zinc, calcium, iodine, and other vital nutrients necessary for women of reproductive age [14]. It is a form of malnutrition that can have significant consequences for maternal health during pregnancy, including anemia, pregnancy complications, bleeding, increased susceptibility to infectious diseases, and an increased risk of miscarriage, stillbirth, birth defects, and low birth weight [5].

The results of the present study suggest a significant association of body mass index (BMI) and supplementary feeding with the incidence of chronic energy deficiency (CED) among pregnant women in South Kalimantan Province. This indicates that both variables may serve as important determinants of maternal nutritional status in South Kalimantan Province and could potentially be relevant in other regions with similar socio-economic and health profiles.

Specifically, the findings of this study demonstrate a significant correlation between body mass index (BMI) and the prevalence of chronic energy deficiency (CED) among pregnant women, with an odds ratio (OR) of 24.43. These findings indicate that pregnant women with a BMI in the underweight range are at high-risk of CED, with a 24.43-fold increased likelihood of experiencing this condition compared to those with a normal BMI. The results of this study are in line with those of a 2021 study conducted in the working area of Suela Health Center in West Nusa Tenggara Province, which identified an association of BMI with CED in pregnant women [15]. Pregnant women with a BMI of less than 18.5 kg/m^2 or in the underweight range are more prone to experiencing CED. A low BMI has been associated with inadequate weight gain during pregnancy, which can adversely affect fetal growth and development [16].

Furthermore, the results of this study align with another study conducted in 2021 in Aceh Province, Indonesia, specifically within the Syamtalira Bayu Health Center working area.

Table 3. Results of the final multivariate test of the relationship between supplementary feeding and body mass index (BMI) and the incidence of chronic energy deficiency in pregnant women in south kalimantan in 2018.

No	Variables	Coef Beta	*p*-value	OR	95% CI
1	Supplementary Feeding 1. Not receiving supplementary food	-1.290	0.022	0.275	0.091 – 0.832
	2. Receiving supplementary food	Ref			
2	Body Mass Index (BMI) 1. At risk of CED (BMI <18.5 kg/m^2)	3.196	<0.001	24.434	4.332 –137.814
	2. Normal BMI	Ref			
3	Constant	-2.620	0.150	0.073	

Source: Secondary Data from the Indonesian Basic Health Survey (Riskesdas) (2018).

This earlier study demonstrated a significant relationship between body mass index (BMI) and the incidence of chronic energy deficiency (CED) in pregnant women, with a BMI of less than 18.5 kg/m^2 being associated with a higher risk of CED (p-value = 0.001). A low BMI is often indicative of low body energy reserves, thereby resulting in the body's inability to meet metabolic needs during pregnancy, which, in turn, increases the risk of chronic malnutrition [17].

The body mass index (BMI) is a metric that can be used to indicate chronic energy deficiency. It is a widely accepted and easily comprehensible metric that can be used to assess the body fat and nutritional status of adults based on their height and weight. In addition, BMI is a readily available and cost-effective metric that has been validated in numerous studies as a reliable indicator of energy deficiency [18].

Furthermore, the present study found that the lack of supplementary feeding was significantly associated with the occurrence of CED in pregnant women, with an odds ratio (OR) of 0.275. The provision of supplementary feeding is a nutritional intervention aimed at meeting the energy and protein requirements of pregnant women to support nutritional recovery and improve maternal and fetal health. This study found that 30.8% of CED cases occurred among pregnant women who received supplementary feeding, indicating that the program primarily targets those experiencing chronic energy deficiency. At the same time, 68.2% of pregnant women who received supplementary feeding did not develop CED, highlighting the effectiveness of the supplementary feeding counseling program. This program regularly distributes supplementary food through integrated pre- and post-natal health and information centers, known as *pos pelayanan terpadu* (posyandu) in Indonesian [1].

According to the 2018 Basic Health Survey report, supplementary feeding as captured in the survey includes three categories: (1) supplementary food provided during each visit to the posyandu as part of supplementary feeding counseling; (2) food specifically allocated to pregnant women experiencing chronic energy deficiency (CED) to aid recovery; and (3) supplementary food received through external assistance. Pregnant women who receive supplementary feeding yet continue to experience CED likely had CED prior to the intervention, making them the primary target group for this recovery strategy. Conversely, pregnant women who do not receive supplementary food and do not exhibit CED may have nutritional statuses reflected by their body mass index (BMI). This study found that 99.2% of pregnant women who did not receive supplementary feeding but did not show CED had a normal BMI, placing them in the non-risk category for CED [1].

Pregnant women are particularly vulnerable to nutritional deficiencies and are therefore a priority group for the supplementary feeding program, which aims to meet their nutritional needs during pregnancy. The supplementary food provided to pregnant women with chronic energy deficiency (CED) consists of layered biscuits specially formulated and fortified with vitamins and minerals to address their specific nutritional requirements [19].

The analysis yielded a Nagelkerke R-squared value of 0.229, indicating that body mass index (BMI) and supplementary feeding together explained 22.9% of the variation in the incidence of chronic energy deficiency (CED) among pregnant women, with the remaining 77.1% attributed to other unexamined factors. This study also found no significant association between educational attainment, employment status, or parity and the occurrence of CED in pregnant women. This lack of association may be due to the generally adequate nutritional status of the participants, as reflected by their normal BMI. Among pregnant women with low educational attainment who did not experience CED, 98.9% had a normal BMI. Similarly, 98.9% of unemployed pregnant women without CED also maintained a normal BMI. Furthermore, 100% of respondents classified as having high-risk parity but not experiencing CED exhibited a normal BMI.

The results of the analysis showed that educational attainment was not significantly associated with the incidence of chronic energy deficiency (CED) in pregnant women in South Kalimantan Province. One possible explanation is the limited variability in the respondents' educational levels, with the majority (65.7%) having low educational attainment and only 34.3% possessing higher education. This imbalance in distribution may have influenced the bivariate analysis results, leading to a statistically nonsignificant relationship between education and CED.

The findings suggest that even among pregnant women with lower educational attainment, non-employment, or high-risk parity, adequate nutritional intake can prevent chronic energy deficiency (CED). The effective implementation of supplementary feeding programs is a vital strategy to ensure sufficient nutrition, ultimately improving maternal health and well-being [19]. Such programs, combined with nutritional education, have been shown to enhance BMI and reduce the prevalence of CED in pregnant women. For example, interventions involving biscuits fortified with moringa or snakehead fish extract have demonstrated significant improvements in BMI and mid-upper arm circumference (MUAC). These fortified biscuits provide a higher average contribution of energy and essential nutrients to pregnant women suffering from CED [20].

CONCLUSION

The study results indicate that among the 169 pregnant women surveyed, the prevalence of chronic energy deficiency (CED) was 15.2%. Body mass index (BMI) and supplementary feeding showed a significant association with the incidence of CED, with BMI identified as the most significant predictor. Pregnant women classified as underweight (low BMI) were 24.43 times more likely to experience CED compared to those with a normal BMI (OR = 24.43). Other factors, including age,

place of residence, educational attainment, employment status, parity, and fruit and vegetable consumption, were not significantly associated with CED. Together, BMI and supplementary feeding accounted for 22.9% of the total variation in CED prevalence.

LIMITATIONS

The present study has certain limitations, primarily due to its cross-sectional design, which restricts the ability to establish a causal relationship between the independent and dependent variables, as data were collected at a single point in time. Additionally, the study did not encompass all the relevant variables necessary for a comprehensive analysis of CED in pregnant women. The study's design precluded the incorporation of factors, such as infection history or protein consumption patterns, as it relied solely on data from the 2018 Indonesian Basic Health Survey report.

A critical concern with the 2018 Indonesian Basic Health Survey data is the utilization of the food frequency questionnaire (FFQ) as opposed to the food recall method for data collection. The FFQ typically yields less comprehensive data regarding daily eating patterns and the quantities of nutrients ingested. This can compromise the precision of estimates for respondents' energy and nutrient consumption. Furthermore, the present study's exclusive focus on South Kalimantan Province limits the generalizability of its findings to the broader context of all provinces in Indonesia. To address this issue, further research using data from all provinces in Indonesia may be necessary.

RECOMMENDATION

A comprehensive strategy is needed to address chronic energy deficiency (CED) among pregnant women. Nutritionally, it is essential that pregnant women receive supplementary feeding, iron supplements, as well as folic acid and calcium supplements. Additionally, leveraging local food resources to enhance nutrient intake is crucial. The implementation of regular MUAC monitoring and nutritional counseling is an indispensable part of this approach. Regular monitoring of both BMI and MUAC, combined with targeted nutritional support, can help manage and prevent CED in pregnant women. Moreover, there is a need to improve access to prenatal services and nutritional education through centers for pre- and post-natal health and information (*posyandu*), as well as *via* social media platforms.

Social and economic support, alongside family empowerment, also play vital roles. The effective implementation of these measures has the potential to reduce the incidence of CED, thereby ensuring better health outcomes for both mothers and infants.

Future research should explore additional factors influencing chronic energy deficiency (CED), such as infection history and protein consumption patterns, to provide a more comprehensive understanding of the condition and its implications. Furthermore, it is recommended that studies investigate the long-term effects of supplementary feeding on both maternal and fetal health outcomes, thereby informing and improving public health strategy planning.

LIST OF ABBREVIATIONS

CED	=	Chronic Energy Deficiency
LBW	=	Low Birth Weight
BMI	=	Body Mass Index
MUAC	=	Mid-Upper Arm Circumference
Riskesdas	=	*Riset Kesehatan Dasar*/ Indonesian Basic Health Survey
OR	=	Odds Ratio
WHO	=	World Health Organization

AUTHORS' CONTRIBUTIONS

It is hereby acknowledged that all of the authors have accepted responsibility for the content of the manuscript and consented to its submission. Following a meticulous review of all results, all authors have unanimously approved the final version of the manuscript.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The present study utilized secondary data from the 2018 Basic Health Survey (Riskesdas), in which data are anonymized and do not contain the personal identity information of the respondents. The data were obtained through official procedures and were used only for research purposes. Therefore, the present study did not require any additional ethical approval. The 2018 Basic Health Survey (Riskesdas) has received ethical clearance from the Health Research Ethics Committee, National Institute of Health Research and Development (HREC-NIHRD).

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013 (http://ethics.iit.edu/ecodes/node/3931).

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Due to privacy restrictions, the data and supporting information are available upon request.

FUNDING

This study did not receive any external funding.

STANDARDS OF REPORTING

STROBE guidelines were followed in the study.

CONFLICT OF INTEREST

Bayu Satria Wiratama is a member of the Editorial Advisory Board of the TOPHJ journal.

ACKNOWLEDGEMENTS

SUPPLEMENTARY MATERIAL

Supplementary material is available on the publisher's website along with the published article.

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