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The Relationship between Nutrient Intake and Anemia with the Incidence of Deficiency Chronic Energy in Adolescent Women

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A B S T R A C T

Introduction: Anemia is a health problem that is often experienced by adolescent girls, in Indonesia it reaches more than 30%. Anemia is characterized by low *hemoglobin* levels caused by insufficient intake of iron and other nutrients which, if prolonged for a long time, can lead to Chronic Energy Deficiency, and significantly affect the physical health, cognitive function, and overall quality of life of adolescent girls. This condition can lead to a variety of complications including learning disabilities, decreased physical fitness, and increased susceptibility to infections. **Objective:** to analyze the relationship between nutritional intake and anemia with the incidence of Chronic Energy Deficiency in adolescent girls. **Methods:** This study used *a cross sectional* design conducted in the dormitory of the Baitul Hikmah College of Health Sciences, a total of 92 subjects were *purposively* selected based on inclusion and exclusion criteria. The data was taken in February-March 2025. Nutritional intake was obtained from food recall 2 × 24 hours and *hemoglobin levels* were measured using *easy touch* GCHb. Data were analyzed using *the Chi-Square* test. **Results:** The results of the study showed that as many as (18.7%) adolescent girls experienced anemia or hemoglobin (Hb) levels< 12 g/dl and Chronic Energy Deficiency (27%). There was no association with nutrient intake (energy p=1.000), (protein p=0.674), (iron p=0.389), (vitamin A p=0.095) and there was a significant association of (vitamin C p=0.000) and (anemia p=0.000) with the incidence of Chronic Energy Deficiency in adolescent girls. **Conclusion:** the importance of prevention of anemia and Chronic Energy Deficiency by improving the quality of menus and nutritional intake in adolescent girls in dormitories.

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1. INTRODUCTION

Anemia affects one-third of the world's population and contributes to increased morbidity and mortality (NHLBI, 2021). Young women are at higher risk of developing anemia because they are still in the growth and development period other than menstruation (Kinyoki et al., 2021). Anemia occurs when hemoglobin concentrations are lower than normal, causing an inability to deliver enough oxygen to the body's tissues. The normal concentration of hemoglobin (Hb) in adolescent girls is ≥12 g/dL (WHO, 2021). Adolescence is an important period for dealing with dietary problems. Poor nutrition during adolescence can also affect future dietary preferences and habits (Partridge, 2020). Adolescent girls are at high risk of developing anemia due to high iron needs during puberty and iron loss during menstruation (Habib et al., 2020). Chronic Energy Deficiency that occurs in adolescent girls is one of the conditions in which adolescent girls or women of childbearing age experience nutritional deficiencies (calories and protein) that last for a long time or are chronic, and can result in health problems. (Ardi, 2021).

There was an increase in the prevalence of anemia among adolescent girls from 2013 to 2018, from 23.9% in 2013 to 27.2% in 2018 (Ministry of Health, 2019). In 2019, as many as 29.9% of women worldwide suffered from anemia, with the highest prevalence still found in the Southeast Asian region at 35%. Meanwhile, the prevalence of anemia in Indonesia in 2019 reached 31.2% (WHO, 2022). The prevalence of anemia in adolescent girls in Lampung in 2023 is quite high, even exceeding the national figure. Data from the Indonesian Health Survey shows a figure of 10.7% in Lampung, while the national figure for adolescent girls is 9.1%. (SKI, 2023).

According to Riskesdas (2023), the prevalence of CEDs in adolescent girls aged 15–19 years is 41.9%, whichshows that almost half of adolescent girls in Indonesia experience chronic nutritional problems that can have an impact on their health, including the risk of giving birth to babies with low birth weight. According to a report by the Ministry of Religious Affairs, the number of students in Indonesia in the 2020/2021 school year reached 4.37 million, of which 3.85 million lived in Islamic boarding schools. Therefore, students who live in Islamic boarding schools need special attention when facing nutritional problems among adolescents (Ministry of Agriculture 2023). Female students in boarding schools suffer from chronic energy deprivation, serious nutritional problems (Naufalina et al., 2023).

Several studies conducted in Islamic boarding schools show a fairly high prevalence of anemia. In one of the Islamic boarding schools in Bogor, it was recorded that 38.1% of students experienced mild anemia and 20.2% suffered from moderate anemia (Ekayanti et al., 2020). Meanwhile, the prevalence of anemia in Islamic boarding schools in Tasikmalaya reached 22.2% (Rahfiludin et al., 2021), in Semarang it was 17.3% (Utami et al., 2022), in Banten by 27.4% (Handini, 2023), and in Bogor in 2022 by 21.7% (Rimbawan et al., 2023). Based on the WHO classification (2015), the prevalence of anemia between 5.0–19.9% is classified as a mild health problem, 20–39.9% is categorized as a moderate problem, and more than 40% is considered a serious public health problem.

The main factors that cause anemia in adolescents are insufficient nutrient consumption, especially iron, and a lack of other substances that support iron absorption, such as vitamin C and protein. Adolescents living in boarding schools are at risk of developing nutritional problems, especially since they are generally in a stage of physical growth and change as well as dense

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academic and religious activities on a daily basis. Therefore, they need adequate nutritional intake to maintain their health (Amalia et al., 2023). Many teenagers who live in boarding schools state that the quality of food provided by the school is poor, inadequate, or unbalanced. This situation results in students leaving food more often, skipping meals, and skipping some meals, which makes them more likely to experience nutritional deficiencies and makes them vulnerable to nutritional problems (Rahayu, 2020).

Anemia and Chronic Energy Deficiency (CED) in adolescent girls are caused by several factors including inadequate nutrition, both in quantity and quality. An unbalanced diet, the habit of skipping meals, the consumption of fast food that is high in calories but low in nutrients, and the lack of nutrition education are the main triggers. The social and economic environment, as well as the habit of living in a boarding school or Islamic boarding school environment that does not pay attention to the quality of food, also aggravates this situation. (Ridwan, 2022). The prevalence (CED) among adolescent girls (15–19 years old) increased from 33.5% in 2018, to 36.3% in 2020. In **Lampung** province, there was a decrease even though it was not predicted, namely by 13.62% in 2018 and decreased to 12.77% in 2019. **(Ministry of Health of the Republic of Indonesia, 2021).**

Anemia as one of the factors that occur in CEDs has a significant impact on adolescent girls, namely: affecting their physical health, cognitive function, and overall quality of life. This condition can lead to a variety of complications including learning disabilities, decreased physical fitness, and increased susceptibility to infection (Ghimire et al., 2024). Previous research has shown that anemia among adolescents is a complex problem that is influenced by a variety of factors. Several studies have also identified the importance of a social environment, clean and healthy living behavior (Amalia et al., 2023). Many studies focus only on individual aspects of adolescents, such as nutritional status, diet, food intake (Ekayanti et al., 2020), without considering the quality of food, type of food, chronic diseases that must be directly associated with anemia to the incidence of CEDs. Low nutritional intake, especially iron, ultimately has the potential to reduce hemoglobin levels. Therefore, this study aims to determine the relationship between nutritional intake and anemia, with the incidence of CED in adolescent girls.

2. METHOD

Study Design

This research employed an analytical observational design with a cross-sectional approach. The purpose was to examine associations between various nutritional and physiological factors and the occurrence of Chronic Energy Deficiency (CED) among adolescent girls. The cross-sectional nature of the study enabled the collection of exposure and outcome data simultaneously, providing a snapshot of the participants' health and nutritional status at a single point in time.

Sample

The study was conducted at the dormitory of STIKes Baitul Hikmah, a health sciences college selected purposively due to its sizable population of female students living in residence. This setting was deemed appropriate for obtaining a sample that could provide a representative

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overview of CED prevalence in the adolescent female population. The selection was further supported by data indicating a relatively high CED rate in Lampung Province, reported at 12.77% (Ministry of Health, 2019).

A total sampling method was utilized, whereby all residents meeting the predefined inclusion criteria were invited to participate. From the initial population of 92 dormitory residents, only 75 students fulfilled the inclusion criteria, which included: (1) residing in the dormitory for a minimum of six months, (2) aged between 18 and 21 years, and (3) providing informed consent to participate.

Instruments and Measurements

The independent variables examined in this study comprised age, Body Mass Index (BMI), Mid-Upper Arm Circumference (MUAC), dietary intake (including energy, macronutrients, and micronutrients), and hemoglobin (Hb) levels. BMI was calculated by dividing weight in kilograms by the square of height in meters, with measurements taken using calibrated equipment and categorized according to WHO nutritional status criteria. MUAC was assessed on the left arm at the midpoint between the acromion and olecranon using a non-elastic tape accurate to 0.1 cm, with values interpreted based on reproductive-age women's nutritional standards. Dietary intake was evaluated through two 24-hour dietary recalls conducted on non-consecutive days (one weekday and one weekend), supported by food photo booklets to aid portion estimation. Interviewers were trained to enhance data validity, and intake adequacy was determined by comparing nutrient levels to recommended daily allowances, classifying macronutrients as deficient (<80% of needs), adequate (80–110%), or excessive (≥110%) (NFNC, 2018), while micronutrient intake (iron, vitamin A, vitamin C) was deemed insufficient if below 77% of RDA and sufficient if ≥77% (Gibson, 2022). Hemoglobin concentration was measured using the Easy Touch GCHb ET-321, a point-of-care device validated against the WHO-recommended cyanmethemoglobin method, and readings were categorized as low (<12 g/dL) or normal (≥12 g/dL); all assessments were conducted by trained health personnel following proper calibration procedures.

Data Collection Procedure

Data collection was conducted on-site at the STIKes Baitul Hikmah dormitory. Anthropometric assessments, blood sample collection for Hb measurement, and dietary interviews were completed during scheduled sessions. Participation was voluntary, and confidentiality was maintained throughout the process. Instruments and protocols were standardized to ensure consistency in data collection across all participants.

Data Analysis

The collected data were initially examined for distribution normality using the Kolmogorov-Smirnov test. Subsequently, bivariate analysis was performed to investigate relationships between independent variables and CED status using the Chi-square test with the contingency coefficient as the measure of association. Statistical analysis was conducted using a computer-assisted statistical software package.

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Ethical Considerations

This study received approval from the Health Research Ethics Committee at the Faculty of Medicine, University of Lampung, under reference number 2158/UN26.18/PP.05.02.00/2024. Participants were informed about the study's purpose, procedures, risks, and benefits before providing written consent. Anonymity and confidentiality were assured, and data were used solely for academic purposes.

3. RESULT

Table 1. Age distribution data is categorized as late adolescents, in the age range of 15-19 years. Based on nutritional status data, it was found that subjects with poor and very thin nutritional status were 25.3%, while obese were 9.3%. Most subjects had a normal nutritional status of 57.4%. Based on the categories of CEDs (LILA < 23.5 cm) and non-CEDs (LILA ≥ 23.5cm) (Ministry of Health of the Republic of Indonesia, 2019), based on Hb levels, it was shown that more than half (81.3%) of the subjects in this study had Hb levels ≥ 12 mg/dL. Meanwhile, those with Hb < 12mg/dl by 18.7%.

Table 1. Distribution of Respondent Characteristics (n=75)

Variabel	Category	n	%
Age	18	10	13,3
	19	27	36
	20	22	29,3
	21	16	21,4
	Mean ± elementary school (years)	19,6 ±1.08	
IMT	Very skinny	6	8
	That	19	25,3
	Normal	43	57,4
	Fat	2	2,6
	Obese	5	6,7
	Mean ± SD	20,4 ± 6,26	
PURPLE	BLUE (PURPLE < 23.5 cm)	20	27
	No CED (LILa ≥ 23.5 cm)	55	73
	Mean ± SD	24,9 ± 2,97	
Hb Level	Anemia	14	18,7
	Normal	61	81,3
	Mean ± SD	12,4 ± 0,76	

Table 2. Distribution of nutritional intake and anemia of adolescent girls (n=75)

Variabel	Mean ± SD	Category	n	%
Nutritional intake				
Energy (Kcal)	2745± 534	Defisit	2	2,7
		Normal	73	97,3
Protein (gr)	66 ± 15	Deficit	8	10,7
		Normal	67	89,3
Iron (mg)	22 ± 11	Deficit	19	25,3
		Normal	56	74,7
Vitamin A (RE)	1125 ± 1164	Defisit	14	18,7
		Normal	61	81,3
Vitamin C (mg)	122 ± 94	Deficit	17	22,7
		Normal	58	77,3
Anemia	12,4 ± 0,76	Anemia	14	18,7
		Normal	61	81,3

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Table 3. Analysis of the Relationship between Nutrient Intake and Anemia and the Incidence of CED in Adolescent Girls at the STIKes Baitul Hikmah Dormitory in Bandar Lampung

Variabel	CED (%)	No CED (%)	OR	p
Energy intake	27,4	72,6	ON	1,000
Asupan Protein	28,4	71,6	ON	0,674
Iron intake	23,2	76,2	ON	0,389
Vitamin A Intake	31,1	68,9	ON	0,095
Vitamin C intake	17,2	82,2	6,857	0,001
Anemia	13,1	86,9	39,750	0,000

NA: Not Available

4. DISCUSSION

The characteristics of respondents at the age of 19 years are the age range of the process of improving physical growth and the development of psychological aspects that have started since previous times, therefore it is necessary to receive special attention regarding nutritional needs considering that they are in the period of active growth and reproductive preparation (WHO, 2022). Nutritional status is very thin and thin can cause disorders in the body, such as weak immunity, menstrual disorders and anemia while obesity can cause a risk of metabolic diseases (Fakhriyah, 2022). The incidence of CED in adolescents is 27%, this figure exceeds the prevalence at the Lampung provincial level of 12.77%, this group is a group that needs immediate nutritional intervention to improve its nutritional status (Telisa, 2020). Based on *hemoglobin* measurements, 18.7% of adolescents experience anemia, this exceeds the incidence rate in Lampung province, preventive efforts are needed even with various obstacles including changing behavior and eating habits (Mutmainah, 2021).

Based on the level of energy adequacy, it was found that only a small part of 2.7%, having an energy deficit in adolescents can increase the risk of micronutrient deficiencies, which can lead to various health problems including anemia (Igbokwe et al., 2025), Most 97.3% have a normal level of adequacy. Energy is an important factor that supports optimal growth and development processes. Adolescence is characterized by changes in body composition and physical activity. Although physical activity does not necessarily increase, energy requirements continue to increase with body size (Parks et al. 2020). Protein intake was also found in some subjects, 10.7% had insufficient protein levels, and the majority of 89.3% of subjects had normal protein levels. Adequate protein intake is necessary to help prevent anemia because protein is an important component of the structure of hemoglobin and plays an important role in the repair of tissues and optimal body function (Sari et al., 2022).

The subjects' vitamin and mineral intake was mostly adequate, only 25.3% had deficient iron levels, 18.7% had deficient vitamin A levels, which were deficient, the majority of 81.3% had vitamin A levels, adequate. Most (77.3%) vitamin C intake was adequate and only 22.7% was inadequate. Low iron intake causes the body to lack oxygen, which affects development or can lead to anemia (Djogo & Letor, 2022). Micronutrients are needed by the body in micronutrients, but they play an important role in various bodily functions, including the production of red blood cells. Micronutrients, especially iron, vitamin A, and Vitamin C, are essential for preventing anemia, and deficiencies in these micronutrients can interfere with red blood cell production and lead to anemia (Dhurde et al., 2024).

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Most of the subjects (81.3%), did not experience anemia/normal, only 18.7% of subjects experienced anemia. Anemia is not a diagnosis, but a presentation of the occurrence of a condition. Therefore, the prevention of anemia through adequate nutritional interventions such as iron supplementation, increased protein intake, and education on a balanced diet should be part of the strategy to prevent CEDs in adolescent girls (Rahmawati, 2023).

Based on this study, there was no positive correlation between energy, protein, iron and vitamin A intake ($p > 0.05$). Energy is obtained through daily food intake mainly from food sources of carbohydrates, proteins and fats. Energy needs are defined as individual energy consumption figures obtained through food intake and are intended to cover energy expenditure derived from basal metabolism, physical activity and *specific dynamic action*. (Arismawati, 2020). The body's proteins are constantly being formed and broken down. The speed at which the body synthesizes enough protein to replace broken proteins is called "protein turnover" in the body. In healthy adults who do not experience weight gain or reduction, equilibrium occurs when the amount of nitrogen consumed is balanced with the amount of nitrogen lost through urine, feces, and other excretory routes. More protein is mobilized daily for metabolic processes in the body than is consumed from food (Scheinin et al, 2021).

Iron is also part of the myglobin that helps store oxygen and several types of enzymes that are useful for the body. Iron source foods include meat, eggs, liver, fish, and green vegetables. Iron deficiency can lead to anemia nutritional problems. Anemia does not reflect a person's disease, only an indicator that a person lacks *hemoglobin* to transport oxygen to various tissues of the body. In adolescent girls, they are more vulnerable and at risk of anemia because their iron requirement is 3 times, they bleed a lot during menstruation (Williams, & Rockey, 2020).

Based on this study, there was a positive correlation between vitamin C intake and anemia ($p < 0.05$) due to the incidence of CED. Vitamin C, commonly known as L-Ascorbic acid, is a water-soluble vitamin that plays a role in the synthesis of collagen, L-carnitine, and neurotransmitters. In addition, vitamin C also plays a role in the process of protein metabolism. Collagen is an essential component of connective tissue and wound healing. Vitamin C is also an important antioxidant and plays a role in the regeneration of vitamin E in the body. Vitamin C also helps optimize the work of the immune system and increase the absorption of nonheme iron (contained in plant-based foods) Humans are mammals that cannot synthesize vitamin C independently (endogenous), so the adequacy of vitamin C is very important in daily intake (Gibson, 2023).

Vitamin C is an important cofactor in the formation of collagen as well as the synthesis of hydroxychlorine and hydroxylicine. Vitamin C is easily absorbed through the gastrointestinal tract. Under normal conditions, the level of vitamin C in the blood will increase after absorption. The levels of vitamin C in leukocytes and platelets are higher compared to the levels in plasma and erythrocytes. Vitamin C is widely distributed throughout the body, with the highest levels found in the glands, while the lowest levels are found in muscles and fat tissues. Vitamin C is also able to stimulate the activity of alkaline phosphate, which is a determinant of the formation of osteoblasts. Thus, vitamin C acts as an organic component in bones to support cell change and the formation of new bone matrices. In addition, vitamin C functions as an antioxidant to protect bone connective tissue from the harm of free radicals. Insufficient vitamin C intake sometimes does not directly have a negative effect on *Bone Mineral Density (BMD),* especially in individuals who regularly exercise (Devi, 2021).

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Anemia is not a diagnosis, but a presentation of the occurrence of a condition. Therefore, the prevention of anemia through adequate nutritional interventions such as iron supplementation, increased protein intake, and education on a balanced diet should be part of the strategy to prevent CEDs in adolescent girls. Early detection of anemia and its management can be an important step in reducing the prevalence of CEDs among adolescents, especially adolescent girls. To overcome anemia and related CED in adolescent girls, it is very important to improve their diet by increasing their intake of energy and nutrients such as iron, protein, and vitamins. Iron supplements or multivitamins are also often recommended, especially for those with nutritional deficiencies. Education about the importance of balanced nutrition and a healthy lifestyle is the key to preventing these two conditions (**Asriyanti** et al, 2023).

The limitations in this study only involve young women in the boarding school environment of STIKes Baitul Hikmah, so the results of this study cannot be generalized to the population of young women in other regions or institutions. Other factors that may influence the incidence of CEDs, such as physical activity, menstrual status, or psychosocial conditions, have not been analyzed in this study. Therefore, follow-up research with a longitudinal design and a wider coverage of variables is highly recommended.

5. CONCLUSION

The results showed that adolescent girls who experienced anemia were 18.7% and those who experienced CED were 27%. There was no association between energy intake (*p=1.000), protein* (*p=0.674*), iron (*p=0.389), and the incidence of CED in adolescent girls. There was a significant relationship between vitamin C intake* (p=0.001) and anemia (p=0.000) with the incidence of CED in adolescent girls. A sustainable health promotion program is needed in the environment at the STIKes Baitul Hikmah women's dormitory to increase awareness and encourage behavior to prevent anemia and CED. For adolescent girls, especially those who are CED, consume fruits that are a source of vitamin C, to increase iron absorption, for example fruits that contain vitamin C, namely oranges, papayas, mangoes and guava. For related institutions and the Health Office through the Health Center, all students should be screened from the beginning of entry for early detection and prevention of non-communicable diseases, especially CEDs in adolescent girls.

6. CONFLICT OF INTEREST

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