

The Relationship Between Energy, Protein, and Iron Intake Levels with the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

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ABSTRACT

Adolescents need energy, protein, and iron, for growth and development. Lack of energy will lead to reduced protein and fat which serve as alternative energy sources. Protein deficiency can affect food transport, resulting in reduced muscle mass. Iron deficiency can cause CED due to its effect on haemoglobin synthesis. The purpose of the study was to determine the relationship between the level of energy, protein, and iron intake with the incidence of CED in class VIII students at SMP Negeri 5 Surabaya. Materials and Methods using analytical observational cross sectional technique with 57 respondents. Data collection technique was random sampling. The study was conducted for 5 months. Data were collected through interviews and measurements of upper arm circumference. The results of the study students with CED category (68.4%). The highest level of energy intake was very low category (71.9%). The highest level of protein intake was very low category (70.2%). The highest level of iron intake was severe deficit category (98.2%). Conclusion there is a significant relationship between energy and protein intake with incidence of CED ($p = 0.000 \alpha < 0.05$) and there is no relationship between iron intake with incidence of CED ($p = 0.143 \alpha > 0.05$).

INTRODUCTION

If energy intake is inadequate, fat reserves in the body will be utilised. If fat reserves are utilised continuously, proteins found in the liver and muscles will be converted into energy. This will lead to muscle mass depletion, as indicated by an upper arm circumference < 23.5 cm. Consequently, CED is the result of persistently low energy intake.¹ On the other hand, a continuous lack of protein intake can cause symptoms such as decreased immunity, susceptibility to disease, and decreased performance. Protein deficiency can also disrupt nutrient transport, meaning that muscle mass becomes smaller.² Surabaya City has the highest number of motorised vehicles in East Java. As the number of motorised vehicles increases, so does the air pollution caused by their exhaust emissions.³ Increased COHb levels can reduce cellular oxygen uptake ability, thereby lowering human blood pressure.⁴ And when the body is deficient in iron, it can lead to Chronic Energy Deficiency (CED) due to its impact on haemoglobin production. When the body is deficient in iron, the body's haemoglobin production is disrupted, so the body has to work harder to meet its oxygen needs.⁵ So, CED occurs when the individual suffers from chronic malnutrition, which can have a negative impact on their health.⁶ If a woman experiences CED and is not intervened quickly, the condition can be dangerous well into the pregnancy and result in a low birth weight baby.⁷

According to WHO data, a large proportion of the population of African and Asian countries, especially in Sub-Saharan Africa and Southeast Asia, make up the main epicentre of global poverty and Chronic Energy Deficiency. There were 815 million cases of CED in 2018 compared to 777 million in 2015, and at least 120 million women (60%) in South and Southeast Asia are estimated to suffer from Chronic Energy Deficiency (CED).⁸ According to Basic Health Research data (2018), the national prevalence of CED among non-pregnant women was 14.5%. In 2018, the prevalence of non-pregnant women in East Java was 13.88%. Indonesia has 36.3% risk of CED among non-pregnant women aged 15-19 years. East Java province, meanwhile, has a 37.73% risk of CED among non-pregnant women aged 15-19 years.⁹ According to provincial statistics on the incidence of CED in Surabaya City, Surabaya is one of 39 districts or cities with an incidence rate of CED risk in non-pregnant women that is greater than the provincial average, which is more than 13.88%.¹⁰

Based on the description of the problem of high air pollution in Surabaya City, especially at the research location, it has a relationship that causes a person to experience Chronic Energy Deficiency (CED), so the researcher chose this location, namely SMP Negeri 5 Surabaya to be used as a research site. Then the results of preliminary studies that have been carried out by measuring the upper arm circumference of 15 Class VIII students, out of 15 students who suffer from CED as many as 11 students (73.3%) while 4 students (26.6%) do not suffer from CED. When compared to the Basic Health Research data, the percentage of SMP Negeri 5 Surabaya students who have a risk or chance of CED is greater when compared to the East Java Province Basic Health Research data in 2018 (37.73%).

Based on these problems, researchers have an interest in conducting research on the Relationship Between the Level of Intake of Energy, Protein, Iron with the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya?

MATERIALS AND METHODS

This study is an analytical observational study with a cross-sectional design.¹¹ The research was conducted at SMP Negeri 5 Surabaya and was conducted from October 2023 to April 2024. The population in this study were class VIII students at SMP Negeri 5 Surabaya, totalling 130 students. The sample in this study amounted to 57 respondents, which were taken by using simple random sampling technique using random numbers in excel application. In this study, to collect data involved a 2x24 hour recall interview and anthropometric measurements, namely upper arm circumference. And using univariate and bivariate analysis using the spearman correlation test to see the relationship between variables.¹²

RESULTS**Table 1. Characteristics of Respondents by Age at SMP Negeri 5 Surabaya**

Age	n	%
13	7	12.3
14	40	70.2
15	10	17.5
Total	57	100

Source: Primary Data, 2024

According to table 1 above, the respondents in this study were 13 years old with 7 students (12.3%), 14 years old with 40 students (70.2%), and 15 years old with 10 students (17.5%).

Table 2. Frequency Distribution of Energy, Protein, and Iron Intake Levels among Class VIII Students at SMP Negeri 5 Surabaya

Energy Intake Level	n	%
Very Low	41	71.9
Low	7	12.3
Normal	8	14.0
Over	1	1.8
Total	57	100
Protein Intake Level	n	%
Very Low	40	70.2
Low	5	8.8
Normal	10	17.5
Over	2	3.5
Total	57	100
Iron Intake Level	n	%
Severe Deficit	56	98.2
Moderate Deficit	1	1.8
Mild Deficit	0	0
Normal	0	0
Over	0	0
Total	57	100

Source: Primary Data, 2024

According to table 2 above, the majority of students have a very low level of energy intake, namely 41 female students (71.9%). The majority of students have protein intake in the very low category, namely a total of 40 students (70.2%). And the majority of students have iron intake in the severe deficit category, namely a total of 56 students (98.2%).

Table 3. Frequency Distribution of Chronic Energy Deficiency (CED) among Class VIII Students at SMP Negeri 5 Surabaya

Category	n	%
CED	39	68.4
Not CED	18	31.6
Total	57	100

Source: Primary Data, 2024

According to table 3 above, it can be seen that the number of Chronic Energy Deficiency incidents at SMPN 5 Surabaya in class VIII students who are categorised as Chronic Energy

Deficiency using upper arm circumference measurements <23.5 cm is 39 students (68.4%). While class VIII students who are categorised as not Chronic Energy Deficiency are 18 students (31.6%).

Table 4. Cross Tabulation of the Relationship between Energy Intake Level and the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

Energy Intake Level	Incidence of CED in Class VIII				Total		P- Value
	CED		Not CED		n	%	
	n	%	n	%			
Very Low	34	59.7	7	12.2	41	72.0	0.000
Low	2	3.5	5	8.8	7	12.2	
Normal	3	5.2	5	8.8	8	14.0	
Over	0	0	1	1.8	1	1.8	
Total	39	68.4	18	31.6	57	100	

Source: Primary Data, 2024

Based on the table, out of 41 students (72%), there were 34 students (59.7%) with very low energy intake who experienced CED, and 7 students (12.2%) who did not experience CED. Of the 7 female students with low energy intake, 2 female students (3.5%) experienced CED and 5 female students (8.8%) did not. Of the 8 girls with normal energy intake, 3 girls (5.2%) had CED and 5 girls (8.8%) did not. Meanwhile, 1 student (1.8%) with over energy intake did not experience CED. Spearman correlation test showed a significant relationship with a p-value of 0.000. With a p-value smaller than α (0.05), H0 was rejected and H1 was accepted, indicating a relationship between energy intake and the incidence of CED.

Table 5. Cross Tabulation of the Relationship between Protein Intake Level and the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

Protein Intake Level	Incidence of CED in Class VIII				Total		P- Value
	CED		Not CED		n	%	
	n	%	n	%			
Very Low	33	57.9	7	12.3	40	70.2	0.000
Low	2	3.5	3	5.3	5	8.8	
Normal	4	7.0	6	10.5	10	17.5	
Over	0	0	2	3.5	2	3.5	
Total	39	68.4	18	31.6	57	100	

Source: Primary Data, 2024

Based on the table, out of 40 female students (70.2%), there were 33 female students (57.9%) with very low protein intake who experienced CED, and 7 female students (12.3%) who did not experience CED. Of the 5 female students with low protein intake, 2 female students (3.5%) experienced CED and 3 female students (5.3%) did not. Of the 10 female students with normal protein intake, 4 female students (7%) experienced CED and 6 female students (10.5%) did not. Of the 2

students with over protein intake, 2 students (3.5%) did not experience CED. Spearman correlation test showed a significant relationship with a p-value of 0.000. The p-value is smaller than α (0.05) H_0 is rejected and H_1 is accepted indicating a relationship between protein intake and the incidence of CED.

DISCUSSION

Characteristics of Respondents by Age at SMP Negeri 5 Surabaya

After the study, there were 7 respondents aged 13 years (12.3%), 40 respondents aged 14 years (70.2%), and 10 respondents aged 15 years (17.5%). Adolescent nutrition intake is very important during this developmental period. Adolescent girls have a tendency to experience malnutrition, especially Chronic Energy Deficiency (CED).¹³ To support the body's metabolism, adolescents must consume the right amount of food for their needs.¹⁴ According to the results of the study, respondents who ate less had a desire to look smaller or slimmer. As a result, individuals prefer to focus on their body image, at this age adolescents are more concerned with their physical image including limiting food consumption or following a wrong diet.¹⁵

Level of Energy Intake in Class VIII Students at SMP Negeri 5 Surabaya

Based on the results of the study, the majority of respondents had the highest level of energy intake, namely in the very low category, namely 41 students (71.9%). The energy intake of most respondents was very low due to several factors, namely often skipping or eating breakfast, improper eating habits, and inappropriate eating habits.¹⁶ Respondents prefer snacks to meals and skip breakfast, even though breakfast is the best source of energy for the brain to concentrate at school. All living things need energy to perform their various tasks. If the amount of energy obtained is less than the amount used, stored energy from muscle or adipose tissue will be utilised to make up the shortfall.¹⁷ There are three main factors that determine eating habits, frequency, type and amount. As a result, an improper diet can jeopardise a person's nutritional status.¹⁸

Level of Protein Intake in Class VIII Students at SMP Negeri 5 Surabaya

Based on the results of the study, the majority of respondents had the highest level of protein intake, namely in the very low category, namely a total of 40 students (70.2%). The protein consumption of the respondents was in the very less category. According to the results of the 2x24 hour recall interview of the respondents, the results of protein consumption were less diverse and in smaller quantities. Other protein-rich food sources can be obtained from fish, which is rarely consumed by respondents. Fish is a healthy and protein-rich food.¹⁹ Fish is high in protein and contains essential amino acids that the body needs. These essential amino acids cannot be made by the body itself and must be obtained from other sources.²⁰

Level of Iron Intake in Class VIII Students at SMP Negeri 5 Surabaya

Based on the results of the study, the majority of respondents had the highest level of iron intake in the severe deficit category, namely 56 students (98.2%). All respondents experienced iron deficiency due to not consuming enough iron-rich foods. Many respondents did not consume fruits with vitamin C content which is important for iron absorption. This lack of vitamin C consumption adds to iron deficiency because a diverse diet increases red blood cell production and iron absorption.²¹ As a result, dietary variation acts as an indirect signal of low vitamin consumption in adolescents, potentially increasing susceptibility to anaemia and other nutritional deficiencies.²²

Relationship between Energy Intake Level and Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

The results of the Spearman correlation test showed a p-value of (0.000). If the p-value is smaller than α (0.05), then H_0 is rejected, which means there is a relationship between energy intake and the incidence of CED in class VIII students at SMP Negeri 5 Surabaya. Insufficient energy intake can cause Chronic Energy Deficiency (CED), because the body does not get enough energy needed to fulfil functional needs and daily activities. Another cause of CED is the unavailability of sufficient fuel for the body to do its job.²³ Insufficient calorie intake leads to a drop in body temperature. The body converts stored fat into energy. If the body continues to consume stored fat as energy until it runs out, it will convert protein stored in the liver and muscles into energy. If protein reserves are depleted regularly, muscle mass will be lost, which can result in Chronic Energy Deficiency.²⁴

Relationship between Protein Intake Level and the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

The results of the Spearman correlation test showed a p-value of (0.000). If the p-value is smaller than α (0.05), then H_0 is rejected, which means there is a relationship between protein intake and the incidence of CED in class VIII students at SMP Negeri 5 Surabaya. Protein has a unique function of building and maintaining body cells and tissues so that protein cannot be replaced by other substances. Lack of continuous intake of protein nutrients will cause symptoms such as decreased endurance, susceptibility to disease, and increased risk of death.²⁵ In Chronic Energy Deficiency caused by a lack of protein intake, the body lacks the materials to repair and maintain these tissues.²⁶ When protein intake is low, the body tends to utilise existing energy reserves, including fats and carbohydrates, to fulfil its energy needs. If protein intake continues to be deficient, then these energy reserves can also be depleted, resulting in Chronic Energy Deficiency (CED).²⁷

Relationship between Iron Intake Level and the Incidence of Chronic Energy Deficiency (CED) in Class VIII Students at SMP Negeri 5 Surabaya

Based on research conducted on Class VIII students at SMP Negeri 5 Surabaya, the results of the Spearman correlation test obtained a p-value of 0.143. This shows that the p-value is more than α (0.05), so H_0 is accepted, meaning that there is no relationship between the level of iron intake and the nutritional status of CED in Class VIII students at SMP Negeri 5 Surabaya. This condition illustrates how iron consumption is only one of the many variables that determine the occurrence of CED.²⁸ Therefore, iron consumption is not the only major factor determining the prevalence or incidence of CED. Another cause of insufficient iron intake in adolescent girls is the frequent consumption of non-heme iron sources and substances that inhibit iron absorption.²⁹ The difference in absorption efficiency between heme and non-heme iron has a major impact on iron levels. Heme iron is easily absorbed by specialised transporters in the cell membrane. Whereas non-heme iron must be converted to heme iron in the body before it can be properly absorbed.³⁰ In addition, inhibitors such as caffeine and tannins in coffee and tea significantly limit the absorption of non-heme iron.³¹

CONCLUSION

The characteristics of grade VIII students at SMPN 5 Surabaya based on age were mostly 14 years old, as many as 40 respondents (70.2%). The highest level of energy intake category was very low, with 41 respondents (71.9%). The highest level of protein intake was very low, with 40 respondents (70.2%). The highest level of iron intake was in the severe deficit category, with 56 respondents (98.2%). The incidence of Chronic Energy Deficiency (CED) in class VIII female students at SMPN 5 Surabaya was highest with 39 respondents (68.4%) experiencing CED. The Spearman correlation test found a significant association between energy intake and CED incidence ($p = 0.000$, $\alpha < 0.05$). Protein intake was shown to be significantly associated with the occurrence of CED ($p = 0.000$, $\alpha < 0.05$). Iron intake did not significantly correlate with CED incidence ($p = 0.143$, $\alpha > 0.05$).

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REFERENCES

1. A Dictara, Angraini, Maya Sari K. The Relationship between Food Intake and Chronic Energy Deficiency (CED) in Pregnant Women in the Working Area of the Sukaraja Public Health Center Bandar Lampung City. Majority. 2020;
2. Morrisey, Beall E. Absence of the Mitochondrial Translocator Protein 18 kDa in Mice Does Not Affect Body Weight or Food Intake Responses to Altered Energy Availability. *J Neuroendocrinol.* 2021;
3. Khairina M. The Description of CO Levels, COHb Levels, And Blood Pressure of Basement Workers X Shopping Centre, Malang. *J Kesehat Lingkung.* 2019;
4. Wijanarko W, Lestari MW. Hubungan Kadar Karboksihemoglobin Dengan Hematokrit Dalam Darah Mahasiswa Tingkat Akhir Terpapar Karbonmonoksida Di Sekolah Tinggi Ilmu Kesehatan Nasional. *J Indones Med Lab Sci.* 2022;3(1):14–26.
5. Telisa E. Asupan Zat Gizi Makro, Asupan Zat Besi, Kadar Haemoglobin (Intake of Macro Nutrition, Iron Intake, Haemoglobin Levels And Chronic Energy Deficiency Risk In Female Adolescent). *Aceh Nutr J.* 2020;
6. Prihatini, Lindayani S. Hubungan Kurang Energi Kronis pada Ibu Hamil Triwulan I dengan Kejadian Bayi Berat Lahir Rendah. *J Ilm Kebidanan.* 2021;
7. T. R. Sinaga, S. D. Purba, M. Simamora, J. A. Pardede CD. Berat Badan Lahir Rendah dengan Kejadian Stunting pada Batit. *J Ilm Permas.* 2021;
8. WHO. The State of Food Security and Nutrition in the World 2018: Building Climate Resilience for Food Security and Nutrition. 2018.
9. Kemenkes RI. Hasil Utama Riskesdas 2018. 2018.
10. Kementerian Kesehatan Republik Indonesia. Hasil Utama Riset Kesehatan Dasar Provinsi Jawa Timur. 2018.
11. Sugiyono. Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta; 2018.
12. Notoatmodjo S. Metodologi Penelitian Kesehatan. Rineka Cipta. Jakarta: PT. Rineka Cipta; 2019. 243 hal.
13. Sandala TC, Maureen I. Punuh, Sanggelorang Y. Gambaran Pengetahuan Tentang Anemia Gizi Besi pada Remaja Putri di SMA Negeri 3 Manado. *J Kesmas.* 2022;11(2):176–81.
14. Herawati V. Hubungan Asupan Energi Protein dan Pengetahuan tentang Gizi Seimbang dengan Status Gizi Remaja di Posyandu Remaja Desa Pangkalan Jambi Kecamatan Bukit Batu. *J Kesehat Tambusai.* 2023;4(1):65–77.
15. Manoppo I, Lang MF. Hubungan Body Image Dengan Status Gizi Pada Remaja Di Desa Kema li. *Nutr J.* 2022;6(1):14.

16. Oematan G, Oematan G, Mege SR. Audio Visual Nutrition Education and Breakfast Habits in Children. *Mattawang J Pengabdian Masy.* 2023;4(2):148–53.
17. Rabiah AN, Ratnawati, Reski S. The Relationship between Nutritional Status and Food Intake with the Physical Fitness Level of Athletes at the Samkot Samarinda Football School in 2022. *Formosa J Sci Technol.* 2022;1(7):945–60.
18. Krisdayani DD, Agustina A, Hanifah L. Hubungan Pola Makan, Pengetahuan Gizi Seimbang Dan Sosial Budaya Dengan Status Gizi Calon Pengantin. *Gizi Indones.* 2023;46(1):11–22.
19. Andhikawati A, Junianto J, Permana R, Oktavia Y. Review: Komposisi Gizi Ikan Terhadap Kesehatan Tubuh Manusia. *Marinade.* 2021;4(02):76–84.
20. Nurapipah M, Lestari A. Edukasi Manfaat Mengonsumsi Ikan Bagi Kesehatan. *J Pengabdian Kpd Masy Kesehat [Internet].* 2023;3(1):57–68. Tersedia pada: https://scholar.google.com/scholar?hl=id&as_sdt=0%2C5&q=Edukasi+Manfaat+Mengonsumsi+Ikan+Bagi+Kesehatan.+Jurnal+&btnG=
21. Amha A, Girum T. Prevalence and associated factors of thinness among adolescent girls attending governmental schools in Aksum Town, Northern Ethiopia. *Med J Dr DY Patil Vidyapeeth.* 2018;158–64.
22. Hasanah I, Adnindya Syafira Y, Lusida N, Fuadiyah F, Fauziah M. Relationship of Iron Consumption with Anemia in Pregnant Women. *Muhammadiyah Int Public Heal Med Proceeding.* 2021;1(1):959–74.
23. Fakhriyah, Lasari HHD, Putri AO, Setiawan MI, Noor MS, Lestari D, et al. Analisis Faktor Risiko Kejadian Kekurangan Energi Kronik (Kek) Pada Remaja Putri Di Wilayah Lahan Basah. *Pros Semin Nas Lingkung Lahan Basah.* 2022;7(April):136–40.
24. A. Aguillard, J. Arricastes, J. tzeng DL. A Cytoskeleton-Based Mechanism Regulates Lipid Metabolism and Energy Homeostasis in Brown Adipose Tissue. *Diabetes Journals.* 2022;
25. Astuti C, Majid R, Prasetya F. Chronic Energy Deficiency in Women from Muna District: Association with Body Image and Knowledge. *Divers Dis Prev Res Integr.* 2022;2(2):76–83.
26. Wardhani P, Agustina, Ery M, Ilmu Kesehatan F, Pembangunan Nasional U. The Correlation Between Body Image and Diet with Chronic Energy Deficiency (Ced) on Female Adolescents in SMAN in West Java. *Jph Rec.* 2020;3(2):127–39.
27. Izzati RF, Mutalazimah M. Energy, Protein Intake, and Chronic Energy Deficiency in Pregnant Women: A Critical Review. *Proc Int Conf Heal Well-Being (ICHWB 2021).* 2022;49(Ichwb 2021):70–7.
28. Lina, Arbaiyah, Meliani Sukmadewi Harahap. Relationship between Chronic Energy Deficiency and Compliance with Taking Fe Tablets with the Incidence of Anemia in Pregnant Women at Kuala Simpang City Health Center Aceh Tamiang. *Sci Midwifery.* 2022;10(4):3047–52.
29. Sumarlan ES, Windiastuti E, Gunardi H. Iron Status, Prevalence and Risk Factors of Iron Deficiency Anemia Among 12- to 15-Year-Old Adolescent Girls from Different Socioeconomic Status in Indonesia. *Makara J Heal Res.* 2018;22(1).

30. Piskin E, Cianciosi D, Gulec S, Tomas M, Capanoglu E. Iron Absorption: Factors, Limitations, and Improvement Methods. *ACS Omega*. 2022;7(24):20441–56.
31. Pipoyan D, Stepanyan S, Beglaryan M, Mantovani A. Assessment of Heme and Non-Heme Iron Intake and Its Dietary Sources among Adults in Armenia. *Nutrients*. 2023;15(7):1–10.