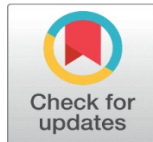


# THE RELATIONSHIP BETWEEN THE INTAKE OF ENERGY, PROTEIN, IRON, AND VITAMIN C WITH HEMOGLOBIN STATUS IN PULMONARY TUBERCULOSIS OUTPATIENTS

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## ABSTRACT

**Background:** Pulmonary Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis* with a treatment period of 6 months to more than one year. The prevalence of pulmonary TB in Indonesia in 2013 was 40% and in South Sumatra in 2018 was 40%. The management of pulmonary TB patients involves several things, namely adequate rest, anti-tuberculosis drug (ATD) therapy, and adequate food intake (sufficient) to recover the patients' pulmonary TB. Purpose in this study investigated the relationship between energy and protein intake, iron, and vitamin C with Hemoglobin (Hb) status in pulmonary TB patients. **Method:** The type of research used is an observational analytic study with a cross sectional research design with a sample size of 50 human subjects. Participants were selected according to the inclusion criteria and interviewed using a prepared questionnaire. Participants' food intake was obtained using a 24-hour food recall method for 3 days. Body weight, height, and blood pressure were measured. Blood samples were taken to determine the participants' hemoglobin levels. **Result:** There was no relationship between the Hb value and energy intake ( $p = 0.658$ ) and protein ( $p = 0.357$ ), while there was a relationship between the Hb value and iron intake ( $p = 0.012$ ) and vitamin C ( $p = 0.001$ ). **Conclusion:** The results of statistical tests showed a relationship between the Hb value with iron and vitamin C intake, while the energy and protein intake had no relationship with the Hb level in pulmonary TB patients.

**Keywords:** Energy Intake, Protein, Iron, Vitamin C, Hb Value, Pulmonary Tuberculosis

## 1. INTRODUCTION

Pulmonary TB is a chronic infectious disease caused by *Mycobacterium tuberculosis* with a treatment period of 6 months to more than one year [Misnadiarly. \(2006\)](#). WHO (World Health Organization) estimates that there are 583,000 people with pulmonary TB every year, with a death toll of 140,000. Pulmonary TB attacks more than 75% of the population of productive age, and 20-30% of family income is lost yearly due to pulmonary TB. Besides, an active patient with pulmonary TB will

infect 10-15 people around him per year, and without effective treatment, 50-60% of pulmonary TB sufferers will die [Laban \(2008\)](#).

Lung infection by the bacterium *Mycobacterium tuberculosis* has a reasonably high number of cases in Indonesia, with 660,000 people in 2010. Based on the WHO report in 2010, Indonesia is ranked 5th in the world with the most pulmonary TB sufferers, after India, China, Nigeria, and Bangladesh [WHO Global Tuberculosis Control \(2010\)](#). While a 2013 WHO report, the prevalence of TB in Indonesia ranks third after India and China, which is nearly 700 thousand cases, the mortality rate is still high, 27/100 thousand population.

Based on the Basic Health Research (Riskesdas) in 2013, the national prevalence of pulmonary TB is still high at 40%. The five provinces with the highest prevalence of pulmonary TB are West Java, Papua, DKI Jakarta, Gorontalo, and Banten. Meanwhile, for the province of South Sumatra, the prevalence of pulmonary TB is 20%.

The results of the pulmonary TB study showed that were found to suffer from malnutrition as much as 55.6% in Semarang in 2014, were found to suffer from chronic energy deficiency, micronutrient deficiencies such as zinc and retinol plasma deficiency, selenium, and probiotics in productive age groups in Indonesia. The infection causes chronic inflammation, decreased intake, nutrient malabsorption, changes in body metabolism, decreased immunity, and body antioxidants. [Erika et al. \(2016\)](#) and [Sarce and Suarni \(2016\)](#). Based on Riskesdas 2018, the prevalence of pulmonary TB in South Sumatra Province was 40%, while in 2013, it was still 20%, meaning that within five years, there was an increase of 20%.

The development of pulmonary TB based on data from the health profile of Palembang for five years from 2008 to 2012, there were 1,233 cases in 2008 (55.9%), 1,077 cases in 2009 (48%), and 1,037 cases. In 2010 (50%), an increase of 2,109 cases in 2011 (59%) and decreased to 1,329 cases in 2012 [Palembang \(2012\)](#).

High Energy High Protein diet is a diet that contains energy and protein above everyday needs. The results showed that 66% of patients with pulmonary TB had a body mass index (BMI) less than expected (18.5 kg / m<sup>2</sup>). Increasing the food intake might improve nutritional status and body weight, BMI, LILA, albumin levels, and Hb levels. It will provide more optimal treatment results [Arsin \(2012\)](#). Each hospital has implemented nutritional therapy for patients according to the recommended diet. However, in reality, the nutritional status of pulmonary TB sufferers is low. For this reason, it is necessary to strive for a service so that patients with pulmonary TB can accept/want to consume the food served. These efforts are through counseling.

## 2. MATERIALS AND METHODS

*Study design and participants:* This study was an observational analytic study with a cross-sectional study design. Researchers made observations or variable measurements at one time, where the researchers observed each subject only once, and the measurement of the subject variables was carried out at the time of the examination. The study was conducted on 50 patients who were included in the inclusion criteria using purposive sampling method. The criteria for the patients included were being diagnosed by a doctor who was positive (+) TB, aged over 18 years, able to communicate well. While patients were not included with the criteria for suffering from serious complications such as kidney disease, heart disease, and liver cirrhosis.

**Measurements:** Patients were measured height and weight, interviewed patients with a prepared questionnaire. The patient's nutritional intake was obtained using the food recall method. The frequency of the patient's food intake was measured for 1 month, then the intake of energy, protein, iron and vitamin C was processed using the Nutrisurvey application. This study has been ethically approved by the university.

**Data analysis:** All variables such as energy, protein, iron, and vitamin C were tested by Chi-Square test. The data were collected together and tested statistically. Statistical analysis was performed using IBM SPSS 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0 ). The levels of statistical significance  $p < 0,05$ .

### 3. RESULTS

Characteristics of respondents consisting of gender, age, and Hb levels are presented in Table 1. The descriptive statistical distribution based on the mean and standard deviation is presented in Table 2. The distribution of the relationship between the intake of energy, protein, iron and vitamin C with Hb status in pulmonary TB patients is shown in Table 3. There was a relationship between Hb value with iron intake ( $p$  value = 0.012) and vitamin C intake ( $p$  value = 0.001) in pulmonary TB patients, while energy intake ( $p$  value = 0.658) and protein intake ( $p$  value = 0.357) did not have a significant relationship with Hb value in pulmonary TB patients. Table 4 shows correlation of the intake of energy, protein, iron, and vitamin C to Hb value. The results of the correlation test in table 4 of iron and vitamin C have a significant relationship, while energy and protein do not show a significant relationship. However, if analyzed more deeply, there is a negative relationship between protein, iron, and vitamin C intake with Hb values, so it can be concluded that if the intake is increased there will be an increase in the subject's Hb value.

**Table 1**

Table 1 The Characteristics of Respondent		
The Characteristics of Respondent	Subject	
	n	%
Gender		
Male	32	64
Female	18	36
TOTAL	50	100
Age		
16-18	1	2
19-29	15	30
30-49	23	46
50-64	9	18
65-80	2	4
TOTAL	50	100
Blood Hb Levels		
Anemia	34	68
Normal	16	32
TOTAL	50	100

**Table 2****Table 2 Descriptive Statistics Distribution Based on Mean and Standard Deviation**

Variable	n	Mean $\pm$ SD	Maximum	Minimum
Energy Intake	50	1794,5 $\pm$ 528,69	3638,6	897,6
Protein Intake	50	61,9 $\pm$ 20,53	125,8	18,5
Iron Intake	50	7,3 $\pm$ 2,94	17,1	2,1
Vit. C Intake	50	41,9 $\pm$ 33,37	156	0

**Table 3****Table 3 The Relationship Distribution of the Intake of Energy, Protein, Iron and Vitamin C with Hb Status in Pulmonary TB Patients**

Variable	Category	Hb Value						<i>p-Value</i>
		Anemia		Normal		Total		
		n	%	n	%	n	%	
Energy Intake	Less	19	65,5	10	34,5	29	100	0,658
	Good	15	71,4	6	28,6	21	100	
	Total	34		16		50		
Protein Intake	Less	13	76,5	4	23,5	17	100	0,357
	Good	21	63,6	12	10,6	33	100	
	Total	34		16		50		
Iron Intake	Less	27	79,4	7	20,6	34	100	0,012
	Good	7	43,8	9	56,3	16	100	
	Total	34		16		50		
Vitamin C Intake	Less	29	82,9	6	17,1	35	100	0,001
	Good	5	33,3	10	66,7	15	100	
	Total	34		16		50		

**Table 4****Table 4 Correlation of the Intake of Energy, Protein, Iron and Vitamin C to Hb Value**

Intake	Hb Value	
	Correlation coefficient	<i>p value</i>
Energy	0,063	0,666
Protein	-0,130	0,367
Iron	-0,357	0,011
Vitamin C	-0,487	0,000

## 4. DISCUSSION

### 4.1. GENDER

Based on the results of this study, the frequency distribution of respondents based on gender is male, mainly as many as 32 people (64%) and 18 women (36%). A large number of incidents of pulmonary TB occur in men because men have higher mobility than women, so the possibility of exposure is more significant. Besides, smoking and consuming alcohol can make it easier for men to become infected with pulmonary TB [Dotulong et al. \(2015\)](#). This result is in line with the research of [Arifah et al. \(2016\)](#), which states that men tend to suffer from pulmonary TB more than women because it may be due to men's social status and occupation.

### 4.2. AGE

Based on the results of this study, the frequency distribution of respondents based on age is mainly from the age of 30-49 years, namely 23 people (46%). Pulmonary TB disease is often found at productive age, namely the age of 15-50 years. It is because the 15-50 age group has very high mobility so that the possibility of being exposed to the Mycobacteri pulmonary TB is greater besides that endogenous reactive (reactivating that already exists in the body) can occur at old age 2015).

### 4.3. HB LEVELS

This study showed that the subjects' Hb levels were mainly anemic, namely 34 people (68%). This result is in line with [Nasution \(2015\)](#) research that pulmonary TB can cause various disorders such as anemia, increased erythrocyte sedimentation, decreased serum albumin, hyponatremia, liver disfunction, leukocytosis, and hypocalcemia. Types of Anemia that occur in pulmonary TB cases are microcytic hypochromic anemia and normocytic normochromic anemia. Anemia is the most common complication of pulmonary TB, and its prevalence ranges from 16 to 76% in several studies [Monjur and Rizwan \(2014\)](#) in [Nasution \(2015\)](#).

TB induces a systemic inflammatory state that affects iron homeostasis. Patients with TB often have additional comorbidities such as anemia which can lead to worse treatment outcomes [Hella et al. \(2018\)](#).

Smoking habits also affect blood Hb levels, and this is in line with Astuti's (2019) study which states that there is a significant relationship between smoking frequency and Hb levels ( $p = 0.019$ ). The Spearman correlation value ( $r = -0.273$ ) shows a negative correlation, which means that the more smoking, the lower the Hb level.

However, the results of Wibowo et al. (2017) concluded that there was no relationship between smoking and Hb levels ( $p = 0.634$ ) and platelet levels ( $p = 0.471$ ). Several factors affect each individual's Hb level: age, gender, nutritional intake, physical activity, the altitude of the area of residence, the habit of smoking cigarettes, the drugs consumed, and the test tools and methods used. Researchers did not further examine several factors that could affect Hb levels, such as nutritional intake, degree of physical activity, and the residence's altitude, which could impact the respondents' Hb levels [Wibowo et al. \(2017\)](#).

#### 4.4. ENERGY INTAKE

Based on [Table 4](#), the proportion of respondents with a greater Hb Anemia value was found in respondents with less energy intake by 19 people (65.5%) compared to the Hb Anemia value and a good energy intake level of 15 people (71.4%). From the chi-square statistical test results with  $\alpha = 0.05$ , it can be concluded that there is no relationship between the Hb value and the respondent's energy intake with a  $p = 0.658$ .

The results of this study are not in line with the research of Mantika et al. (2014), where there is a relationship between energy intake and Hb levels ( $p = 0.000$ ).

However, the results of this study are in line with [Erdi \(2013\)](#) study, which states that there is no significant relationship between energy sufficiency levels and Hb levels ( $p > 0.05$ ). Presumably, the energy intake is mainly from food sources of carbohydrates, so it does not contribute significant amounts of iron. It is known that iron is the food that contributes more to Hb as an indicator of anemia status. Iron is a group of needed minerals, as the core of Hb, the main constituent of red blood cells.

#### 4.5. PROTEIN INTAKE

Based on [Table 4](#), the proportion of respondents with a greater Hb Anemia value was found in respondents with a good protein intake level of 21 people (63.6%) compared to the Hb Anemia value and a low protein intake level of 13 people (76.5%). From the chi-square statistical test results with  $\alpha = 0.05$ , it can be concluded that there is no relationship between the Hb value and the respondent's protein intake with a  $p = 0.357$ .

The results of this study are not in line with research by [Yuliati et al. \(2017\)](#), where there is a relationship between protein intake and Hb levels ( $p = 0.005$ ). There is a suspicion that the food source of protein that is commonly consumed, for example, is a source of animal protein from the fish, meat, and processed food groups as it is known that animal food is a source of heme iron. Furthermore, it is also not in line with the research of [Eniwati and Sofyan \(2019\)](#), where there is a relationship between protein intake and Hb levels in adolescent girls ( $p = 0.035$ ).

Then the results of this study are in line with [Sulistiyorini \(2006\)](#) and [Astuti \(2010\)](#) research, which shows that there is no significant relationship between protein intake and Hb levels ( $r = 0$ ). It is presumably because almost all study subjects, both anemic and non-anemic, are deficient in protein.

#### 4.6. INTAKE OF IRON AND VITAMIN C

Based on [Table 4](#), the proportion of respondents with a greater Hb Anemia value was found in respondents with less iron intake, 27 people (79.4%) compared to the Hb Anemia value and 7 people (43.8%) with good iron intake.

From the chi-square statistical test results with  $\alpha = 0.05$ , it can be concluded that there is a relationship between the Hb value and the respondent's iron intake with a  $p = 0.012$ . Then based on table 11, the proportion of respondents with a greater Hb Anemia value was found in respondents with less vitamin C intake 29 people (82.9%) compared to the Hb Anemia value and 5 people with good vitamin C intake levels (33.3%). From the chi-square statistical test results with  $\alpha = 0.05$ , it can be concluded that there is a relationship between the Hb value and the respondent's vitamin C intake with a  $p\text{-value} = 0.001$ .



This study's results align with [Suwarni \(2013\)](#) research which states that there is a significant relationship between iron and vitamin C supplements to increase Hb levels. Many factors influence the formation of Hb, one of which is the presence of iron in the body. 70% of Fe is in Hb, while 26% is as iron reserves in the liver, spleen, and bones [Reksodiputro \(1994\)](#) in [Suwarni \(2013\)](#).

The main factors in iron balance and metabolism are intake, storage, and loss. Iron intake is strongly influenced by the amount of input, bioavailability, and absorption capacity. The amount of input is, of course, very individual, depending on the needs. The absorption ability is increased by the presence of vitamin C. Fe and vitamin C groups from the examination results were able to have the most significant effect in increasing Hb levels [Suwarni \(2013\)](#).

Research conducted by [Vilchèze et al. \(2013\)](#) stated that Vitamin C can increase Fe concentration in *M. tuberculosis* bacteria culture.

Then the results of this study are also in line with [Astuti \(2010\)](#) study, which states that there is a significant relationship between vitamin C intake and iron intake ( $r = 0.765$ ) and iron intake with Hb ( $r = 0.675$ ). It is possible because the formation of Hb requires iron, while its absorption requires vitamin C.

Das (2003) showed that giving iron supplementation in pulmonary TB patients with associated mild to moderate anemia can accelerate the return to normal initial hematopoiesis by increasing Fe saturation in transferrin. Moreover, the research of [Isanaka \(2011\)](#) shows the results of the effect of iron deficiency on pulmonary TB patients.

Iron is a mineral essential for the growth of all cells. This is needed to help red blood cells deliver oxygen to other body parts. Iron deficiency is the single largest cause of malnutrition worldwide and the most common cause of anemia [Novita et al. \(2018\)](#).

TB patients are also advised to eat foods that contain iron. The best sources of iron are beef, chicken liver, chicken, turkey, fish, and shellfish.

## 5. CONCLUSION

Based on the results of research and discussion of the relationship between the intake of energy, protein, iron, and vitamin C and Hb status in outpatient pulmonary TB patients, it can be concluded that there is a relationship between the Hb value and the intake of iron and vitamin C. In contrast, Energy and protein intake had no relationship with Hb levels in pulmonary TB patients.

## CONFLICT OF INTERESTS

None.

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## REFERENCES

Arifah. M. R, Darmono. D, Muchlis. A. U. S. (2016). Pemberian Kombinasi Probiotik dan Zinc terhadap perubahan kadar hemoglobin, albumin, dan indeks massa tubuh pada pasien Tuberkulosis Paru. Jurnal Gizi Klinik Indonesia. 13 (1), 7-13. <https://doi.org/10.22146/ijcn.23024>.

- Arsunan, A., Wahiduddin, and Jumriani, A., (2012). Gambaran Asupan Zat Gizi dan Status Gizi Penderita TB Paru di Kota Makassar. *Jurnal Universitas Hasanuddin*.
- Astuti C. W., and Satrianugraha M. D., (2019). Hubungan Frekuensi Merokok dengan Kadar Hemoglobin dan Kebugaran Jasmani Siswa Kelas XI di Sekolah Menengah Kejuruan Nasional Kota Cirebon. *Jurnal Kedokteran dan Kesehatan*. 5 (2).
- Astuti, Y. (2010). Hubungan antara Asupan Protein, Zat Besi dan Vitamin C dengan Kadar Hb pada Anak Umur (7-15) tahun di Desa Sidoharjo, Samigaluh, Kulon Progo. *Jurnal Kedokteran dan Kesehatan*. 10 (2), 172-179.
- Devi, U., Rao, C., Srivastava, V., Rath, P., and Das, B. (2003). Effect of Iron Supplementation on Mild to Moderate Anaemia in Pulmonary Tuberculosis. *British Journal of Nutrition*, 90(3), 541-550. <https://doi.org/10.1079/BJN2003936>.
- Dotulong, J., Sapulete, M. R., and Kandou, G. D. (2015). Hubungan Faktor Risiko Umur, Jenis Kelamin Dan Kepadatan Hunian Dengan Kejadian Penyakit Tb Paru Di Desa Wori Kecamatan Wori. *Jurnal Kedokteran Komunitas dan Tropik*. 3(2).
- Eniwati, and Sofyan M. W. (2019). Hubungan Asupan Protein Nabati Dengan Kadar Hemoglobin Pada Wanita Usia Remaja Vegan. *Medula*. 9(1), 223-236.
- Erdi, H., (2013). Hubungan Tingkat Kecukupan Protein dan Zat Besi (Fe) dengan Kadar Hemoglobin Ibu Hamil di Kota Bogor. *Jurnal Universitas IPB*.
- Hamid, H. (2013). Makanan sebagai Pendukung Kesembuhan TB Paru. Bandung.
- Hella, J., Cercamondi, C.I., Mhimbira, F., Sasamalo, M., Stoffel, N., Zwahlen, M., Bodmer, T., Gagneux, S., Reither, K., Zimmermann, M.B. and Risch, L., (2018). Anemia in tuberculosis cases and household controls from Tanzania: contribution of disease, coinfections, and the role of hepcidin. *PloS one*, 13(4). <https://doi.org/10.1371/journal.pone.0195985>.
- Isanaka, S., Mugusi, F., Urassa, W., Willett, W.C., Bosch, R.J., Villamor, E., Spiegelman, D., Duggan, C., Fawzi, W.W. (2012). Iron Deficiency and Anemia Predict Mortality in Patients with Tuberculosis. *J Nutr*. 142(2), 350-7. <https://doi.org/10.3945/jn.111.144287>.
- Kemenkes R.I. (2010). Laporan Riset Kesehatan Dasar (RISKESDAS) Nasional. Jakarta : Badan Pengembangan dan Penelitian Kesehatan, Departemen Kesehatan RI.
- Kemenkes R.I. (2013). Laporan Riset Kesehatan Dasar (RISKESDAS) Nasional. Jakarta : Badan Pengembangan dan Penelitian Kesehatan, Departemen Kesehatan RI.
- Kemenkes R.I. (2018). Laporan Riset Kesehatan Dasar (RISKESDAS) Nasional. Jakarta : Badan Pengembangan dan Penelitian Kesehatan, Departemen Kesehatan RI.
- Laban, Y. Y. (2008). Penyakit dan Cara Pencegahan TBC. Yogyakarta : Kanisius.
- Lemeshow, S., Hosmer Jr, D., W., Klar, J., and dan Lwanga, S.K. (1997). Besar Sampel dalam Penelitian Kesehatan. Yogyakarta : Gadjah Mada University Press.
- Mantika, A.I., and Mulyati, T. (2014). Hubungan asupan energi, protein, zat besi dan aktivitas fisik dengan kadar hemoglobin tenaga kerja di pabrik pengolahan rambut PT. Won Jin Indonesia. *Journal of Nutrition College*, 3(4), 848-854. <https://doi.org/10.14710/jnc.v3i4.6890>.
- Misnadiarly. (2006). Mengenal, mencegah, menanggulangi TBC-Paru, ekstra Paru pada anak dan kehamilan. Jakarta : OBOR.
- Monjur, F., and Rizwan, F. (2014). A Cross-sectional Study of Morphological Types of Anemia in Pulmonary Tuberculosis Patient and Associated Risk



- Indicators in a Selected Hospital of Dhaka City, Bangladesh. *International Journal Chemical Environment Biological Science*. 2(4), 215-9.
- Nasution, S. D., (2015). Malnutrisi dan Anemia Pada Penderita Tuberkulosis Paru. *Medical Journal of Lampung University*. 4(8), 29-36.
- Novita, E., Pariyana, and Zata, I. (2018). Pengaruh Pemberian Tablet Fe terhadap Peningkatan Kadar Hemoglobin Pasien TB di Kecamatan Seberang Ulu I Kota Palembang. *Sriwijaya Journal of Medicine*. 1(2), 95-100. <https://doi.org/10.32539/SJM.v1i2.14>.
- Palembang, D. K. (2012). Data Penyakit TB Paru Kota Palembang. Palembang.
- Paramani, N. (2013). Hubungan dukungan pengawas minum obat (PMO) dengan kepatuhan berobat pasien Tuberkulosis Paru di Puskesmas Limboto Kabupaten Gorontalo. Universitas Negeri Gorontalo Repository.
- Sulistyorini. (2006). Hubungan tingkat Konsumsi Zat Gizi Dengan Status Anemia Pada Anak Sekolah Dasar Di Daerah Endemis Malaria (Studi Di Sdn Ngreco Iii Kecamatan Tegalombo Kabupaten Pacitan). *Jurnal Media Gizi Indonesia*. 1(3).
- Suwarni, S. (2013). Pengaruh Pemberian Suplemen Besi dan Vitamin C terhadap Daya Tahan Aerob dan Kadar Hemoglobin. *Jurnal Pendidikan Kesehatan Universitas Sebelas Maret*. 1(2).
- Vilchèze, C., Hartman T, Weinrick, B., and Jacobs, W.R. Jr. (2013). Mycobacterium tuberculosis is extraordinarily sensitive to killing by a vitamin C-induced Fenton reaction. *Nature Communications*, 4(1881). <https://doi.org/10.1038/ncomms2898>.
- Wibowo, D. V., Damajanty H.C. Pangemanan, Hedison Polii. (2017). Hubungan merokok dengan kadar hemoglobin dan Trombosit pada Perokok Dewasa. *eBiomedik*. 5(2).
- Yuliati, H., Widajanti, L., and Aruben, R. (2017). Hubungan Tingkat Kecukupan Energi, Protein, Besi, Vitamin C Dan Suplemen Tablet Besi Dengan Kadar Hemoglobin Ibu Hamil Trimester Ii Dan Iii (Di wilayah Kerja Puskesmas Purwanegara 2 Kabupaten Banjarnegara). *Jurnal Kesehatan Masyarakat (Undip)*, 5(4), 675 - 682.