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MACRONUTRIENT INTAKE AMONG MULTIDRUG-RESISTANT TUBERCULOSIS PATIENTS IN THREE REFERRAL HOSPITALS IN INDONESIA

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ABSTRACT

Poor nutritional status, such as macro- and micronutrient deficiencies, might lead to worse clinical outcomes in multidrug-resistant tuberculosis (MDR-TB) patients. This study aimed to describe the macronutrient intake among MDR-TB patients and then compare those findings with the Indonesian recommended dietary allowance (RDA). A cross-sectional study of MDR-TB outpatients aged 18-65 years treated with the nine- or 18-month regimens at the end of the first month of treatment was conducted. Macronutrient intake data were obtained from a food consumption survey (24-hour food recall) of MDR-TB outpatients that was conducted by interviewing, recording, and then analyzing using NutriSurvey software, and compared with the RDA of the Ministry of Health of Indonesia. There were 63 outpatients with MDR-TB. The mean age was 38 (SD 12) years, and most of the patients were male (58.7%). Nutritional status based on BMI < 18,5 kg/m2 was observed in 43 patients (68.3%). According to the survey, after the end of the first month of MDR-TB treatment, the median (min–max) daily intake of energy was 1386.5 (519.4 – 2963.6) kcal per day, and the mean of protein was 49.6 (SD 23.0) grams per day. The median (min-max) daily intake of fat was 43.0 (1.1-170.6) grams per day, and the mean carbohydrate was 209.16 (87.9) grams per day. The proportions of energy, protein, fat, and carbohydrate deficiency were 85,7%, 68,8%, 74,6%, 90,5%, respectively. Macronutrient intake among MDR TB patients in this study was lower than the Indonesian recommended dietary allowance. These findings indicate that additional food intake and dietary counseling are needed in MDR-TB patients in Indonesia.

Keywords: food intake; macronutrient; multidrug-resistant tuberculosis; survey

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INTRODUCTION

Multidrug-resistant TB (MDR-TB) remains a public health crisis that poses a threat to health security (World Health Organization, 2024) Multidrug-resistant tuberculosis is defined as tuberculosis that is resistant to at least two of the most important first-line anti-TB drugs, rifampicin and isoniazid, as determined by drug susceptibility testing (Kementerian Kesehatan RI, 2020; World Health Organization, 2024). Currently, Indonesia is the third largest contributor to MDR/RR-TB cases globally.(Kementerian Kesehatan RI, 2024; World Health Organization, 2024) The prevalence of malnutrition in MDR TB patients ranges from 35-75% in low- and middle-income countries, including Indonesia (Damji et al., 2022; Wagnew et al., 2023). Moderate to severe malnutrition is a risk factor for higher mortality among patients with tuberculosis (Damji et al., 2022; Jovita et al., 2022). Poor nutritional status, such as macro- and micronutrient deficiencies, can lead to immunodeficiency, both cell-mediated and humoral immune responses (Chandrasekaran et al., 2017). Hence, it was associated with a

longer time to sputum conversion, worse treatment outcomes (Chandrasekaran et al., 2017; Ockenga et al., 2023).

A tuberculosis patient experiences an increased basal metabolic rate (BMR) and *requires* more energy to maintain body function. Previous studies showed an association between TB and malnutrition (Bhargava et al., 2013; Ockenga et al., 2023). Dietary requirements for MDR-TB patients include energy, macronutrients, and micronutrients (Jovita et al., 2022; Ren et al., 2019). Food consumption surveys (24-hour food recall) can provide information to assess the nutritional intake of patients. However, there is insufficient evidence regarding the nutritional intake of MDR-TB patients in Indonesia, especially macronutrients. This study aimed to describe the macronutrient intake among multidrug-resistant tuberculosis (MDR-TB) patients and then compare those findings with the Indonesian RDA.

METHOD

Participants and Study Design

This cross-sectional study was conducted at RSPI Sulianti Saroso, Jakarta, Pasar Rebo Hospital, Jakarta, and Dr. M. Goenawan Partowidigdo Hospital, West Java, from December 2023 to November 2024. Patients involved in this study were part of a cohort study designed to describe bedaquiline and levofloxacin plasma concentrations in MDR-TB patients. The inclusion criteria were MDR-TB outpatients aged 18-65 years treated with the nine or 18-month all-oral regimen for MDR-TB treatment. Patients were excluded if they were pregnant or HIV positive, had severe uncontrolled diabetes, cancer, digestive system disorders, cardiovascular system disorders, or hepatic or renal problems. A total of 63 patients were included in this study. Patients were enrolled using a sequential sampling procedure.

Measurements and Procedure

Dietary assessment described the intake of carbohydrate, protein, and fat was assessed using a 24-hour food recall after the end of the first month of MDR-TB treatment. According to the end of the first month of MDR-TB treatment, patients were generally more clinically stable, and this time point aligned with the routine clinical monitoring schedule by the TB program. Patients were instructed to recall all food they had consumed the previous day from the time they woke up. Standardized household measures (plates, cups, or spoons) were used to estimate the amount of food consumed. The patient was informed of the sizes of the plate or the cup, or the spoon. Food intake was calculated using the NutriSurvey software, which was packaged in the Indonesian food database. The content of the diet for the Indonesian version was used to determine the content of macronutrients in the diet. The results were compared with the recommended dietary allowance (RDA) for the Indonesian guideline by the Minister of Health, Regulation No. 28 of 2019. Dietary deficiency was defined as a low macronutrient intake below the RDA guideline for each male or female and each categorical age of the patient. The RDA guidelines are presented in Table 1.

Table 1.
The Recommended Dietary Allowance Guideline

Nutrients	Male			Female		
	18 – 29 years	30 – 49 years	50 – 65 years	18 – 29 years	30 – 49 years	50 – 65 years
Energy (kcal)	2650	2550	2150	2250	2150	1800
Protein (g/day)	60	65	65	60	60	58
Fat (g/day)	75	70	60	65	60	50
Carbohydrate (g/day	430	415	340	360	340	280

Statistical Analysis and Ethical Clearance

The collected data were compiled using statistical descriptive methods without hypothesis testing. Quantitative data of demographic, behavioral, and clinical characteristics with a normal distribution are presented as the mean (standard deviation), and non-normally distributed data are presented as the median (maximum-minimum). Data on macronutrient intakes were presented as mean (standard deviation) and median (min-max). Data on dietary deficiency were presented as frequencies (absolute number and their percentage). This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia (KET-1497/UN2).F1/ETIK/PPM.00.02/2023). Written informed consent was obtained from all patients.

RESULT

A total of 63 patients were in this study; the mean age of them was 38 (SD 12) years, and most patients were male (58.7%). More than half of the patients were married (65.1%) and underweight (< 18.5 kg m^2). Demographic data (age, sex, ethnicity, occupation, and marital status), behavioral characteristics (smoking and alcohol consumption history), and clinical characteristics (previous TB treatment, BMI, and laboratory results) among 63 MDR-TB Patients at baseline are shown in Table 2.

Table 2.
Demographic Data, Behavioral and Clinical Characteristics of 63 MDR-TB Patients at Baseline

Variable	f (%) (n = 63)
Age (years), mean (SD)	38 (12)
Sex, n (%)	
Male	37 (58.7)
Female	26 (41.3)
Ethnicity, n (%)	
Java	56 (88.9)
Other	7 (11.1)
Previous TB treatment, n (%)	
No	21 (33.3)
Yes	42 (66.7)
Occupation, n (%)	
Unemplyoyed	28 (44.5)
Employed	35 (55.5)
Marital Status, n (%)	
Married	41 (65.1)
Single/Divorced	22 (34.9)
Smoking status history, n (%)	
Non-smoker	31 (49.2)
Smoker	32 (50.8)

Variable	f (%) (n = 63)
Alcohol consumption history, n (%)	
No	52 (82.5)
Yes	11 (17.5)
BMI (kg/m2), mean (SD)	17.6 (2.7)
Categorical BMI, n (%)	
Normal weight (18.5 to 24.9 kg m^2)	20 (31.7)
Underweight (< 18.5 kg m^2)	43 (68.3)
Laboratory results	
Hemoglobin (g/dl), mean (SD)	11.7 (1.8)
AST (U/L), median (min-max)	19 (4-70)
ALT (U/L), median (min-max)	16 (5-66)
Creatinine (mg/dL), rerata (SD)	0.7 (0,2)
Albumin (g/L), median (min-maks)	3.2 (2,0-4.9)

AST: aspartate aminotransferase; ALT: alanine aminotransferase

The mean daily energy intake was 1484.4 (648.7 kcal). We described dietary deficiency for each patient based on their categorical sex and age (18 – 29 years, 30 – 49 years, 50 – 65 years), and then compared those findings with the Indonesian RDA. The daily energy and macronutrient intakes and deficiencies among 63 MDR-TB patients are shown in Table 3.

Table 3.
Energy and Macronutrient Intakes and Deficiencies Among 63 MDR-TB Patients

Energy and macronutrient intakes/day	Mean (SD) Median (min–max)	Dietary Deficiency*						
		Male (n)			Female (n)			Total n (%)
		18 – 29 years	30 – 49 years	50-65 years	18-29 years	30-49 years	50-65 years	
Calories (Kcal)		7	21	6	6	9	5	54
Mean (SD)	1484.4 (648.7)							(85.7)
Median (min-max)	1386.5 (519.4 – 2963.6)							
Protein (g)		7	16	6	3	7	5	44
Mean (SD)	49.6 (23.1)							(68.8)
Median (min-max)	47.8 (9.7 – 110.4)							
Fat (g)		7	15	7	3	9	6	47
Mean (SD)	49.4 (34.9)							(74.6)
Median (min-max)	43 (1.1 – 170.6)							
Carbohydrate (g)		7	22	7	6	10	5	57
Mean (SD)	209.16 (87.9)							(90.5)
Median (min-max)	202.2 (76.6-416.9)							

*A low macronutrient intake below the RDA 2019

DISCUSSION

This study showed that most of the outpatient MDR TB patients had a deficiency of energy and macronutrients at the end of the first month of MDR-TB treatment. The mean age of the patients was 38 (SD 12) years, with 58.7% males. Most patients (68.3%) were malnourished based on body mass index data (BMI < 18.5 kg/m^2), which is a higher percentage of malnutrition from the middle-income countries than in the TB cohorts from Europe (24%). This finding indicated that the burden of malnutrition remains high among MDR-TB patients, also in Indonesia. However, this is our BMI baseline data. Adults with newly diagnosed TB disease have significantly lower body weight and BMI (Jennifer KF, Ekaterina S, Maia K, Nestani T, Gautam H, 201 C.E.). Malnutrition can lead to impairment of the cell-mediated immune system and negative effects on the immune system against *Mycobacterium tuberculosis* (Mtb), increasing an individual's susceptibility to progression of infection to disease and reactivation of latent TB (Chandrasekaran et al., 2017). Jennifer et al. showed a cohort study with serial data of macronutrient intake in MDR-TB patients. Their findings

showed that MDR-TB treatment was associated with significantly increased body weight, BMI, and fat-free mass over time (Jennifer KF, Ekaterina S, Maia K, Nestani T, Gautam H, 201 C.E.). Sanchez et al showed that the body composition in 24 adults with TB in Los Angeles increased by approximately 5.5% from baseline to week 4 after initiation of TB treatment (Sanchez et al., 2011). Sayem et al suggest that nutritional intake support during MDR TB treatment contributed to an improvement in the BMI of patients (Sayem et al., 2020). Moreover, a high-fat diet significantly increases both the rate and extent of gastrointestinal absorption of bedaquiline, which is one of the core drugs of MDR-TB treatment (Wang X, Zhao X, Yang S, He K, Wen Q, 2025). A higher rate of successful treatment might be expected if good nutrition is given, besides the optimal drug treatment for an MDRTB patient.

In this study, at the end of the first month of MDR-TB treatment, the proportions of energy, protein, fat, and carbohydrate deficiencies among MDR-TB patients based on the RDA showed 85.7%, 68.8%, 74.6%, and 90.5%, respectively. In a cross-sectional study in India, 70.5% of the MDR-TB patients had protein deficiency based on the RDA (Jovita et al., 2022). Insufficient protein intake is common in underdeveloped and developing countries. The consequences of protein deficiency can be nonspecific and include anemia, impaired nutrient absorption, cardiovascular dysfunction, muscle wasting, immunodeficiency, hypoalbuminemia, edema, loss of bone mass, and skin atrophy (Espinosa-Salas S, 2023). Protein-calorie malnutrition (PCM) can reduce the functional roles in cell-mediated immunity (Ren et al., 2019). Even though the low intake of dietary carbohydrates and fats did not lead to a specific deficiency other than energy (Espinosa-Salas S, 2023). However, the low intake of fats or carbohydrates can have important implications for an individual's defence against TB (Espinosa-Salas S, 2023; World Health Organization, 2013). Carbohydrates and fats are converted to energy, while proteins and fats are used to make structural and functional components of human tissue, which means a regeneration of healthy lung tissues in TB patients (World Health Organization, 2013).

The limitation of this study is that micronutrients such as iron, zinc, and vitamins were not evaluated, which also play an important role in nutrient intake for MDR-TB patients. However, the study provides important insight that nutritional support, both in terms of energy and macronutrients, should be a priority in MDR-TB management programs. Improving dietary intake through nutrition education, food supplementation, and socio-economic support should be a major consideration. Further research is needed to evaluate the impact of nutrition interventions on MDR-TB outcomes in Indonesia.

CONCLUSION

Macronutrient intake among MDR TB patients in this study was lower than the Indonesian recommended dietary allowance. These findings indicate that additional food intake and dietary counseling are needed in MDR-TB patients in Indonesia.

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