Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Assessment of Nutritional Status of Sputum Positive Pulmonary Tuberculosis Patients in a Medical College

Shailly[1], Rakesh Kumar Jagdish[2], Krittibus Samui[3,4]

[1]Senior Resident, Department of Pulmonary Medicine, Maulana Azad Medical College, New Delhi, India, [2]Senior Resident, Department of Hepatology, Institute of Liver and Biliary Sciences, New Delhi, India, [3]Ex-Senior Resident, Department of Pulmonary Medicine, Maulana Azad Medical College, New Delhi, India, [4]Present DNB Super Speciality Trainee and Senior Registrar, Department of Critical Care Medicine, Jaypee Hospital, Noida, Uttar Pradesh, India

Abstract

Introduction: Tuberculosis (TB) has been understood as a disease of wasting since it causes significant deficiencies in nearly every nutritional marker.

Aims and Objective: The purpose of this study is to assess the nutritional status of patients of sputum positive pulmonary TB patients and to identify the factors if malnutrition is present.

Materials and Methods: Two hundred patients of sputum positive for pulmonary TB were selected in a medical college on an outpatient service basis. The most common nutritional and biochemical assessment was done by blood hemoglobin and serum albumin level. All other relevant parameters were also recorded.

Results: About 10.5% of patients of severe anemia, 20% of patients of moderate anemia, and 35.5% of patients of mild anemia were found. About 12.5% cases of severe albumin deficiency (<2 g/dl), 24.5% cases of moderate albumin deficiency (≤2.5 g/dl), and 37% cases of mild albumin deficiency (≤3 g/dl) were also noted. There was a significant correlation between decrease calorie intake and decrease albumin levels. In the rural population, there were 79.16% malnourished in <20 years age group. Male preponderance (66%) was noted with male:female ratio of 2:1. About 86.5% of the patients were illiterate. About 87% of patients belong to lower social class. About 37% of cases were smoker and out of these smokers, 71% were malnourished. About 35% of cases were alcoholic and out of these alcoholic, 71% were malnourished.

Conclusion: Sputum positive TB patients have poor nutritional status. Malnutrition is found in individuals with factors of rural background, male patients, poor literary status, low family income, smoking, and alcohol addiction.

Key words: Albumin, Hemoglobin, Malnutrition, Tuberculosis

INTRODUCTION

Tuberculosis (TB) is a contagious disease which is closely related to poverty, under-nutrition, and poor immune function.[1] Body mass index (BMI) (kg/m^2), skinfold thickness, mid-upper arm circumference, grip strength, body fat percentage, calorie stores, muscle mass, serum albumin, blood hemoglobin, plasma retinol, plasma zinc, selenium, iron, and Vitamins A, C, D, and E have all been found to be depressed in TB patients.[2-4] Several vitamin deficiencies have been seen to be common in TB patients. Furthermore, the risk of active TB has also been ascribed to vitamin deficiency.[5] Therefore, it can be difficult to distinguish vitamin deficiency that happened from the disease from vitamin deficiency that predisposed to the development of the disease.[6,7] Vitamin A deficiency is perhaps the best-studied micronutrient deficiency in TB with many studies demonstrating markedly decreased serum levels in TB patients.[8-10] In TB, weight loss is one of the most common manifestations of nutritional wasting, though probably not the most clinically significant in terms of effect on health and survival. The bulk of weight loss in patients with TB is fat mass, though the fat-free component

Access this article online

www.ijss-sn.com

Month of Submission : 10-2019
Month of Peer Review : 11-2019
Month of Acceptance : 12-2019
Month of Publishing : 12-2019

Corresponding Author: Dr. Krittibus Samui, Jilipi Bagan Near, Atachaki, P.O. - Sripally, Burdwan - 713 103, West Bengal, India.

also lost in significant amounts, has more of a result on the physical functioning of the patient. Protein deficiency has been described in TB and albumin and prealbumin have been found to be useful markers both for the diagnosis of deficiency and monitoring of its reversal.[11,12] Like TB, HIV often results nutritional deficiencies and clinical wasting, particularly in the later stages.[13,14] Malnutrition decreases the efficacy of the Bacillus Calmette–Guérin (BCG) vaccine in two different ways. First, the maintenance of good nutrition is important for continuing vaccine-induced immune protection. Due to deteriorating nutritional status, tuberculin skin test and BCG vaccination result in a marked decrease in the size of indurations.[15] Second, severe malnutrition during BCG administration can permanently affect vaccine-induced immune protection.[16]

Review of Literature

TB is associated with various socio-economic factors such as poverty, poor housing, and economic deprivation, which causes poor nutritional status and poor immune function. Nutrition is important for making healthy and proper functioning of all systems of the body including the immune system. This is because malnutrition weakens the immune system and thus the capability of the individual to fight fatal infection like TB and their ability to halt disease progression will be compromised.[17] Treating of comorbid conditions has value for improving access and responses to TB treatment and it should be a part of care for people with TB. The aim should be to improve the general health and quality of life. The food and nutritional care successfully result health promotion and disease prevention. Under-nutrition is an important risk factor as well as a common consequence of TB. However, nutrition assessment and care are important components of improving rehabilitation and quality of people's life. Improved nutritional care and support can improve the health outcomes for people with TB. To improve the clinical care of people with TB, the focus is specially done on nutritional assessment, counseling, and management.[18]

Malnutrition refers to either overnutrition or undernutrition or both. Undernutrition refers to the nutritional status of the person having suboptimal and thereby health and growth will be impaired. Undernutrition may be due to illness-causing decreased nutrient intake and metabolism or result from inadequate intake of macronutrients, micronutrients, or both.[19-21] Undernutrition is commonly associated with malabsorption, pneumonia, TB, and HIV. The association between TB and undernutrition has been known since before. Undernutrition is endemic in India. About 34% of men and 36% of women 15–49 years in India are undernourished as per NFHS-3 estimates. As undernutrition, the leading cause of immunodeficiency globally, weakens power to fight against the TB. These people are at risk up to 4 times more likely to develop TB disease than healthy people.[22] TB makes undernutrition worse and undernutrition weakens the immunity power. As a result, latent TB will develop into active disease.[23] Most patients of active TB are in a catabolic state and result in weight loss.[24-26]

Weight loss is found to be one of the most common presenting complaints of patients with TB.[27,28] Weight loss in TB can be caused by several factors such as reduced food intake due to loss of appetite, nausea and abdominal pain, nutrient losses from vomiting and diarrhea, and metabolic changes due to the disease.[29,30] Low BMI and lack of adequate weight gain with TB treatment are the increased risk factors for death[31] and TB relapse[32,33] and may indicate the severity of TB, poor treatment response and/or the presence of other comorbid conditions.

TB can worsen preexisting undernutrition by decreasing appetite and by increased catabolism. High prevalence of undernutrition in TB patients results in increased deaths and risk of relapse. The prevalence, severity, and implications of undernutrition in Indian TB patients particularly are found from India's rural areas compared to urban areas.[34]

Nutrition care or management of persons with active TB with moderate undernutrition includes assessing their nutritional status, identifying, and treating the underlying causes of malnutrition and improving the nutrient intake through education, counseling, food assistance, and other activities.[35] TB is commonly associated with comorbidities such as HIV, diabetes mellitus, smoking, and alcohol or substance misuse. These should be fully considered during nutrition screening, assessment, and counseling. Unintentional weight loss is one of the best predictors of worst clinical outcome. In older people, it is associated with significant morbidity and mortality.[36]

Aims and Objectives

Main aims and objectives of this study are as follows:

1. To assess the nutritional status of the patient having sputum positive pulmonary TB
2. If malnutrition is found, assessment of the factors affecting malnutrition.

MATERIALS AND METHODS

The study was conducted from December 15, 2015, to September 15, 2016, in a government medical college. It was a cross-sectional study of sputum smear-positive TB patients. As per the previous year data of sample collection (2014), on an average 1482 sputum smear-positive patients were diagnosed and treated in outpatient

department, roughly seven sputum smear-positive patients were diagnosed per day. Hence, every seventh patient who was diagnosed as sputum smear-positive in outpatient department by systematic random sampling technique was opted for the study. The desired sample size of 200 was achieved in almost 10 months. Anthropometric measurements were done using parameters such as height, weight, and BMI. The Quetelet index relates weight (kg) to the square of the height (m^2), which enables calculation of BMI. The WHO categorizes underweight as BMI <18.5, normal as 18.5–24.9, overweight as 25–29.9, and obese as 30–39.9, and extreme obesity >40. Most common nutritional and biochemical assessment was done by blood hemoglobin and serum albumin level.

Inclusion Criteria

All sputum positive patients diagnosed as TB as per diagnostic algorithm under RNTCP by sputum microscopy having consent for study had been included in the study.

Exclusion Criteria

The following criteria were excluded in the study:

1. Patient refusing to give consent to participate in the study
2. Sputum negative pulmonary TB
3. Extrapulmonary TB
4. Carcinoma lung
5. Other causes of pulmonary diseases.

The pre-tested, semi-structured, and validated questionnaire was used to get the information about the personal history, socio-economic status, nutritional history, and physical examination. The questionnaire included the personal history of the patient, i.e., name, age, sex, address, education, occupation, and income. Modified Kuppuswamy scale was used to assess socio-economic status of the patients which is based on three parameters that are education, occupation, and income.

Furthermore, medical history of the patient regarding RNTCP ATT category of the patient, HIV status, and metabolic disease was enquired. History of smoking and alcoholism was taken. Patients were also examined physically for vital signs, pallor etc. Patient was investigated for anemia and hypoproteinemia. Nutritional history including daily diet, calorie calculation on diet basis, and calorie requirement according to weight and occupation was taken and assessed.

BMI was calculated by Quetelet's index (Weight in kg/height in m^2). Historically, serum proteins such as albumin have been widely used by physicians to determine patient nutritional status. Serum albumin <2 g/dl is defined as severe, <2.5 g/dl is moderate, and <3 g/dl is mild malnutrition.

History of weight loss and signs of undernutrition, such as visible wasting or edema, were noted. Clinical assessment for comorbid conditions and concurrent treatments was also recorded. History and clinical diagnosis, medical history was helpful in raising suspicion for increased risk of malnutrition and the presence or absence of inflammation. Physical examination revealed the presence of several of the diagnostic characteristics of malnutrition such as weight loss or gain, fluid retention, loss of muscle or fat, and other signs of specific macro and/or micronutrient deficiencies.

Screening included the questions regarding loss of appetite, loss of weight, mobility, any stress, and BMI. Scoring was done after this. Then, assessment was done by asking about the diet including meals, protein intake, fluid intake, and nutritional status. Mid arm circumference was measured by measuring the circumference of the left upper arm, measured at the mid-point between the tip of the shoulder and the tip of the elbow. Calf circumference was measured at the fullest part of the calf. Screening and assessment score was calculated. Information regarding food and nutrient intake were obtained from the patient and/or caregiver. A modified diet history, 24 h recall, "calorie counts" (either observed intake/estimated post-meal plate waste), and/or prior documentation of periods of inadequate food intake in the patient's medical record were used as "evidence" of inadequate intake. A food frequency multi-question questionnaire was used to explore dietary intake over a period of time.

OBSERVATION AND RESULTS

The present study was conducted on 200 cases of sputum positive pulmonary TB patients.

Following observations were drawn from the results of present study:

1. Out of 200 cases maximum number of patients were from 41 to 60 years age group (35.5%), followed by 21–40 years' age group (30.5%)
2. Mean age was 45.36 ± 18.974
3. In rural population, there were 79.16% malnourished in <20 age group
4. About 63.93% were malnourished in 21–40 age groups, of which 64.1% were from rural area. About 54.92% were malnourished in 41–60 age groups, of which 74.35% were from rural area. About 59.09% were malnourished in more than 60 age groups. Among these, 84.61% from rural area [Table 1]
5. Most of the patients were from rural areas, i.e., 70.5% cases whereas urban area patients were 29.5%
6. Male preponderance (66%) was noted in our study, with male:female ratio 2:1

7. Out of 141 rural patients, 68.08% were males and 31.91% were females
8. Out of 59 urban patients, 61.01% were males and 38.98% were females
9. As per the modified Kuppuswamy classification, most of our patients (86.5%) were illiterate or studied up to primary school level whereas only 2% were graduates [Table 2]
10. Most of (85.5%) our patients were unemployed (41%) and unskilled worker (44.5%), whereas only 1.5% was skilled worker in regular employment
11. On the basis of education, occupation, and income, most of our patients belong to lower (87%) Kuppuswamy social class, of which 84.5% were in upper lower class and 2.5% in lower class, followed by middle Kuppuswamy social class (13%), of which 11% were in lower-middle, and 2% were in upper-middle class [Table 3]
12. Diabetes mellitus was present in 25.5% of cases
13. History of contact with active TB case was present in 8.5% of cases
14. About 37% of cases were smoker and out of these smokers, 71% were malnourished [Table 4]
15. About 35% of cases were alcoholic and out of these alcoholic, 71% were malnourished [Table 4]
16. Weight loss was reported by 95.5% cases, of which 75% reported more than 3 kg loss and 2.5% having 1–3 kg loss in past 1 week
17. Pallor was present in 85% of cases. Out of these, 65.29% were malnourished [Table 5]
18. Pallor with malnourished was seen in 69.36% of rural patients and 30.63% urban patients. Edema was present in 62.5% of cases
19. 61.5% cases have BMI below normal range as per the WHO criteria, i.e., underweight (<18.5). Mean BMI was 17.50 ± 3.94 [Table 6]
20. Out of 61.5% underweight patients, 29.26% were from urban area, of which 58.33% were males and 41.67% were females. About 70.73% were from rural area, of which 66.67% were males and 33.33% were females [Table 7]
21. Patient reported MIS questionnaire after taking history and doing examination. About 79% of cases were classified as malnourished category
22. Mid arm circumference was <21 cm in 76% of cases, and calf circumference was below 31 cm in 72% of cases
23. About 12.5% cases were having severe albumin deficiency (<2 g/dl), 24.5% were having moderate

Table 1: Distribution of patients according to the age

Age group (years)	≤20	21–40	41–60	>60
Number of patients (%)	24 (12)	61 (30.5)	71 (35.5)	44 (22)
Malnourished (%)	19 (79.16)	39 (63.93)	39 (54.92)	26 (59.09)
Rural (%)	11 (57.89)	25 (64.1)	29 (74.35)	22 (84.61)
Urban (%)	8 (42.11)	14 (73.68)	10 (52.63)	4 (21.05)
Mean±SD (years)	45.36±18.974			

Table 2: Distribution of patients as per literacy level

Education	Number of patients (%)
Primary school certificate, illiterate	173 (86.5)
Intermediate, post-high school diploma, high school certificate	23 (11.5)
Graduate or postgraduate	4 (2.0)
Total	200 (100.0)

Table 3: Distribution of patients according to the modified Kuppuswamy scale

Socioeconomic status	Number of patients (%)
Lower	5 (2.5)
Upper lower	169 (84.5)
Lower middle	22 (11.0)
Upper middle	4 (2.0)
Total	200 (100.0)

Table 4: Distribution of patients based on their addiction

Addiction	Number of patients (%)	Malnourished (%)
Smoking	74 (37.0)	53 (71)
Alcoholism	70 (35.0)	50 (71)

Table 5: Distribution of pallor in patients

Pallor	Number of patients (%)	Malnourished (%)
Yes	170 (85.0)	111 (65.29)
No	30 (15.0)	-
Total	200 (100.0)	-

Table 6: Distribution of patients in relation to body mass index (who classification)

BMI grading	Number of patients (%)
Overweight (>25)	6 (3)
Normal (18.5–24.9)	71 (35.5)
Underweight (<18.5)	123 (61.5)
Total	200 (100.0)
Mean±SD	17.50±3.94

BMI: Body mass index, SD: Standard deviation

Table 7: Distribution of underweight patients in relation to area and gender

Underweight	Number of patients (%)	
	Male	Female
Rural	58 (66.67)	29 (33.33)
Urban	21 (58.33)	15 (41.67)

Table 8: Correlation between differential serum protein-albumin and calorie intake

Differential Serum Protein-albumin	Calorie intake, *n* (%)				Total
	1%–25%	26%–50%	51%–75%	76%–100%	
<2 (g/dL)	3 (12.0)	13 (52.0)	9 (36.0)	0 (0.0)	25 (100.0)
≤2.5 (g/dL)	4 (8.2)	31 (63.3)	12 (24.5)	2 (4.1)	49 (100.0)
≤3 (g/dL)	5 (6.8)	31 (41.9)	29 (39.2)	9 (12.2)	74 (100.0)
>3 (g/dL)	11 (21.2)	20 (38.5)	14 (26.9)	7 (13.5)	52 (100.0)
P			0.031		
Significance			Significant		

Table 9: Distribution of hemoglobin level of patients (who classification)

Hemoglobin in (g/dL)	Number of patients (%)
<7 (severe)	21 (10.5)
7–8.9 (moderate)	40 (20)
9–10.9 (mild)	71 (35.5)
≥11 (normal)	68 (34)

albumin deficiency (≤2.5 g/dl), and 37% having mild albumin deficiency (≤3 g/dl). About 26% of patients have serum albumin in the normal range. There was a significant correlation between decrease calorie intake and decrease albumin in patients [Table 8]

24. About 10.5% of patients were having severe anemia. About 20% of patients were having moderate anemia. About 35.5% of patients were having mild anemia. About 34% had hemoglobin in normal range [Table 9].

Majority of the malnourished patients were from rural background. In contrast to normal population, higher proportion of malnourished was seen in males. Alcohol and smoking were found to be other factors affecting malnutrition. There is increased prevalence of malnutrition among the illiterate group. Poor nutrition status was seen in patients having low income.

DISCUSSION

TB is associated with poverty and malnutrition. Nutritional status is significantly lower in patients with active TB compared with healthy controls. Factors affecting malnutrition need to be identified so that these can be addressed to have impact on TB. In the present study, out of 200 cases, maximum number of patients was from 41 to 60 years of age group (35.5%), followed by 21–40 years of age group (30.5%). These age group individuals are mostly out of home for earning purpose. It indicates high burden in economically earning group and impacts on financial burden on society. About 22% were in the age group >60 years and 12% were in the age group <20 years. Mean age of patients is 45.36 ± 18.974. About 79.16% were malnourished in ≤20 age group, of which 57.89% were from rural areas. About 63.93% were malnourished in 21–40 age groups, of which 64.1% were from rural areas. About 54.92% were malnourished in 41–60 groups, of which 74.35% were from rural areas. Similarly, 59.09% were malnourished in >60 age group, of which 84.61% were from rural areas. In a study conducted by Nunez-Rocha *et al.*,[37] (2000), the mean age was 42.4 ± 19.9 years which was almost similar to present study. In the present study, significant male predominance was found with male:female 2:1. Males were 66% and females were 34%. Likely due to male dominating society, more males are taking healthcare services than females and as males are mostly out of their home for earning purpose, so more likely to come in contact with open cases of TB. In a study conducted by Dargie *et al.*,[17] around 55.8% were males and 44.2% were females which is similar to our study. In our study, as per modified Kuppuswamy classification, most of our patients (86.5%) were illiterate or studied up to primary school level whereas only 2% were graduate showing the importance of literacy as per Table 4. In a study conducted by Dargie *et al.*,[17] 50.3% were illiterate or studied up to primary school. About 18.3% were tertiary educated. Most of our patients in present study were from rural area and India is a developing country. Hence, illiteracy is a major problem.

In the present study, most of (85.5%) our patients were unemployed (41%) and unskilled worker (44.5%), whereas only 1.5% were skilled worker in regular employment as per Table 5. In a study conducted by Dargie *et al.*,[17] 28.3% were unemployed and 14.7% were daily laborers. About 23.1% were employed. This difference is due to different sample collection. India is a developing country where unemployment is a major problem. Hence, earning is also affecting as observed. Earning is also a factor contributing in cause of malnutrition. On the basis of education, occupation and income, most of our patients belong to lower (87%) socio-economic class, of which 84.5% were in upper lower class and 2.5% in lower class, followed by middle social class (13%), of which 11% were in lower-middle and 2% were in upper-middle class. In the present study, HIV positivity was seen in only 2.5% cases. In a study conducted by Manjareeka and Nanda,[38] 12.3% of TB patients were HIV positive. In a study conducted by Giri *et al.*,[39] 17% of patients were HIV positive. In the present

study, diabetes mellitus was present in 25.5% of cases. In a study conducted by Raghuraman *et al.*,[40] the prevalence of diabetes in TB patients was found to be 29% cases which is similar to the present study.

In the present study, 37% of cases were smoker. In a study conducted by Mahishale *et al.*,[41] 32.21% were smokers which was similar to our study. In a study by Wang and Shen,[42] the proportion of cigarette smoking was 54.6% in TB cases, which was significantly higher than in controls (45.1%) in China. No female was smoker in our study. In the present study, 35% of cases were alcoholic. No females consumed alcohol. In a study conducted by Suhadev *et al.*,[43] 29% were found to consume alcohol which was very similar to our study.

Patient reported MIS questionnaire after taking history and doing an examination. Seven-nine percent of cases were classified as malnourished category, 17% were at risk of malnutrition, and 4% cases were in normal range. In the present study, 61.5% of cases had BMI below normal range as per the WHO classification and the mean BMI was 17.50 ± 3.94. Out of 123 underweight patients, 29.26% were from urban area and 70.73% were from rural areas. About 58.33% were males and 41.67% were females from urban areas. About 66.67% were males and 33.33% were females from rural areas. In a study conducted by Nunez-Rocha *et al.*,[37] mean BMI was 19.8 ± 3.2; 57% presented malnutrition. In a study conducted by Kumar *et al.*,[44] mean BMI was 17.33 which was same as our study. About 12.5% cases were having severe albumin deficiency (<2 g/dl), 24.5% were having moderate albumin deficiency (≤2.5 g/dl), and 37% having mild albumin deficiency (≤3 g/dl). About 26% patients have serum albumin in normal range.[45] Hence, a total of 74% of patients were having hypoalbuminemia in our study. In a study conducted by Morris *et al.*,[46] 72% were having hypoalbuminemia which is similar to our study. Hemoglobin level was below 7 g/dl (severe anemia) in 10.5% cases, between 7 g/dl and 8.9 g/dl (moderate anemia) in 20% cases, and between 9 g/dl and 11 g/dl (mild anemia) in 35.5% cases. Hence, a total of 66% of patients were anemic in our study. In a study conducted by Nagu *et al.*,[47] 86% were anemic which is similar to our study. In a study conducted by Olaniyi and Aken'Ova,[48] anemia occurred in 93.6% cases which are similar to our study.

CONCLUSION

Sputum positive TB patients have poor nutritional status. Malnutrition is found in individuals with factors of rural background, male patients, poor literary status, low family income, smoking, and alcohol addiction. Hence, we advise to increase the awareness among patients regarding the importance of nutrition and to discourage the addiction to improve the prognosis of TB patients and decrease the prevalence of TB. Macronutrient requirements in active TB like other infectious diseases are likely to increase energy requirement. Studies show that subjects who receive food supplements during TB treatment tend to gain more weight compared with those not receiving food supplements.

REFERENCES

1. World Health Organization. Global Tuberculosis Report 2013. http://www.apps.who.int/iris/bitstream/10665/91355/1/9789241564656_eng.pdf. [Last accessed on 2017 Nov 11].
2. Kennedy N, Ramsay A, Uiso L, Gutmann J, Ngowi FI, Gillespie SH. Nutritional status and weight gain patients with pulmonary tuberculosis in Tanzania. Trans R Soc Trop Med Hyg 1996;90:162-6.
3. Onwubalili JK. Malnutrition among tuberculosis patients in Harrow, England. Eur J Clin Nutr 1988;42:363-6.
4. Harries AD, Nkhoma WA, Thompson PJ, Nyangulu DS, Wirima JJ. Nutritional status in Malawian patients with pulmonary tuberculosis and response to chemotherapy. Eur J Clin Nutr 1988;42:445-50.
5. Kassu A, Yabutani T, Mahmud ZH, Mohammad A, Nguyen N, Huong BT. Alterations in serum levels of trace elements in tuberculosis and HIV infections. Eur J Clin Nutr 2006;60:580-6.
6. Madebo T, Lindtjørn B, Aukrust P, Berge RK. Circulating antioxidants and lipid peroxidation products in untreated tuberculosis patients in Ethiopia. Am J Clin Nutr 2003;78:117-22.
7. Hanekom WA, Potgieter S, Hughes EJ, Malan H, Kessow G, Hussey GD. Vitamin A status and therapy in childhood pulmonary tuberculosis. J Pediatr 1997;131:925-7.
8. Karyadi E, West CE, Schultink W, Nelwan RH, Gross R, Amin Z, *et al*. A double-blind, placebo-controlled study of Vitamin A and zinc supplementation in persons with tuberculosis in Indonesia: Effects on clinical response and nutritional status. Am J Clin Nutr 2002;75:720-7.
9. Evans DI, Attock B. Folate deficiency in pulmonary tuberculosis: Relationship to treatment and to serum Vitamin A and beta-carotene. Tubercle 1971;52:288-94.
10. Rwangabwoba JM, Fischman H, Semba RD. Serum Vitamin A levels during tuberculosis and human immunodeficiency virus infection. Int J Tuberc Lung Dis 1998;2:771-3.
11. Scalcini M, Occenac R, Manfreda J, Long R. Pulmonary tuberculosis, human immunodeficiency virus Type-1 and malnutrition. Bull Int Union Tuberc Lung Dis 1991;66:37-41.
12. Adebisi SA, Oluboyo PO, Oladipo OO. The usefulness of serum albumin and urinary creatinine as biochemical indices for monitoring the nutritional status of Nigerians with pulmonary tuberculosis. Niger Postgrad Med J 2003;10:247-50.
13. Süttmann U, Ockenga J, Selberg O, Hoogestraat L, Deicher H, Müller MJ. Incidence and prognostic value of malnutrition and wasting in human immunodeficiency virus-infected out patients. J Acquir Immune Defic Syndr Hum Retrovirol 1995;8:239-46.
14. Tang AM, Forrester J, Spiegelman D, Knox TA, Tchetgen E, Gorbach SL. Weight loss and survival in HIV-positive patients in the era of highly active antiretroviral therapy. J Acquir Immune Defic Syndr 2002;31:230-6.
15. Kielmann AA, Uberoi IS, Chandra RK, Mehra VL. The effect of nutritional status on immune capacity and immune responses in preschool children in a rural community in India. Bull World Health Organ 1976;54:477-83.
16. Satyanarayana K, Bhaskaram P, Seshu VC, Reddy V. Influence of nutrition on postvaccinial tuberculin sensitivity. Am J Clin Nutr 1980;33:2334-7.
17. Dargie B, Tesfaye G, Worku A. Prevalence and associated factors of undernutrition among adult tuberculosis patients in some selected public health facilities of Addis Ababa, Ethiopia: A cross-sectional study. BMC Nutr 2016;2:1-7.
18. World Health Organization. Guideline: Nutritional Care and Support for Patients with Tuberculosis. Geneva: World Health Organization; 2013. Available from: https://apps.who.int/iris/bitstream/

handle/10665/94836/9789241506410_eng.pdf;jsessionid=61BD6468B9BEEF30CE85831B83FF94E5?sequence=1.
19. Cegielski JP, McMurray DN. The relationship between malnutrition and tuberculosis: Evidence from studies in humans and experimental animals. Int J Tuberc Lung Dis 2004;8:286-98.
20. Lonnroth K, Williams BG, Cegielski P, Dye C. A consistent log-linear relationship between tuberculosis incidence and body mass index. Int J Epidemol 2010;39:149-55.
21. The Influence of Nutrition on the Risk and Outcomes of Tuberculosis. In: HIV/AIDS, Tuberculosis, and Nutrition: Scientific Inquiry into the Nutritional Influences on Human Immunity with Special References to HIV Infection and Active Tuberculosis in South Africa. Pretoria: Academy of Science of South Africa; 2007. p. 153-72.
22. Bhargava A, Benedetti A, Oxlade O, Pai M, Menzies D. Undernutrition and the incidence of tuberculosis in India: National and subnational estimates of the population-attributable fraction related to undernutrition. Natl Med J India 2014;27:128-33.
23. Papathakis P, Piwoz E. USAID/Africa's Health for 2010. Nutrition and Tuberculosis: A Review of the Literature and Considerations for TB Control Programs. Washington, DC: Agency for International Development; 2008. Available from: https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1009&context=fsn_fac.
24. Zachariah R, Spielmann MP, Harries AD, Salanipont FM. Moderate to severe malnutrition in patients with tuberculosis is a risk factor associated with early death. Trans R Soc Trop Med Hyg 2002;96:291-4.
25. Dodor E. Evaluation of nutritional status of new tuberculosis patients at the Effia-Nkwanta regional hospital. Ghana Med J 2008;42:22-8.
26. Ramakrishnan CV, Rajendran K, Jacob PG, Fox W, Radhakrishna S. The role of diet in the treatment of pulmonary tuberculosis. An evaluation in a controlled chemotherapy study in home and sanatorium patients in south India. Bull World Health Organ 1961;25:339-59.
27. Hira SK, Dupont HL, Lanjewar DN, Dholakia YN. Severe weight loss: The predominant clinical presentation of tuberculosis in patients with HIV infection in India. Natl Med J India 1998;11:256-8.
28. Miller LG, Asch SM, Yu EI, Knowles L, Gelberg L, Davidson P. A population-based survey of tuberculosis symptoms: How atypical are atypical presentations? Clin Infect Dis 2000;30:293-9.
29. Metcalfe N. A study of tuberculosis, malnutrition and gender in Sri Lanka. Trans R Soc Trop Med Hyg 2005;99:115-9.
30. Podewils LJ, Holtz T, Riekstina V, Skripconoka V, Zarovska E, Kirvelaite G. Impact of malnutrition on clinical presentation, clinical course, and mortality in MDR-TB patients. Epidemiol Infect 2011;139:113-20.
31. Hanrahan CF, Golub JE, Mohapi L, Tshabangu N, Modisenyane T, Chaisson RE, *et al*. Body mass index and risk of tuberculosis and death. AIDS 2010;24:1501-8.
32. Khan A, Sterling TR, Reves R, Vernon A, Horsburgh CR. Lack of weight gain and relapse risk in a large tuberculosis treatment trial. Am J Respir Crit Care Med 2006;174:344-8.
33. Krapp F, Veliz JC, Cornejo E, Gotuzzo E, Seas C. Bodyweight gain to predict treatment outcome in patients with pulmonary tuberculosis in Peru. Int J Tuberc Lung Dis 2008;12:1153-9.
34. Bhargava A, Chatterjee M, Jain Y, Chatterjee B, Kataria A, Bhargava M, *et al*. Nutritional status of adult patients with pulmonary tuberculosis in Rural Central India and its association with mortality. PLoS One 2013;8:e77979.
35. IMAI District Clinician Manual: Hospital Care for Adolescent and Adults. Guidelines for the Management of Common Illnesses with Limited Resources. Available from: https://www.who.int/hiv/pub/imai/imai2011/en/.
36. Ahmed T, Haboubi N. Assessment and management of nutrition in older people and its importance to health. Clin Interv Aging 2010;5:207-16.
37. Nunez-Rocha GM, Salinas-Martínez AM, Villarreal-Ríos E, Garza-Elizondo ME, González-Rodríguez F. Nutritional risk in patients with pulmonary tuberculosis: The patient's or the health services' problem? Salud Publica Mex 2000;42:126-32.
38. Manjareeka M, Nanda S. Prevalence of HIV infection among tuberculosis patients in Eastern India. J Infect Public Health 2013;6:358-62.
39. Giri PA, Deshpande JD, Phalke DB. Prevalence of pulmonary tuberculosis among HIV positive patients attending antiretroviral therapy clinic. N Am J Med Sci 2013;5:367-70.
40. Raghuraman S, Vasudevan KP, Govindarajan S, Chinnakali P, Panigrahi KC. Prevalence of Diabetes Mellitus among Tuberculosis Patients in Urban Puducherry. N Am J Med Sci 2014;6:30-4.
41. Mahishale V, Patil B, Lolly M, Eti A, Khan S. Prevalence of smoking and its impact on treatment outcomes in newly diagnosed pulmonary tuberculosis patients: A hospital-based prospective study. Chonnam Med J 2015;51:86-90.
42. Wang J, Shen H. Review of cigarette smoking and tuberculosis in China: Intervention is needed for smoking cessation among tuberculosis patients. BMC Public Health 2009;9:292.
43. Suhadev M, Thomas BE, Sakthivel MR, Murugesan P, Chandrasekaran V, Charles N, *et al*. Alcohol use disorders (AUD) among tuberculosis patients: A study from Chennai, South India. PLoS One 2011;6:e19485.
44. Kumar A, Kakkar R, Kandpal SD, Sindhwani G. Nutritional status in multi-drug resistance tuberculosis patients. Indian J Community Health 2014;26 Suppl S2:204.
45. Wilkinson RJ, Liewalyn M, Toossi Z, Patel P, Paswol G, Lalvani A, *et al*. Influence of Vitamin D deficiency and Vitamin D receptor polymorphisms on tuberculosis among Gujarati Asians in West London: A case control study. Lancet 2000;355:618-21.
46. Morris DW, Bird AR, Nell H. The haematological and biochemical changes in severe pulmonary tuberculosis. Q J Med 1990;73:1151-9.
47. Nagu J, Spiegelman D, Hertzmark E, Aboud S, Makani J, Matee MI, *et al*. Anemia at the initiation of tuberculosis therapy is associated with delayed sputum conversion among pulmonary tuberculosis patients in Dar-es-Salaam, Tanzania. PLoS One 2014;9:e91229.
48. Olaniyi JA, Aken'Ova YA. Haematological profile of patients with pulmonary tuberculosis in Ibadan, Nigeria. Afr J Med Med Sci 2003;32:239-42.

How to cite this article: Shailly, Jagdish RK, Samui K. Assessment of Nutritional Status of Sputum Positive Pulmonary Tuberculosis Patients in a Medical College. Int J Sci Stud 2019;7(9):41-47.

Source of Support: Nil, **Conflicts of Interest:** None declared.