Assessment of Body Mass Index and Nutritional Status in Pulmonary Tuberculosis Patients

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Summary:

Background: Pulmonary tuberculosis is a chronic infectious disease which affects nutritional status of the patients. The presence of poor nutritional status in pulmonary tuberculosis patients has been one of the most important determining factor in recommending adjuvant nutrient therapy to prevent oxidative stress and further complication.

Objective: This study was designed to assess the nutritional status and body mass index of pulmonary tuberculosis patients.

Patients and methods: During the period 1st of June 2010 to 30th of May 2011, a prospective study was done on 60 patients with active pulmonary tuberculosis and 60 controls.
Levels of total protein (TP), albumin (ALB.), triglyceride (TG), total cholesterol (TC), high density lipoprotein cholesterol (HDLC), low density lipoprotein cholesterol (LDLC), and body mass index (BMI) were measured.

Results: The mean levels of TP (59.5 ± 0.8g/dl), ALB (23.4 ± 1.8g/dl), TC (138.7 ± 4.9mg/dl), HDLC (32.2 ± 4.0mg/dl), LDLC (86.5 ± 1.3mg/dl) and TG (62.4 ± 1.3mg/dl) were significantly lower while the level of globulin (36.2 ± 1.2g/dl) was significantly higher in pulmonary tuberculosis patients when compared with controls (TP=81.2 ± 4.5g/dl; ALB= 50.0 ± 4.0g/dl; TC = 213.5 ± 26.8mg/dl; HDLC = 57.4 ± 8.5mg/dl; LDLC = 161.1 ± 28.3mg/dl; TG= 148.5 ± 37.1mg/dl; globulin = 31.4 ± 1.7g/dl respectively). (P <0.05)
The body mass index (16.9 ± 1.1kg/m2) was significantly lower when compared with controls (BMI= 23.5 ± 2.1kg/m2). (P <0.05)20

Conclusion: There is a significant degree of nutritional depletion and weight loss in PTB patients than in general population. BMI is considered to be a useful technique for assessment of nutritional state of PTB. The nutritional derangement could call for prompt nutritional intervention in the management of pulmonary tuberculosis patients.

Keyword: BMI :BODY MASS INDEX. PTB: PULMONARY TUBERCULOSIS.

Introduction:

Tuberculosis or TB is a common and often deadly infectious disease caused by various strains of mycobacteria, usually Mycobacterium tuberculosis in humans.(1) Tuberculosis usually attacks the lungs but can also affect other parts of the body. It spread through the air when people who have the disease cough, sneeze, or spit.(2) Worldwide, TB is responsible for more than 1.5 million deaths every year, (3) with an estimated rate of 13.7 million prevalent cases of TB in 2007 (206 per 100.000 population).(4) Therefore, despite recent progress, TB remains an important global public health problem .(4) Tuberculosis has been associated with malnutrition. Yamanaka et al (5) reported that serum cholesterol was significantly lower in tuberculosis patients and was worse in homeless patients who were prone to starvation. Body Mass Index (BMI) The body mass index (BMI), or Quetelet index, is a statistical measure of the weight of a person scaled according to height. It was invented between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing "social physics" Body mass index is defined as the individual's body weight divided by the square of their height. The formulas universally used in medicine produce a unit of measure of kg/m2; Body mass index accurately calculated using the formulas below

$$BMI = \frac{weight\ (kg)}{height^2(m^2)}$$

Provided a simple numeric measure of a person›s «fatness» or «thinness», allowing health professionals to discuss over- and under-weight problems more objectively with their patients. The current value settings are as follows: a BMI of 18.5 to 25 may indicate optimal weight; a BMI lower than 18.5 suggests the person is underweight while a number above 25 may indicate the person is overweight; a BMI below 17.5 may indicate the

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person has anorexia or a related disorder; a number above 30 suggests the person is obese (over 40, morbidly obese). The limitations and disadvantage of BMI that may overestimate adiposity on those with more lean body mass (e.g. athletes) while underestimating adiposity on those with less lean body mass (e.g. the elderly), A further limitation relates to loss of height through aging. In this situation, BMI will increase without any corresponding increase in weight. Nutritional state in tuberculosis: Albumin, a major plasma protein of 69 KD has been reported low in pulmonary TB. (6)This observation was in agreement with the studies reported significantly decreased serum albumin levels in newly diagnosed pulmonary TB patients.(Increased serum albumin after one week of drug therapy has been reported by Vissers et al. The Mycobacteria activate the invaded macrophages resulting to free radical burst High serum levels of these free radicals and high concentration of lipid peroxidation products are characteristics of by patients with advanced tuberculosis.(5,6) The peroxidation could cause reduced concentration of serum lipids and tissue inflammation. (6) Yamanaka et al 2001 also reported that serum cholesterol was significantly lower in tuberculosis patients and was worse in homeless patients.(7) Weight loss and nutritional depletion are often seen in patients with tuberculosis at the time of tuberculosis diagnosis. (8, 9) Malnutrition appears to increase the risk of developing tuberculosis, particularly in animal models. (10)However, cause and effect are difficult to distinguish because tuberculosis disease causes weight loss. Among tuberculin skin-test–positive U.S. Navy recruits, the risk of tuberculosis was nearly fourfold higher among men who were at least 10% underweight at baseline than in men who were at least 10% overweight. Body mass index (BMI) is a more accurate marker of nutritional status than weight because it also takes height into account. In a study among 1,717,655 Norwegians older than 14 yr who were monitored for 8–19 yr after intake into a radiographic screening program, the relative risk of tuberculosis among persons in the lowest BMI category was more than fivefold higher than the group in the highest BMI category, and it was independent of sex, age, and radiographic findings. (12) Weight gain and other improvements in nutritional indicators after effective chemotherapy for tuberculosis have been reported. (13)

Patients and methods:
I. Patients: A prospective study was conducted over 12 month period from 1st of June 2010 to 30th of May 2011; 60 patients (34 male, 26 female) with active pulmonary tuberculosis were studied. The patients were collected from the Chest and Respiratory Disease Teaching Specialized Center in Baghdad. Tuberculosis was considered active when a patient had signs of clinical and radiological pulmonary tuberculosis, including positive Ziehl Neelsen staining of sputum showing acid-fast bacilli. The 60 patients with active pulmonary tuberculosis (PTB) were verbally consented to participate in the study and were drawn from Baghdad governorate. Eligibility for entry into the study included typical symptoms of pulmonary tuberculosis such as cough, fever, weight loss, night sweats,

fibrocavitary lung infiltrate on chest radiograph and at least one sputum specimen staining positively with Ziehl-Neelsen (ZN) for acid-fast bacilli. Patients with a history of previous treatment for tuberculosis were not studied in order to exclude those with previous lung fibrosis or infection with multidrug-resistant tuberculosis (MDRTB). Patients with other co-existing lung disease, defined as a history of previous respiratory disease or clinical or radiological evidence of lung lesion other than tuberculosis, and patients suffering from other diseases and chronic illnesses like cardiac disease or metabolic problems including chronic liver disease, renal failure or diabetes mellitus were also excluded from this study. None of the tuberculosis patients or the control subjects were using any kind of treatment or prophylaxis for chronic disease, such as hypertension, diabetes mellitus, coronary artery disease, or other diseases that could affect the results of our study. Sixty healthy subjects (32 men, 28 women) from the same area were recruited as control subjects. All control subjects identified themselves as healthy volunteers and were companions of non- tuberculous patients.39 After a routine interview to exclude individuals with all types of acute or chronic disease, the volunteers underwent clinical examination and some basic laboratory investigations to exclude those with infection or diseases that can affect the nutritional state. The data were collected in special designed questionnaire filled by the researcher through a standardized approach of history, examination and investigation for both cases and control. The main data and parameters included in our study are: Patient>s age, gender, residency, occupation, BMI, Total protein, albumin and globulin, Total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides, HB and ESR. For each subject included in our study, we send him for: chest x-ray, sputum for AFB, blood sample for; erythrocyte sedimentation rate(ESR), hemoglobin(Hb),white blood count (WBC), total serum protein, S. albumin, S.globulin, total serum cholesterol, S.triglyceride, HDL, LDL.

II. Methods: Complete physical examination was done including measurement of body mass index. Standardized procedures were used to measure body weight and height. The weighing and height scales were calibrated regularly, and all subjects were weighed while wearing minimal clothing. BMI was defined as weight in kilograms divided by the square of height in meters (kg/m2). «Low BMI» was a BMI of less than 18.5.(86)

Blood samples: Peripheral venous blood samples from patients with pulmonary tuberculosis were drawn into sterile tubes without additives between 8 am and 10 am after the subjects had fasted overnight. In the patient group, all blood samples were taken before the start of tuberculosis treatment. Blood samples from the healthy control subjects were collected and processed identically.

Total protein, albumin and globulin estimation: Total protein was measured by Biuret method. The albumin concentration was determined by the brilliant cresol green solution. The globulin level was calculated by substracting the value of albumin from that of total protein). Determination of plasma

lipids: Total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides were measured by enzymatic procedures using kit Other investigations Serum concentrations of ESR, Hb, WBC, CXR,

Statistical Analysis
Statistical package for social sciences version 18 (SPSS v.18) was used for data input and analysis. Discrete variable presented as number and percentages. Continuous variables presented as mean and standard deviation. Chi square test for independence used to test the significance of association between discrete variables. T test for two independent samples used to test the significance of difference between two normally distributed continuous samples. All P values used were asymptotic and two sided.

Results:
The study sample composed of 60 cases of AFB positive pulmonary tuberculosis (57% are males and 43% females) with and 60 controls (53% males and 47% females) ,(There was no significant association between gender and disease status (P >0.05, table 1).The mean age of the cases was 46.8 ± 12.8 year agnd of controls was 49.5 ± 12.4 year and there was no significant difference in mean age of the two groups (P>0.05, table 1) The mean BMI of cases was (16.9 ± 1.1kg/m2) which was lower than BMI of controls (23.5 ± 2.1kg/m2) (and this difference was significant (P <0.05 table 1) Regarding the laboratory nutritional indicators used in our study (serum protein and serum albumin): The mean serum protein and serum albumin levels in cases were 59.5 ± 0.8gm/dl and 23.4 ± 1.8gm/dl respectively while in controls they were 81.2 ± 4.5gm/ dl and 50.0 ± 4.0gm/dl respectively .Compared to controls; the lower levels of serum proteins and serum albumin in TB patients were significant (P <0.05, table 2). In regard to the serum globulin; PTB patients significantly have higher mean serum globulin (36.2 ± 1.2g/dl) than control (31.4 ± 1.7g/dl) (p<0.05, table 2, .PTB patients significantly have lower mean plasma TC, TG, HDL & LDL than control (p<0.05, table 2,).

Table 1: Demographic characteristics of study sample.

Variables	Pulmonary TB N = 60	Control Group N = 60	P
Age (year); Mean ± SD	46.8 ± 12.8	49.5 ± 12.4	0.244
Gender; n (%) Male Female	34 (56.7) 26 (43.3)	32 (53.3) 28 (46.7)	0.714
BMI (kg/m2) ; Mean ± SD	16.9 ± 1.1	23.5 ± 2.1	0.000

TB; tuberculosis, N; number, P; P value, SD; standard deviation, %; percent.

Table 2: Mean levels of laboratory findings for the study sample.

Variables	Pulmonary TB N = 60	Control Group N = 60	P
Serum Proteins; Mean ± SD			
Total Serum Proteins (g/L)	59.5 ± 0.8	81.2 ± 4.5	0.000
S.Albumin (g/L)	23.4 ± 1.8	50.0 ± 4.0	0.000
S.Globulin (g/L)	36.2 ± 1.2	31.4 ± 1.7	0.000
Lipid Profile; Mean ± SD			
Total Cholesterol (mg/dl)	138.7± 4.9	213.5 ± 26.8	0.000
S.Triglyceride (mg/dl)	62.4 ± 1.3	148.5 ± 37.1	0.000
HDL (mg/dl)	32.2 ± 4.0	57.4 ± 8.5	0.000
LDL (mg/dl)	86.5 ± 1.3	161.1 ± 28.3	0.000

TB; tuberculosis, N; number, P; P value, SD; standard deviation, ⁒; percent.

Concerning the correlation between different study variables: In the disease group, there was a significant direct correlation between the BMI and each of TSP, serum albumin, TC, TG and LDL (P < 0.05, table 4 & figure 1, 2).There was a significant inverse correlation between BMI and serum globulin (P < 0.05, table 3 & figure 1).There was no significant correlation between BMI and HDL (P > 0.05, table 3)

Table 3: Correlation of BMI of AFB smear positive PTB patients with serum proteins and lipid profile.

Variables	Spearman>s Correlation Coefficient	P
Serum Proteins (g/L)		
Total Serum Proteins	0.481	0.000
S.Albumin	0.569	0.000
S.Globulin	- 0.502	0.000
Lipid Profile (mg/dl)		
Total Cholesterol	0.501	0.000
S.Triglyceride	0.449	0.000
HDL	0.233	0.073
LDL	0.439	0.000

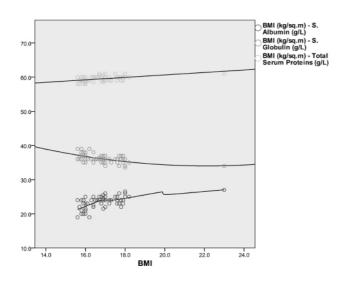N; number, P; P value, SD; standard deviation, %; percent.

Figure 1: Correlation of BMI of AFB smear positive PTB patients with serum proteins.
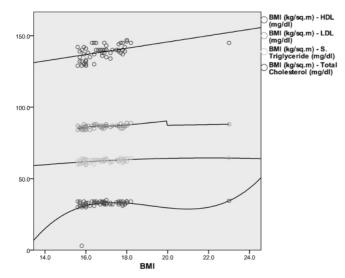

Figure 2: Correlation of BMI of AFB smear positive PTB patients with lipid profile.

Discussion:

In our study the statistical analysis had been shown that the underweight was more common among PTB group than in control group and the normal weight was more common among control group than PTB group shown in table (1), also there was a significant relationship between the underweight group and with the nutritional state of patient as shown in table (3) and figure (1, 2). Also we found that there is no significant difference between gender and the nutritional status in both PTB and control group ,And there was no significant difference in mean age of the two groups. The present study shows significantly lower levels of total protein and albumin in subjects with pulmonary tuberculosis. Similar report was given by Yamagishi et al (14), that albumin and total protein were significantly lower in pulmonary tuberculosis. Akashi et

al (15) reported that the total protein, albumin, cholinesterase, hemoglobin and lymphocyte were significantly lower in homeless patients when compared with non-homeless tuberculosis patients and healthy men. Camargo et al (16) also observed lower levels of albumin and heamatocrite in tuberculosis. Albumin is an important component of plasma antioxidant activity that primarily binds free fatty acids, divalent cations and hydrogen oxochloride (HOCI) (17). It is a negative acute phase protein which the plasma value decreases during infection, injury or stress possibly as a result of increased metabolic need for tissue repair and free radical neutralization. The free radicals attack the cell membrane causing tissue damage and wasting disease in pulmonary tuberculosis patients with resultant high level of uric acid (a powerful antioxidant). The uric acid is endogenously produced as a compensatory mechanism for the neutralization of free radicals (18). Lower levels of total protein and albumin in this study might have been caused by anorexia, poor appetite, malnutrition and mal-absorption commonly observed in tuberculosis. The lower level of albumin may therefore be one of the complications associated with pulmonary tuberculosis. Significantly high level of globulin observed in tuberculosis in our study might have arisen from combination of elevation of different globulin fractions. Arinola and Igbi (19) reported high levels of IgG and IgM in pulmonary tuberculosis. Tamura et al (10) also stated that hyperglobulinaemia in tuberculosis is one of the predictive factors for the development of residual pleural thickening in tuberculous pleurisy. Anderson et al (18) reported higher levels of alpha-I-antitrypsin in pulmonary tuberculosis patients. The high level of globulin observed in this study support the fact that humoral immune response is less affected and raises the possibility of polyclonal B cell activation in tuberculosis patients. Lower levels of TC, TG, LDLC and HDLC were observed in this study. Piasecka et al (12) and Krishna et al, (83) have reported high levels of lipid peroxidation in all categories of pulmonary tuberculosis patients, irrespective of treatment status and this might have caused reduction in the concentration of serum lipids as observed in our study. It was shown that total cholesterol was significantly lower in tuberculosis patients when compared with pulmonary tuberculosis-free controls (24, 25). Triglycerides and LDL cholesterol are the chief constituents of cell membranes (84), while the HDL cholesterol protects the arterial walls of the blood circulatory system (85). Lower levels of lipids noticed in these patients could be a factor that predisposes them to cell and tissue damage, cardiovascular problems and low cellular immunity (26,). The lower levels of total cholesterol, HDLC, LDLC and TG observed in this study could be the result of impaired rate of lipid production and enhanced lipid catabolic rate associated with tuberculosis. The result of this study shows lower BMI and nutritional profiles in pulmonary tuberculosis patients. There was a significant direct correlation between the BMI and each of TSP, serum albumin, TC, TG and LDL. There was a significant inverse correlation between BMI and serum globulin. There was no significant correlation between BMI and HDL. These could be associated

with heavy load of free radicals, oxidative stress and lipid peroxidation. Improved nutrition and supplementation with antioxidant therapy in the treatment of pulmonary tuberculosis may prevent the oxidative stress and further complications. As compared with these studies our study has limited number of patients, duration of study, and lack of facilities but we hope that it clears the way for further research.

Conclusion:
BMI is considered to be a useful technique for assessment of nutritional state of PTB. The prevalence of underweight is more common with PTB than general population There is a significant degree of nutritional depletion and weight loss in PTB patients than in general population.

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