Research Article

A study on nutritional status and change in body mass index with treatment outcome in smear-positive pulmonary TB patients on DOTS in Amritsar city

Manisha Nagpal[1], Priyanka Devgun[1], Naresh Chawla[2]

[1]Department of Community Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar, Punjab, India.
[2]District TB Officer, Amritsar, Punjab, India.
Correspondence to: Manisha Nagpal, E-mail: manishaspm@gmail.com

Received November 16, 2014. Accepted November 27, 2014.

Abstract

Background: The association between tuberculosis (TB) and malnutrition has been recognized for a long time. A body mass index (BMI) below 18.5 increases the risk of TB by 2–3 times. Conversely, an increase in body weight lowers the risk.

Objective: To assess the nutritional status and change of patients' bodyweight over time depending on TB treatment outcome.

Materials and Methods: The study was conducted on newly identified smear-positive patients registered under DOTS in two treatment units present in Amritsar city, Punjab, India. BMI of every patient was calculated from the weight and height measurements at the time of registration and again on completion of treatment. Nutritional requirement of the subjects was calculated using the Harris–Benedict equation. Data management and analysis was done by using Microsoft excel and SPSS software, version 17.00.

Results: Of 250 patients, 149 (59.6%) were men and 101 (40.4%) women. Male preponderance, with male to female ratio of 1.5:1 was seen; 97.3% of the total men and all of the women were taking diet deficient in calories. It was observed that, in the beginning, 69.2% patients were underweight among which 34% are severely underweight having BMI < 16 kg/m^2; 29.6% cases were having normal BMI, while only 1.2% cases were preobese. At the end of treatment, it was evident that 62.8% of the cases were still underweight, 34.9% of the cases showed normal BMI, and 2.3% were in the preobese category.

Conclusion: In this study, it was observed that that mean BMI in cured cases at the end of treatment was higher when compared with cases with outcome as failure. The results were found to be statistically significant. So, it was concluded that poor nutritional status is associated with unfavorable outcome in TB.

KEY WORDS: Tuberculosis, malnutrition, body mass index (BMI), directly observed treatment, short course (DOTS)

Introduction

Globally, every year, India has the highest number of new cases of tuberculosis (TB), multidrug-resistant TB (MDR-TB), and deaths related to TB.[1] India continues to have a large burden of poverty and undernutrition among both adults and children.[2] TB has been called "phthisis" owing to profound wasting. In a book published in 1949, which reviewed the epidemiological risk factors for TB at a global level, Dr. JB McDougall of the WHO stated: "The nutrition of the individual using the term in its widest sense, is the most vital factor in the prevention of tuberculous disease."[3] Malnutrition can predispose pulmonary tuberculosis (PTB). Conversely, PTB can result in malnutrition. Undernutrition selectively compromises cell-mediated immunity, which is the principal defense against Mycobacterium tuberculosis and, thereby, increases the risk of reactivation of latent infection to disease.[4] Moreover, poor nutritional status is associated with risk of TB relapse and mortality.[5]

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2015.1611201493	

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." BMI is defined as the individual's body weight divided by the square of their height. It is a more accurate marker of nutritional status than weight because it also takes height into account.[6] A successful TB treatment should result in weight gain among underweight individuals through restoring muscle and fat mass, depending on the nutritional intake.[7] Previous studies on cohorts of mixed HIV status have shown that weight changes during early TB treatment can be useful indicators of TB treatment outcomes.[8]

The objective of this article was to assess the nutritional status and change in patients' bodyweight over time depending on the TB treatment outcome. We hypothesized that the trends of patients' bodyweight with poor outcome, those who had died or failed during treatment, differed from those who had been treated successfully.[8]

Materials and Methods

The study was conducted on newly identified smear-positive patients registered under directly observed treatment, short course (DOTS) in two treatment units (TUs) present in Amritsar city, Punjab, India: the Chest and TB Hospital and the Civil Hospital. A predesigned and pretested pro forma was administered to the subjects after taking their consent. Approval of college ethical committee was granted at the time of the submission of the plan of the study.

On the basis of the quarterly reports of both the TUs and by the expected incidence of new smear-positive (NSP) cases in the northern zone of India, which is 95/lac population/year, a quota of 250 cases was affixed. (As population covered by the two TUs is approximately 11 lac, the expected NSP cases in a year comes around 1045 and expected cases in a quarterly cohort is around 250.) Thus, the study sample consisted of 250 NSP cases that were enrolled from December 1, 2009, to February 28, 2010. The study period was extended till the projected number was achieved.

NSP patients aged more than 15 years were included in the study. Patients with extra PTB and smear-negative TB patients were excluded.

BMI of every patient was calculated from the weight and height measurements at the time of registration and again on the completion of treatment. Height was measured with a narrow, flexible, nonstretchable measuring tape. The patient was asked to stand along the wall, feet parallel, and heels, buttocks, shoulders, and back of the head touching the wall. The head was held comfortably erect. A flat surface object was held on top of the head, and by lowering measuring tape, height was recorded in centimeters. A standard stand-on-scale weighing machine was used for measuring weight. It was regularly standardized by putting a known weight over it. The patient was made to stand on machine without shoes at the center of the platform without touching anything. Weight was recorded at the time of registration and again on the completion of the treatment:

$$\text{BMI} = \text{Weight (Kg)}/\text{Height}^2\ \text{(m)}.$$

The cases were classified based on BMI (kg/m^2) as per WHO criteria as follows:

- Severe underweight: <16.00
- Moderate underweight: 16–16.99
- Mild underweight: 17–18.49
- Normal: 18.5–24.99
- Preobese: 25–29.9
- Obese: ≥30

Nutritional Requirement of the Subject Assessed by Using Harris–Benedict Equation[9]

1. Step 1
   a. Basic metabolic rate (BMR; male) = 66 + (13.7× weight in kg) + (5× height in cm) − (6.76× age in years).
   b. BMR (female) = 655 + (9.6× weight in kg) + (1.8× height in cm) − (4.7× age in years)

2. Step 2
   a. Applying the Harris–Benedict principle daily calories needed
      - Little to no exercise: BMR × 1.2
      - Light exercise (1 day to 3 days/week): BMR × 1.375
      - Moderate exercise (3–5 days/week): BMR × 1.55
      - Heavy exercise (6–7 days/week): BMR × 1.725
      - Very heavy exercise (twice per day): BMR × 1.9

Data management and analysis was done by using Microsoft Excel and SPSS software, version 17.00.

Results

This study was carried out on 250 newly diagnosed smear-positive PTB cases registered under two TUs present in Amritsar city, Punjab, India. The total sample consisted of 149 (59.6%) male and 101 (40.4%) female patients. It was observed that majority (94.8%) of the cases belonged to economically productive age group of 15–59 years [Table 1].

Table 1 shows that 97.3% of the total male patients and all of the female patients were taking diet deficient in calories.

It is observed that, in the beginning, 69.2% patients were underweight among which 34% were severely underweight having BMI < 16 kg/m^2; 29.6% cases were having normal BMI while only 1.2% cases were preobese [Table 2]. At the end of the treatment, it was evident that 62.8% of the cases were still underweight, 34.9% of the cases were having normal BMI, and 2.3% arrived in the preobese category. Weight of 27 cases could not be recorded at the end, which included cases that died, defaulted, transferred out, or cases that did not come.

Table 1: Distribution of cases according to calorie intake

Calorie intake	Male (n = 149), N (column %)	Female (n = 101), N (column %)	Total (n = 250), N (column %)
Less than required {row %}	145 (97.3) {58.9}	101 (100.0) {41.1}	246 (98.4) {100.0}
Mean deficit ± SD	800 ± 325.3	485 ± 213.2	671 ± 323.6
Adequate {row %}	4 (2.7) {100.0}	0 (0) {0}	4 (1.6) {100.0}

Table 2: Distribution of cases according to BMI in the beginning and at the end of treatment

Grades	In the beginning (n = 250), n (%)	At the end of treatment (n = 223), a n (%)
Severe underweight	85 (34.0)	55 (24.7)
Moderate underweight	29 (11.6)	36 (16.1)
Mild underweight	59 (23.6)	49 (22.0)
Normal	74 (29.6)	78 (34.9)
Preobese	3 (1.2)	5 (2.3)

[a]Excluding dropouts.

Table 3: Distribution showing the treatment outcome and the changes in mean BMI at the beginning and at the end of treatment in cured and failure cases

Outcome	No. of cases, n = 250 (%)	BMI at the beginning (mean ± SD)	BMI at the end (mean ± SD)	Significance
Cured	210 (84.0)	17.37 ± 2.87	17.87 ± 2.83	t = 10.151, df = 209, p < 0.001
Failure	13 (5.2)	18.27 ± 3.28	18.18 ± 3.08	t = 0.808, df = 12, p = 0.435
Treatment completed	1 (0.4)	Mean BMI at the end of treatment could not be calculated		
Defaulted	12 (4.8)			
Transferred out	4 (1.6)			
Died	10 (4.0)			

Table 3 illustrates that, among the total 250 cases under study, 84% were cured and 0.4% completed treatment. Thirteen cases were sputum positive even 5 months after treatment, that is, failure rate was 5.2%; 4.8% cases defaulted, 1.6% transferred out, and 4% died during the treatment. Mean BMI in cured cases at the beginning of the treatment was 17.37 ± 2.87 and at the end of the treatment was 17.87 ± 2.83. The results were found to be statistically significant (p < 0.001). While in cases that were failure, mean BMI at the beginning of the treatment was 18.27 ± 3.28 and at the end of the treatment was 18.18 ± 3.08. The results were not found to be statistically significant (p = 0.435).

Discussion

The age-wise distribution showed that 94.8% cases were from 15 to 59 years age group and only 5.2% were 60 years or older. In this study, it was observed that, of the total 250 cases, 59.6% were males and 40.4% were females, that is, male to female ratio of 1.5:1 approximately.

The association between TB and malnutrition is well recognized. As cell-mediated immunity is the key host defense against TB, malnutrition is, therefore, an important risk factor for the development of TB. In this study, it was observed [Table 1] that majority (98.4%) of the cases were taking diet deficient in calories. BMI was calculated at the time of registration and at the end of the treatment. Table 2 illustrates the distribution of cases according to BMI. At the end of the treatment, BMI of 223 cases was recorded, excluding those who were dropouts or did not come at the completion of the treatment. It was observed that, in the beginning, 69.2% of the cases were underweight (BMI < 18.5 kg/m^2) and, at the end, 62.8% still remained underweight; 29.6% were normal (BMI = 18.5–24.99 kg/m^2) and 1.2% were preobese (BMI = 25–29.9 kg/m^2) at the beginning which increased to 34.9% and 2.3%, respectively, at the end of treatment. Table 3 shows the treatment outcomes of the NSP cases observed in this study: cured (84%), treatment completed (0.4%), failure (5.2%), defaulted (4.8%), transferred out (1.6%), and died (4%). It reveals significant change in mean BMI in cured cases from 17.37 ± 2.87 in the beginning to 17.87 ± 2.83 at the end of the treatment (p = <0.001), showing significant weight gain in cured cases. The change in the mean BMI of the failure cases before and after the treatment was not significant (p = 0.435).

The findings in our study are in consonance with the findings of the study conducted by Mohrana et al.[10] in a tertiary level health facility of Orissa, India, which showed that 91.4% of the cases belonged to economically productive age group of 15–59 years.[10] A study conducted by Chand et al.[11] at Chest and TB hospital, Amritsar, Punjab, India, showed that, among total 200 TB patients under study, 120 (60%) were male and 80 (40%) were female patients.[11] A review of studies by WHO, Stop TB Department, Geneva, Switzerland, showed a log-linear inverse relationship between TB incidence and BMI. In other words, across all these studies, TB incidence increased exponentially as BMI decreased.[12] In this study also, it was observed that 69.2% of the cases registered were having low BMI of <18.5. Another case–control study by Pakasi et al.[13] reported that, of 121 TB patients, 87% had malnutrition compared to 33% among controls. In addition, mean BMI of the patients was significantly lower than that of controls.[13] The findings in our study are in accordance with the study conducted by Chennaveerappa et al.[14] at Hassan, Karnataka, India, showing that, among 58 NSP patients, treatment 49 patients (84%) got cured, 4 (6%) patients died, 3 (5%) patients were defaulters, and 2 patients were treatment failures.[14] In another study conducted by Vasantha et al. in Tiruvallur district, Tamil Nadu, India, it was observed that the average gain in weight was 3.22 kg among smear-positive cases registered under DOTS. It was concluded that there is an association between gain in weight with DOT and cure of the patients.[15]

Our study had certain limitations and strengths such as cross-sectional nature of the study with limited number of patients and duration of study but we hope that it clears the way for further research. Moreover, other risk factors of poor weight gain and unfavorable outcome such as presence of comorbidities and addictions in TB patients were not taken into account.

Our study has important implications. The nutritional profile of a population has been considered an important determinant of TB. The classic article by Rose[16] highlighted the importance of addressing the determinants of the population incidence rate of a disease by a population-based strategy to “lower the mean level of risk factors, and to shift the whole distribution of exposure to a more favorable direction.”[16]

Conclusion

From this study, it is concluded that poor nutritional status is associated with the risk of TB and unfavorable outcome. Despite the high burden of malnutrition, assessment of nutrition intake is often neglected in clinical practice and in national TB programs. There is a need of nutritional counseling and supplementation, which may improve TB treatment outcomes. The observation of Rene Dubos, the noted microbiologist, experimental pathologist and humanist, appears prescient and relevant in this context: “It is most unlikely that drugs alone, or drugs supplemented by vaccination, can control TB in the underprivileged countries of the world as long as their nutritional status has not been raised to a reasonable level.”[17]

References

1. World Health Organization. *Global Tuberculosis Report 2012*. Geneva: WHO, 2013.
2. International Institute for Population Sciences (IIPS) and Macro International. *National Family Health Survey (NFHS-3), 2005–06: India*, Vol. 1. Mumbai, India: IIPS, 2007.
3. McDougal JB. *Tuberculosis—A Global Study in Social Pathology*. Baltimore, MD: Williams & Wilkins, 1949.
4. Lönnroth K, Jaramillo E, Williams BG, Dye C, Raviglione M. Drivers of tuberculosis epidemics: The role of risk factors and social determinants. Soc Sci Med 2009;68:2240–6.
5. Mupere E, Parraga IM, Tisch DJ, Mayanja HK, Whalen CC. Low nutrient intake among adult women and patients with severe tuberculosis disease in Uganda: A cross-sectional study. *BMC Public Health* 2012;12:1050.
6. Sultan KM, Alobaidy MW, AL-Jubouri AM, Naser AA, AL-Sabah AA. Assessment of body mass index and nutritional status in pulmonary tuberculosis patients. J Fac Med Baghdad 2012; 54(3):204–8.
7. Semba RD, Darnton-Hill I, De Pee S. Addressing tuberculosis in the context of malnutrition and HIV coinfection. Food Nutr Bull 2010;31:S345–64.
8. Bernabe-Ortiz A, Carcamo CP, Sanchez JF, Rios J. Weight variation over time and its association with tuberculosis treatment outcome: A longitudinal analysis. PLoS One 2011;6:e18474.
9. Wikipedia. *Harris–Benedict equation*. Available at: http://en.wikipedia.org/wiki/harris-benedict_equation (last accessed on May 13, 2014).
10. Mohrana PR, Statapathy DM, Sahani NC, Behera TR, Jena D, Tripathi RM. An analysis of treatment outcome among tuberculosis patients put under DOTS at a tertiary level health facility of Orissa. J Community Med 2009;5(2)1–10.
11. Chand N, Singh T, Khalsa JS, Verma V, Rathore JS. A study of socio-economic impact of tuberculosis on patients and their family. Chest 2004;126(4):832S.
12. Lonnroth K, William BG, Cagielski P, Dye C. A consistent log-linear relationship between tuberculosis incidence and BMI. Int J Epidemiol 2009;39:149–55.
13. Pakasi TA, Karyadi E, Dolmans WM, Vandermeer JW, Vandervelden K. Malnutrition and socio-demographic factors associated with pulmonary tuberculosis in Timor and Rote islands, Indonesia. Int J Tuberc Lung Dis 2009;13(6):755–9.
14. Chennaveerappa PK, Siddharam SM, Halesha BR, Vittal BG, Jayashree N. Treatment outcome of tuberculosis patients registered at DOTS centre in a teaching hospital, south India. Int J Biol Med Res 2011;2:487–9.
15. Vasantha M, Gopi PG, Subramani R. Weight gain in patients with tuberculosis treated under DOTS. Indian J Tuberc 2009;56:5–9.
16. Rose G. Sick individuals and sick populations. Int J Epidemiol 1985;14:32–8.
17. Dubos RJ. Health and disease. JAMA 1960;174:505–7.

How to cite this article: Nagpal M, Devgun P, Chawla N. A study on nutritional status and change in body mass index with treatment outcome in smear-positive pulmonary TB patients on DOTS in Amritsar city. Int J Med Sci Public Health 2015;4:454-457

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