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ARTICLE

Tuberculosis treatment and nutritional status among the tribals of Northeast India

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ABSTRACT The data for the present study was collected cross-sectionally among a total sample of 247 adult tribal males between the age 20-40 years inhabiting Manipur, Northeast India. The subjects comprised of TB patients and healthy non-patients taken as control group (CG). The TB patients were categorized into three groups viz.: Before starting treatment (BST), after 2 months of treatment (2MOT), after completion of treatment(ACT). Anthropometric measurements like weight, height and mid upper arm circumference were taken for the study. The index of nutritional status like body mass index(BMI) was computed. The percentage of chronic energy deficiency (CED) based on body mass index (BMI<18.5kg/m^2) for the different groups of subjects were 64.5%(BST), 49%(2MOT), 34%(ACT) and 6.3%(CG) respectively. The CED based on mid upper arm circumference (MUAC<22.0cm) was found to be 43.5%(BST), 30.9(2MOT), 26%(ACT) respectively. Based on the World Health Organization BMI classification, the prevalence of CED (BMI<18.5kg/m^2) among tuberculosis patients in the different stages of treatment was from high to very high indicating a critical situation. The prevalence of undernutrition based on MUAC among the TB patients was also clearly evident but not so in healthy non patient subjects. Regular intake of medicine is clearly reflected in significant improvement in nutritional status indices.
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KEY WORDS

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mid upper arm circumference
body mass index

Weight loss with a concomitant loss of body fat and nutritional depletion are observed frequently in patients with pulmonary tuberculosis. Tuberculosis (TB) is one of the most globally serious health problems and is one of the most important causes of death among adults in developing countries. Worldwide, one person out of three is infected with the disease - that is, 2 billion people in total. Global estimate of the burden of tuberculosis related disease and death for 1997 indicated that 8 million people developed active tuberculosis every year and nearly 2 million died (Smith 2004). Pulmonary TB, a chronic infectious disease caused by mycobacterium tuberculosis, is characterized by prolonged cough, hemoptysis, chest pain and dyspnea. Systemic manifestations of the disease include fever, malaise, anorexia, weight loss, weakness and night sweats (Hopewell 1994).

India alone accounts for one-third of the global burden of TB and every year more than 1.8 million new cases appear in the country. Approximately 4,00,000 people die from TB every year in India, more than 1,000 die every day and 100 million work days are lost (Directorate General of Health Services 2005). The situation in the remote tribal areas is still grim. Among the tribals the prevalence of tuberculosis was found to be affected by socio-economic status, nutrition, family size, customs, beliefs and use of medical facilities (Tungdim et al. 2008).

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The use of anthropometry as an indicator of nutritional status of adults has now been well established (World Health Organization 1995). The body mass index (BMI) and high levels of undernutrition (based on BMI) is a major public health problem especially among rural underprivileged adults of developing countries (World Health Organization 1995). Although adult nutritional status can be evaluated in many ways, the BMI is the most widely used because its use is inexpensive, non-invasive and suitable for large scale surveys (Lohman et al. 1988; Ferro-Luzzi et al. 1992; James et al. 1994; Tyagi and Kapoor 2004; Tyagi et al. 2005; Sinha and Kapoor 2006; Sinha and Kapoor 2007). Thus, BMI is the most established anthropometric indicator used not only for assessment of adult nutritional status but also the socio-economic condition of a population, specially adult populations in developing countries (Shetty and James 1994; Nube et al. 1998; Khongsdier 2002; Bose et al. 2006; Bose et al. 2007). Fernald (2007) in his study among the Mexican adults found that socio-economic status is related to body mass index.

Another anthropometric measure that can be used to evaluate adult nutritional status is mid upper arm circumference (MUAC). It has been found that MUAC is particularly effective in the determination of malnutrition among adults in developing countries (James et al. 1994).

Several studies like association of body mass index and incidence of tuberculosis (Tverdal 1986), nutritional status and weight gain in patients with pulmonary tuberculosis in

Table 1. Basic data of subjects.

Subjects	n	Height(cm) Mean ± SD	Weight(kg) Mean ± SD	MUAC(cm) Mean ± SD	BMI(kg/m^2) Mean ± SD
BST	62	161.6 ± 5.88	46.8 ± 6.64	22.1 ± 2.38	17.9 ± 2.18
2MOT	55	163.5 ± 5.23	50.1 ± 6.13	23.1 ± 2.39	18.7 ± 2.14
ACT	50	163.5 ± 4.93	51.8 ± 6.09	23.3 ± 2.65	19.4 ± 2.0
CG	80	163.9 ± 5.71	57.4 ± 5.82	26.0 ± 1.97	21.4 ± 2.12
F- value		2.32*	36.9*	37.4*	35.3*

*p<0.01. CG: healthy controls; BST: before starting treatment; 2MOT: after two months of treatment; ACT: after completion of treatment. MUAC: mid upper arm circumference. BMI: body mass index.

Table 2. Distribution of subjects according to nutritional status based on body mass index(BMI).

Subjects	n	CED III	CED II	CED I	Total CED	Normal	Overweight
BST	62	19.4%	16.1%	29%	64.5%	35.5%	-
2MOT	55	5.5%	20%	23.6%	49.1%	50.9%	-
ACT	50	4%	10%	20%	34%	66%	-
CG	80	-	2.5%	3.8%	6.3%	87.5%	6.3%

CG: healthy controls; BST: before starting treatment; 2MOT: after two months of treatment; ACT: after completion of treatment.

Tanzania (Kennedy et al. 1996), have been conducted. Malnutrition though observed frequently in patients with pulmonary tuberculosis(TB) but the assessment of their nutritional status during TB treatment as assessed by BMI and MUAC is non-existent on the tribals of India. In view of this, the present investigation was undertaken to study the influence of pulmonary tuberculosis treatment on the anthropometric indicators of nutritional status among the tribal adults of Manipur, Northeast India.

Materials and Methods

The present study was conducted among adult tribal males in Manipur. Manipur lies in the North-Eastern region of the Indian sub-continent, between 23° 50´ latitudes and 25° 30´ North and 93° 10´ and 94° 30´ East longitudes, bordering Myanmar in the East, Nagaland in the North, Assam and Mizoram in the West. The density of population is 82 per sq.km., the literacy rate is 59.89% and the per capita income is Rs. 3502/- (Census 1991).

According to the 1991 census report, Manipur has a population of around 1,837,149 out of which the tribal population accounts for approximately 30 percent. In the geographical classification it may be simply divided into a valley at the centre and the hills surrounding it. The hills are said to be abode of the tribals. It should be noted that all the different ethnic groups are of the same Mongoloid group and have very close similarities in their culture and traditional habits. The main occupation of the people is agriculture and rice is their staple food.

A cross sectional study among the adult pulmonary tuberculosis (TB) patients between 20-40 years of age was conducted in the four TB centers in Manipur. The TB patients selected were categorized into 3 groups in consultation with the Delhi State TB center, India as (i) Before starting treatment (BST) which includes subjects who were confirmed by the doctors as having TB and were to start their treatment (ii) The patients who had completed two months of treatment (2MOT) and this group included subjects who had been taking regular TB medicine for the last 2 months as confirmed from doctors at their respective TB centers. These subjects came to various TB centers/ hospitals for constant monitoring. The third group included subjects who were at the completion of TB treatment (ACT) as confirmed by the doctors at respective TB centers and hospitals. All these three group of subjects (BST, 2MOT & ACT) were independent of each other. None of the subjects were related to each other by birth or by marriage. Controls (CG) were healthy subjects with no history of tuberculosis, matched with cases for age, and selected from among the non-family neighbors of the patients.

Certain guidelines were laid down for selecting the subjects who had TB and were willing to co-operate in the present study, (1) only those subjects who took their medicines regularly as confirmed by the doctors and/or health workers and also followed the dietary norms as advised by doctors were taken, (2) only those subjects were retained in the sample who refrained from alcohol and smoking during the course of treatment, (3) only new cases who had pulmonary tuberculosis were taken, (4) none of the HIV +ve patients

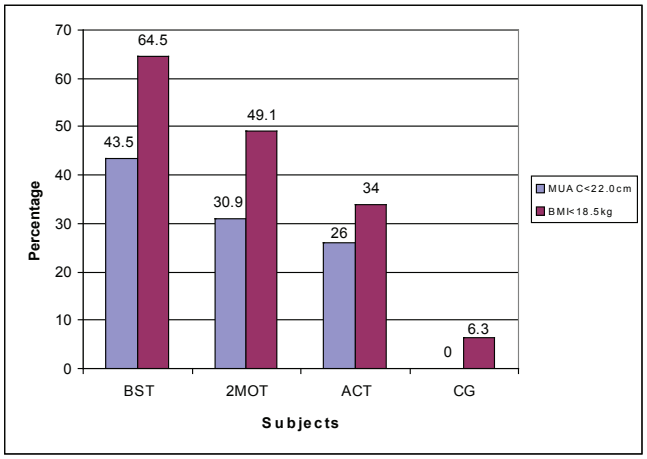

Figure 1. Prevalence of undernutrition based on body mass index and mid upper arm circumference among the subjects in different groups.

were retained in the sample. Exclusion criteria for the controls were as follows: previous anti-TB treatment, any form of disease and HIV+ve as confirmed by the doctors.

Each subject was measured for height, body weight and mid upper arm circumference. Body weight was measured to the nearest 0.1kg using a beam balance scale with subjects wearing only light clothes and no shoes. The height was measured to the nearest 0.1cm with a Harpenden anthropometer. The mid upper arm circumference was measured to the nearest 0.1 cm using a flexible steel tape. All these measurements were taken by following the techniques described by Weiner and Lourie (1981). Body mass index was calculated as body weight in kg divided by height in meter squared [BMI=wt (kg)/ height (m^2)].

The World Health Organization's classification (World Health Organization 1995) of the public health problem of low BMI, based on adult populations worldwide, was followed. This classification categorizes prevalence according to percentage of a population with BMI<18.5 as follows

Low (5-9%): warning sign, monitoring required.

Medium (10-19%): serious situation.

High (20-39%): serious situation.

Very high (≥40%): critical situation.

Nutritional status was also evaluated following the standard cut off point of MUAC (James et al. 1994). The following cut off values was used:

Under-nutrition: MUAC < 22.0cm

Normal: MUAC > 22.0cm

Descriptive statistics were performed for the anthropometric variables viz, height, body weight, MUAC and BMI for subjects in the different stages of TB treatment and healthy controls. The t-test was used for comparison between the different groups of subjects. The differences between the test groups and healthy controls in respect of each anthropometric variable were tested by one way analysis of variance(ANOVA). All data was analysed using SPSS 13.0 version.

Results

Figure 1. shows the prevalence of undernutrition based on BMI and MUAC. The subjects before starting treatment showed highest prevalence of undernutrition. The healthy control subjects also suffered from CED based on BMI only but not on MUAC.

Table 1 gives the means and standard deviations of height, weight, mid upper arm circumference (MUAC) and body mass index (BMI) according to different stages of treatment and in healthy controls. It was found that the mean values of all the measurements among subjects before starting treatment (BST) was the lowest and was highest among healthy control subjects. The ANOVA test for height ($F=2.32$, $p<0.01$), weight ($F=36.9$, $p<0.01$), MUAC($F=37.4$, $p<0.01$) and BMI($F=35.3$, $p<0.01$) showed significant differences among TB patients and healthy controls.

The percentage distribution of BMI categories is given in Table 2. Following the World Health Organization (1995) classification of CED, 64.5% of the subjects before starting treatment, 49.1% of subjects after two months of treatment, 34% of the subjects at the completion of treatment and 6.3% of the healthy controls were found to be CED.

Table 3 shows that the percentage of subjects who were undernourished based on MUAC<22.0 cm was highest among subjects before starting treatment (43.5%) followed by subjects after two months of treatment (30.9%) and then subjects at the completion of treatment. None of the healthy control subjects were found to be undernourished based on MUAC.

Table 4 displays the value of 't' with the level of significance in the anthropometric indicators of chronic energy deficiency between different groups of subjects. Both the anthropometric indicators (MUAC & BMI) of chronic energy deficiency were found to be statistically significant ($p<0.001$) between TB patients at different stages of treatment (BST, 2MOT & ACT) and the healthy controls (CG). The mid upper arm upper circumference (MUAC) was also found to be statistically significant ($p<0.05$) between subjects before starting treatment(BST) and after two months of treatment (2MOT) and after completion of treatment (ACT). The body mass index(BMI) was also found to be statistically significant ($p<0.001$) between subjects before starting treatment (BST) and after completion of treatment (ACT). The BMI also showed statistically significant difference ($p<0.05$) between patients before starting treatment (BST) and after two months of treatment(2MOT).

Discussion

Malnutrition together with socio-cultural and economic factors, poor sanitation, lack of awareness makes people

Table 3. Distribution of subjects according to nutritional status based on mid upper arm circumference (MUAC).

Subjects	n	MUAC <22.0 cm	MUAC >22.0 cm
BST	62	43.5%	56.5%
2MOT	55	30.9%	69.1%
ACT	50	26%	74%
CG	80	-	100%

CG-healthy controls; BST-before starting treatment; 2MOT-after two months of treatment; ACT-After completion of treatment. MUAC-mid upper arm circumference. BMI-body mass index.

Table 4. Value of 't' with level of significance in the anthropometric indicators of chronic energy deficiency between different groups of subjects.

Subjects	MUAC	BMI
CG & BST	10.6***	9.6***
CG & 2MOT	7.7***	7.1***
CG & ACT	6.7***	5.4***
BST & 2MOT	2.21*	2.05*
BST & ACT	2.41*	3.64***
2MOT & ACT	0.34	1.56

*p<0.05, **p<0.01, ***p<0.001. CG-healthy controls; BST-before starting treatment; 2MOT-after two months of treatment; ACT-After completion of treatment. MUAC-mid upper arm circumference. BMI-body mass index.

more susceptible to diseases. Diseases further aggravate the situation regarding the nutritional status and causes partly retardation in physical well being.

The mean value of BMI of the healthy controls in present population was higher than in many populations in Northeast India (Khongsdier 2001; Khongsdier 2002) and South Indian populations (Ferro-Luzzi et al. 1992). It was observed that weight, MUAC and BMI were significantly higher in the healthy control subjects than in the subjects who had TB and were at different stages of treatment. Tungdim et al. (2008) have found that the socio-economic status of the healthy controls was found to be comparatively higher than the TB patients at different stages of treatment which confound with the findings of Ginzburg and Dadamukhamedov (1990) and Ulijaszek (1997).

It was demonstrated that the nutritional status as assessed by body weight, body mass index and mid upper arm circumference was significantly poor in TB patients as compared with healthy controls. Similarly, Tverdal (1986) found a distinct association between an increasing risk of pulmonary TB with a decreasing body mass index which was observed for both sexes, all age groups, and at all lengths of observations. It is well established that people show a decrease in their body fat content with increasing level of physical activity or a decrease in energy intake. The decrease in energy intake might be due to less food intake, poor eating habits or anorexia. There is no doubt that one of the symptoms of TB is anorexia or loss of appetite which would cause a loss in body weight with a concomitant decrease in body fat and muscle mass.

The poor nutritional status of patients with pulmonary TB may be due to anorexia, impaired absorption of nutrients or increased catabolism (Hopewell 1994). The TB patients and healthy subjects had similar food habits and food intakes because their socio-cultural background and living conditions were similar. Thus, infectious disease such as TB may have led to impaired absorption and increased rates of metabolism (Ginzburg and Dadamukhamedov 1990; Ulijaszek 1997). TB is probably associated with more severe malnutrition than other chronic illnesses (Karyadi et al. 2000). In a study by Saha and Rao (1989) the nutritional status of the patients with TB was worse than that of those with leprosy.

The results of the present investigations have shown that there is a certain impact of treatment on the nutritional status of the TB patients. Onwubalili (1988) also found that chemotherapy was associated with progressive nutritional recovery and restoration of nutritional related indices among patients with active TB.

It was found that TB patients showed significant increase in body weight, BMI and MUAC from the time treatment started till two months of TB treatment which is supplemented by the study done by Sukumaran et al. (2002) where they found that 62% of the patients studied experienced improvement in symptoms within two months of starting treatment. Contrary to our findings, Kennedy et al. (1996) found that TB patients displayed evidence of malnutrition both before and after treatment in a longitudinal study among the Tanzanian population and thus weight gain during therapy was an unreliable indicator of overall treatment response. However, the TB patients showed no significant improvement from two months of treatment till the completion of treatment indicating the importance of regular medication in first two months of treatment and perhaps lack of proper diet even with regular treatment in later stage (2MOT to ACT) can explain the non-significant improvement in the anthropometric indices. Good diet is certainly very important during rehabilitation. The TB patients in the present study belonged to relatively low socio-economic status and had large families to feed as compared to healthy controls.

It was found that malnutrition appeared to increase the risk of developing tuberculosis which was also found by Cegielsky and McMurray (2004). It can thus be perceived that there is a strong association of tuberculosis with anthropometric indicators of CED especially BMI and MUAC. BMI<18.5kg/m^2 and MUAC<22.0 cm are found to be the likely predictors of tuberculosis in the present study and significant improvement with TB treatment in various anthropometric indices an important pointer of regular intake of medicine.

Thus, in the present study it was found that the tuberculosis patients displayed high prevalence of CED as compared to the healthy controls. A disease associated depletion of fat stores and muscle wastage was observed and with treatment, the body dimensions improved along with better fatness level, muscle strength and mass. It is quite clear that with course of treatment among patients the anthropometric indicators come closer to healthy controls.

The BMI and MUAC are significantly influenced by chronic disease like tuberculosis and that tuberculosis leads to loss of energy reserve and muscle wastage which later predisposes individuals to chronic energy deficiency.

It is evident from the present study that nutritional status as assessed by various anthropometric indices of the TB patients significantly improved with treatment. Thus, increase in weight, body mass index and mid upper arm circumference during therapy appeared to be reliable indicators of overall treatment response.

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