brac

HEALTH

Working Paper ■ March 2013

Beyond Drugs: TB Patients in Bangladesh need Urgent Attention for Nutrition Support during Convalescene

Qazi Shafayetul Islam
Syed Masud Ahmed
Md. Akramul Islam
Md. Kamruzzaman
Mahfuza Rifat

Beyond Drugs: TB Patients in Bangladesh Need Urgent Attention for Nutrition Support during Convalescence

Qazi Shafayetul Islam
Syed Masud Ahmed
Md. Akramul Islam
Md. Kamruzzaman
Mahfuza Rifat

March 2013

Research and Evaluation Division
BRAC Centre, 75 Mohakhali, Dhaka 1212, Bangladesh
E-mail: research@brac.net, www.brac.net/research
Telephone: 9881265, 8824180-87

For more details about the report please contact: shafayetul.qi@brac.net

ACRONYMS

BMI	Body Mass Index
CED	Chronic Energy Deficiency
DOTS	Directly Observed Therapy, Short-Course
MUAC	Mid Upper Arm Circumference
NTP	National Tuberculosis Programme
RED	Research and evaluation Division
SPSS	Statistical Package for Social Science
TB	Tuberculosis
WHO	World Health Organization

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The authors are grateful to the study respondents who shared their valuable time and experience with us. The study was funded by GFATM and conducted by the Research and Evaluation Division (RED) of BRAC. Thanks to Dr. Syedur Rahman and Dr. Mahfuza Rifat of BRAC for reviewing the report. Finally, the editorial support received from former Chief, Editing & Publication Mr. Hasan Shareef Ahmed of RED is acknowledged.

RED is supported by BRAC's core fund and funds from donor agencies, organizations and governments worldwide. Current donors of BRAC and RED include Aga Khan Foundation Canada, AusAID, Australian High Commission, Brigham Young University, Bill and Melinda Gates Foundation, BRAC University, NIKE Foundation, Campaign for Popular Education, Canadian International Development Agency, Charities Aid Foundation-America, Columbia University (USA), Conrad N Hilton Foundation, Danish International Development Agency, DEKA Emergence Energy (USA), Department for International Development (DFID) of UK, Embassy of Denmark, Embassy of Japan, European Commission, Fidelis France, GITAC Consult GmbH, The Global Fund, GTZ-Germany, Government of Bangladesh, The Hospital for Sick Children, ICDDR,B Centre for Health and Population Research, ICLARM/World Fish Centre, Institute of Development Studies (Sussex, UK), Inter-cooperation Bangladesh, International Committee of the Red Cross, Japan International Cooperation Agency, International Research and Exchange Board, The Johanriter, Land O Lakes (USA), Manusher Jonno Foundation, Micro-Nutrient Initiative, NORAD, NOVIB, OXFAM America, Plan Bangladesh, The Population Council (USA), RNE/DGIS, Embassy of the Kingdom of the Netherlands, Royal Norwegian Embassy, Scojo Foundation Incorporation, SIDA, Sight Savers, Stanford Medical School, Swiss Development Cooperation, ULG Northumbrain, UNICEF, United Way International, University of Calgary, University of Leeds, University of Manchester (UK), World Bank, World Food Programme, and World Health Organization.

RED received wide support and cooperation from all divisions of BRAC, particularly from the field staff and the people of Bangladesh without whose sincere support and patronage no field research could be conducted smoothly. RED also received useful comments, suggestions, and guidance from researchers, reviewers, and editors from within and outside the country, which helped improve the quality of research and research outputs. RED is indebted to BRAC management for its continued support.

EXECUTIVE SUMMARY

Tuberculosis (TB) is a global disease, which is responsible for 1.4 million deaths each year (WHO 2010). Bangladesh is the sixth highest TB-burden country in the world. TB treatment may be complicated when malnutrition also coexists in patients. TB has been found to coexist with malnutrition among patients at the beginning of treatment in both developed and developing countries (Zachariah *et al.* 2002, Onwubalili JK 1988, Kennedy *et al.* 1996, Harries *et al.* 1988). Nutrition supplementation can play an important role in improving the disease condition to reduce further morbidity and mortality. Some TB-burden countries have already started food supplementation programme for patients' healthy life (Farmer *et al.* 1991, Karyadi *et al.* 2002, Paton *et al.* 2004, Aye and Wyss 2009).

There is no nutrition intervention programme for patients in DOTS (Directly observed treatment, short course) approach to TB treatment under National TB Control Programme (NTP) of Bangladesh, where malnutrition is prevalent. Even, Bangladesh does not have much information about the nutritional situation of TB patients to formulate nutrition intervention. To fill-in this knowledge gap and help in informed design of a nutrition intervention for TB patients, this study measured the nutritional status (using Body Mass Index or BMI) of TB patients before, at two months, and after completion of TB treatment (DOTS) to study the changes during treatment and its relation with various socioeconomic and demographic factors including household food availability and consumption.

METHODS

About 1,110 TB patients were registered at 10 peri-urban DOTS clinics in Dhaka city from May 2009 to April 2010. Of them, 1,066 were enrolled for the study. We also included 910 healthy controls selected from non-family neighbours of the patients based on availability. A healthy control had no TB, diabetes, or any other disease including mental disorder, and was not currently pregnant or lactating. They were age and sex–matched with TB patients. The information of patients on age, sex, duration of symptoms, patient' types, school education, employment status, religion, marital status, and family size were collected. The nutrition indicators [weight (kg), height (cm.), and mid upper arm circumference (MUAC, cm.)] of both the groups were measured before staring treatment. Later, such information was taken from patients at two months and after completion of treatment. The BMI was calculated as body weight (kg) divided by height in meter square (BMI=wt (kg)/height m^2). BMI ≤ 18.5 kg/m^2 and MUAC <22.0 cm were taken as cut-off points for malnutrition. In-depth interviews with 40 TB patients were also conducted to explore the socioeconomic barriers that impeded patients in accessing adequate food during illness. In addition, food availability at household (food security) and patients' food consumption were assessed using a set of questionnaires (quantitative survey with 305 TB patients, sub-sample of 1,066 TB patients).

KEY FINDINGS

1. About two-thirds of the TB patients (67%) had low BMI (<18.5 kg/m^2) before starting treatment (DOTS), whereas, it was 23% in healthy control. The low BMI was more prevalent among those who earned less than Tk. 6,000 (71%), were illiterate (73%), males (73%), sputum-positive (74%), patients with chronic illness

(> 6 weeks) (75%), and were unmarried (77%). At the end of treatment, half of the patients (49.9%) had low BMI. Among them, 12% had severe malnutrition (BMI≤16kg/m^2).

2. The MUAC <22.0 cm was highest among patients before (42%), after two months (39%), and at the end of treatment (34%) compared to control group (9%, before treatment).
3. The TB patients did not have comprehensive knowledge about nutrition and TB. Poverty and loss of appetite were identified as major barriers in accessing adequate food. Further, the community had socio-cultural barriers (social isolation, lack of family support, sudden changes in food prices, etc.) that impeded accessing adequate food.
4. The majority of TB patients' households (49%) had occasional to chronic food deficit all the year round, and 39% of the households had to change both quality and quantity of food during crisis period (lean period, price hike, etc.)
5. Nearly half of the TB patients did not eat animal protein (45-49%) and micronutrients source of food such as fruits once a week (49%) and 60% of them never ate extra food (snacks) in between two meals.

CONCLUSION

Malnutrition among TB patients during treatment is a serious problem impeding rapid recovery and should be given due attention. We strongly suggest to include nutrition education and supplementation component in TB DOTS programme, and thereby, helping in speedy recovery and reducing the risk of mortality and morbidity among TB patients.

RECOMMENDATIONS

Based upon the findings, we recommend the following:

Nutrition surveillance for patients undergoing DOTS

Nutrition surveillance is required in DOTS to screen out TB patients with MUAC < 22cm and BMI <18.5 cm, and provision of special nutrition care (nutrition education and food supplementation) must be established until completion of treatment regimen.

Awareness campaign

A sustained national campaign to build awareness on the necessity of maintaining good nutrition during TB DOTS treatment is necessary for motivating the community. Education and motivation is needed so that family gives priority to the TB patient during household food allocation. Capacity building of the TB healthcare providers on the importance of nutrition in TB patients is necessary to guide patients properly regarding food to be taken.

Food programme

For less severe cases, various community-based options (e.g., community food bank from left-over food from the rich households, mobilizing the community to give some food by individual household each day, raising community resources to buy some protein-rich food, etc.) should be considered for providing some extra energy-dense food to the patient. The programme can provide cash or food for these malnourished TB patients from its own resources, if available.

INTRODUCTION

Over one-third of the global population are infected with *Mycobacterium tuberculosis* (WHO 2008) and it continues to be one of the major causes of death among adults, accounting for 1.4 million deaths each year worldwide (WHO 2010). TB is also a major public health problem in Bangladesh, which ranks sixth among the world's highest TB-burden countries, though a significant improvement has been achieved in controlling TB during the last few years (WHO 2008, Barua *et al.* 2008). To combat TB, the government of Bangladesh (GoB) in partnership with different non-government organizations (NGO) including BRAC has been implementing the National TB Control Programme (NTP) using DOTS strategy since 1993. BRAC has success story in controlling TB efficiently and achieved the targets in case detection and treatment success rate set by the World Health Organization (WHO) in 2005 (NTP 2010). However, BRAC assumes that the programme has another challenge in TB patients who often suffer from malnutrition. BRAC perceives that it would be difficult to control TB efficiently if malnutrition is not addressed properly.

TB coexists with malnutrition in both developed and developing countries (Zachariah *et al.* 2002, Onwubalili JK 1988, Kennedy *et al.* 1996, Harries *et al.* 1988). Malnutrition is an important risk factor for getting tuberculosis and for mortality (Pakasi *et al.* 2009, Zachariah *et al.* 2002). Thus, adequate nutrition is essential for normal health and functioning of all systems (Cegielski *et al.* 2004). TB accounts for more than 25% of avoidable adult deaths in developing countries due to micronutrient deficiency (Raviglione *et al.* 1995). Low concentrations of micronutrients are common in TB patients affecting the immune system (Karyadi *et al.* 2000). Deficiency of vitamin D and C in the body could re-infect the body again (Wilkinson *et al.* 2000, Rwangabwoba *et al.* 1998). Deficiency of zinc results in decreased phagocytosis and leads to a reduced number of circulating T cells (Karyadi *et al.* 2000). Such impairment of immune system could result in re-infection in the body. The deficiency of vitamin A impairs normal functioning of T and B lymphocytes, macrophage activity, and generation of antibody response (Semba 1998). Further, TB patients had significantly low body mass index (BMI), low protein, fat, and haemoglobin. Low BMI is commonly found in TB patients which could cause recurrence of TB (Schaible and Kaufmann 2007, Leyton and Camb 1946, Chan *et al*. 1996). Low level of fat is common among TB patients and is associated with mortality in miliary TB cases. So, there is no doubt that nutritional management is more crucial for TB patients.

Nutritional supplementation during TB treatment appeared to accelerate the beneficial therapeutic effect of chemotherapy and other nutritional indicators (Armojos *et al*. 2010, PrayGod *et al.* 2011). Food supplementation improves body weight and quality of life of TB patients (Jahnavi and Sudha 2010). Vitamin A and zinc supplementation improves the effect of TB medication and results in earlier sputum-smear conversion or more clearance of bacteria (Abu *et al.* 1995, Karyadi *et al.* 2002, Ramakrishan *et al.*1961). The improved outcome was indicated by the higher number of patients with sputum-negative for bacilli and significantly lower mean lesion area in the lungs (Karyadi *et al*. 2002). So, integration of nutrition interventions with TB Control Programme is increasing, especially in the countries with high burden of TB (Metcalfe 2004, Dador 2008, Pakasi *et al.* 2009).

Some countries started nutrition interventions either on pilot basis or incorporated nutrition interventions in TB control progrmme for effective treatment outcomes vis-a-vis improved nutritional status (Farmer *et al.* 1991, Karyadi *et al.* 2002, Paton *et al.* 2004). Still many countries with high TB burden cannot start nutrition programme. These may be lack of information about nutrition and lack of financial resources. The effective management of TB, therefore, requires detailed evaluation of nutritional status since this can help prevent or modify many complication of disease and also help in making projections of the interaction of nutritional status on the clinical course of the disease (Rosenberg 1998).

TB has been recognized. However, malnutrition in TB is neither addressed nor is the situation systematically assessed in Bangladesh to formulize nutrition interventions in national TB control programme. Being in lead, BRAC alone covers 283 sub-districts (62.8% of total 460) of the country and controls TB efficiently. Moreover, BRAC wants to focus more on nutritional management of TB patients. However, Bangladesh lacked information on TB and nutrition. BRAC Research and Evaluation Division (RED) initiated a study to explore nutritional status of TB patients in BRAC TB control programme areas and the barriers that the patients confront mostly in accessing adequate food during illness. To accomplish this, information is needed to help design programme intervention for improving nutritional situation of TB patients. Thus, the study addressed the nutritional indicators like weight, height, BMI, MUAC of TB patients before starting TB treatment and compared the situation with control group. Furthermore, this study explored the changes in nutritional status (BMI) in relation with socioeconomic factors in different periods of treatment (two and six months of treatment), and the barriers that patients mostly confront in accessing adequate food during the illness.

OBJECTIVES

GENERAL OBJECTIVE

This study aims to explore the level and determinants of under-nutrition among TB patients undergoing treatment (DOTS approach), follow the changes during the duration of treatment, and identify barriers that patients mostly face in accessing nutritious food during illness.

The specific objectives of the study were:

- To measure weight, height, and MUAC of TB patients at different time (before, at two months, and after completion of the treatment) in diagnosed TB patients and normally healthy controls (matched for age and sex)
- To explore the relationship of the nutritional status with varios socioeconomic and demographic factors,
- To explore the barriers (knowledge, socio-cultural, economical, household food availability) that impeded accessing adequate food, and
- To know the food consumption habit of patients during treatment.

MATERIALS AND METHOD

STUDY SETTINGS

The study was conducted at microscopy and DOTS clinics in Dhaka city during May 2009 to December 2010. Every microscopy and DOTS clinic has facility for examining sputum of TB suspects and it provides TB drugs at regular interval. All the clinics were under BRAC TB control programme (Table 1).

Table 1. Distribution of microscopy and DOTS clinic

Sl	Microscopy and DOTS clinic
1	Dakkhin Khan Microscopy and DOTS clinic
2	MBMC & H Microscopy and DOTS clinic
3	Mirpur Microscopy and DOTS clinic
4	Jagannathpur Microscopy and DOTS clinic
5	Badda Microscopy and DOTS clinic
6	Madertek Microscopy and DOTS clinic
7	Bhagolpur Microscopy and DOTS clinic
8	Kamrangirchar Microscopy and DOTS clinic
9	Shyampur Microscopy and DOTS clinic
10	Matuail Microscopy and DOTS clinic

TB CONTROL PROGRAMME OF BRAC

BRAC has infrastructures including health centre/office with medical doctors, and para-professionals who work for TB control programme. BRAC-trained female volunteer health workers known as *Shasthya Shebikas* (SS) are the nucleus of this programme. They work under direct supervision of *Shasthya Kormis* (paid worker), para-professionals and physicians. The uniqueness of BRAC approaches is that it manages TB cases at community level, instead of clinics. BRAC assigns a cluster of 250 neighbourhood households on average to each SS. Further, BRAC has DOTS clinics or sputum microscopy facilities over the BRAC TB control programme areas including peri-urban areas that operates for 6 days/week. A TB suspect can easily access these facilities for any help. Cases of TB were diagnosed in suspects through sputum-smear microscopy under DOTS strategy of National TB Control Programme (NTP). BRAC is implementing TB control programme in association of NTP in 42 districts including peri-urban Dhaka. The suspected TB patients (with history of cough > 3 weeks) directly visit these DOTS clinic or referred to by SSs for sputum examination. Three samples of sputum of each suspected case are examined under microscope. Those who found to have TB (sputum-positive) are registered and get treatment. Those who have no germ on sputum but have symptoms of TB, are asked for X-ray examinations at government facilities. If they found to have TB (sputum-negative), are also registered for treatment. In addition, extra-pulmonary TB cases (other than lung TB) are directly registered here for treatment. A laboratory technician is appointed for managing all activities in each sputum microscopy laboratory (rural areas) or microscopy and DOTS clinic (peri-urban areas).

In intensive phase (first two months of TB treatment), patients are supervised for direct observation of treatment by SSs under the supervision of DOTS clinics in peri-urbn areas. Before starting continuous phase (next four months of standard duration), the patients (except extra pulmonary TB) have to come again to DOTS clinic for sputum examination. This enables review of progress of treatment to be made. However, they again come to DOTS at the end of 5th and 6th months (or after completion) of treatment to explore the outcome of treatment. The treatment regimens and outcomes used throughout Bangladesh under DOTS strategy of NTP. Treatment is provided free of charge to all TB patients. However, patients who need X-ray, different tests, and different medicines need to pay. BRAC has been playing a critical role in association with NTP in achieving high detection and cure of TB patients.

STUDY POPULATION

The study included the adult TB patients (sputum-positive, sputum-negative, and extra-pulmonary types) aged >15 years who were newly diagnosed by sputum test/x-rays/clinical symptoms, etc. and were registered for treatment at 10 Microscopy and DOTS clinics of BRAC . The study included 1,110 new TB patients during the study period. Of them, 42 were excluded (3.9%) for different reasons. Thus, 1,066 patients (624 male and 444 female) provided information up to the end of treatment. On the other hand, 554 males and 356 females were included as healthy controls (comparison group). In the study, sputum-positive indicates presence of TB germ in sputum detected by microscope. The germ presents in lungs. Sputum-negative indicates absence of TB germ under microscope but TB germ occurs in lungs, and

extra-pulmonary indicates presence of TB germ in other organs of body and TB germ could not be detected by microscope.

SAMPLE AND SAMPLING

We applied three sampling methods in the study. For measuring the nutritional status, we included all the 10 Microscopy and DOTS clinics to capture all TB patients in Dhaka city. We included those TB patients who were registered at clinics from May 2009 to April 2010. We excluded the patients who had previous history of TB or took anti-TB treatment, were pregnant or currently lactating, had diabetic mellitus, and had any form of disease as confirmed by the doctors. A total of 1,110 were eligible for the study. Of them, 42 were not available for giving information. The reasons were: 17 did not continue the treatment, 14 were transferred, 6 died, 5 refused to provide information. Thus, we excluded 42 patients from the analysis. We had complete information of 1,066 patients. They provided information on age, sex, education, income, religion, marital status, TB types, duration of illness, employment status, and family size. The information on weight, height, and MUAC was taken from patients before starting treatment (BST), at two months (2MOT), and after completion of treatment (ACT). In the study, we also included healthy controls. Controls did not have history of TB in their life, no diabetes, and were not pregnant/in lactation conditions, and any form of disease including mental disorder. They were age- and sex-matched with TB patients (one for each TB case). They were selected from among the non-family neighbours of the patients. However, around 12% of controls did not agree to provide information or to participate. Thus, 910 healthy controls were available to provide information on weight, height, and MUAC once (at the initial period of the study).

Secondly, for exploring household food availability (food security) and barriers we have taken a sub-sample from 1,066 TB patients. Thus, 305 TB patients (155 male and 150 female) were randomly selected from 1,066 TB patients for obtaining information on food consumption and household food availability/security (Fig.3). In-depth interview was done on 40 out of 305 TB patients for obtaining information on knowledge and different socioeconomical barriers. For in-depth interview or qualitative survey (patients' awareness about nutrition and barriers), four patients (two male and two female) from each DOTS clinic were taken purposively.

SAMPLE SIZE CALCULATION

n=pq*1.96/d2 =0.5*0.5*1.96/0.0025=384

p=0.5

q=1.0-0.5=0.5

d=0..05

The whole population was known (<10,000 TB patients)

Ultimate sample was calculated using flowing formula,

$$\frac{n}{n/N+1}$$

=272

= 305 (after increasing)

DATA COLLECTION

A structured questionnaire was used to collect socioeconomic information. The laboratory technician obtained all information during the study period. They were given intensive training before starting treatment. Each of the TB patients and controls was measured for height (cm), body weight (kg) and MUAC (cm) before starting treatment (BST). Later, only TB patients were measured for weight, height, and MUAC at two months (2MOT) and after completion of treatment (ACT). The body weight was measured to the nearest 0.1 kg using a digital weighing scale with precision of 0.1 kg with minimal clothes and no shoes. The same instruments were used to take the measurements of all the patients and were calibrated each morning to ensure precision. The height of the patients was measured while standing erect without shoes by wooden height scale. Both height and weight were recorded to two decimal places. The MUAC was measured to the nearest 0.1 cm using a flexible plastic tape. All these measurement were taken by following the technique described by Weiner and Lourie (1981). BMI was calculated as body weight in kg divided by height in meter square (BMI= weight in Kg/height in meter^2).

During in-depth interview, two anthropologists took information - one conducted the interview and another took information. In addition, they used tape recorder to grasps all information. A checklist was developed for in-depth interview. A structured questionnaire for quantitative survey was developed for obtaining information on food availability at household level (food security) and food consumption of patients. Food security at the household level was assessed using a set of questionnaire that includes 10 questions developed for rural households in Bangladesh. The questions were adopted from BRAC/Cornell University study in Bangladesh (Frongillo 2003, Parveen 2009). There were three major dimensions of this assessment; theme 1: frequency of consumption of certain food items in the last week before interview, theme 2: recent food security status in terms of access to enough (quantity) food, access to quality (nutritious) food and dependency on food in the last month, and theme 3: year-round food security status, in terms of meal frequency in a day for most of the time in the last year, changes in food consumption during crisis period and perceived food sufficiency status in the last year before interview. Three-day recall method was applied to gather food consumption data. A checklist of food items was used to help respondents recall the food items consumed. The quantity of food consumed at household level was first estimated in household measures (cup, spoon, bowl, etc.). The enumerators then converted those measures into their raw weight in grams.

DATA ANALYSIS AND PROCESSING

The data were analyzed using SPSS version 16.0. The height and weight measurements were used to calculate BMI. The height, weight, MUAC and BMI of TB patients at different times were compared to healthy controls. F-test was made to explore the significance of difference. The change in BMI was then computed by subtracting BMI of different periods of treatment, and used to categorize the patients in two groups - BMI decreased and BMI increased. A BMI of 18.5-24.9 kg/m^2 was defined as normal, >25 kg/m^2 over-weight, and <18.5 kg/m^2 as malnourished (chronic energy deficient or CED). Different degrees of malnutrition were also defined as follows: mild malnutrition (CED I), BMI=17.0-18.4 kg/m2; moderate malnutrition (CED II), BMI=16.0-16.9 kg/m^2; severe malnutrition (CED III), BMI=<16kg/m^2 (Macallan 1999, James *et al*. 1998, WHO 1995) . Nutritional status was also evaluated following the standard cut-off point of MUAC (James *et al.* 1994). The flowing cut-off value was used: under-nutrition = MUAC<22.0 cm and normal = MUAC ≥22.0 cm. Chi-square

test was done to determine whether any socioeconomic factors were associated with malnutrition at different time of treatment.

In the case of qualitative survey, two researchers with anthropological background conducted the in-depth interview. They developed the matrix to capture the themes and sub-theme to check the validity. After developing matrix, content analysis was done. This survey addressed the knowledge of TB patients on nutrition, importance of nutritional care, barriers that they mostly confront in accessing adequate food.

While analyzing food consumption, per capita calorie consumption was derived by dividing the total consumption of three days. The food items were pooled into six groups. It was based on the six basic food groups such as cereals, pulse, vegetables, fruits, animal products, and oil (Jalal *et al.* 2009). Dietary diversity scores were used in the analysis based on food groups.

ETHICAL ISSUES

The study was reviewed and approved by Research and Evaluation Division (RED) of BRAC. The institutional ethics committee does not have to be consulted as no intervention is involved. All respondents were informed that their responses would remain anonymous, and verbal consent was obtained.

RESULTS

Two-thirds of TB patients (65%) was aged <35 years (Table 2). The mean ages of patients and healthy controls were 33.4 (±14.42) and 33.2 (± 13.95) years, respectively ($p>0.05$). Mostly, they were sputum-positive TB patients (69%), Muslim (96%), and married (72%). One-third of them had no school education. Most of the males (81%) were involved in earning during their illness. Majority of them (60%) were identified within six weeks of their illness.

Table 3 shows the mean and standard deviation of weight, height, MUAC and BMI of patients and control groups. The mean values of all the measurements of TB patients were lower compared to control group before starting treatment (weight 44.4 *vs* 51.3, MUAC 22.6 *vs* 24.9, BMI 17.8 *vs* 20.3). However, the mean values increased after completion of treatment but the values still were lower than control group (weight 47.4 *vs* 51.3, MUAC 23.3 *vs* 24.9, BMI 19.0 *vs* 20.3). Sex variation was also observed (Annex Table 10-11). Table 4 displays the value of 't' (obtained from t-test) with the level of significance in the anthropometric indicators (MUAC and BMI) between different periods of treatment. Both the anthropometric indicators were found to be statistically significant ($p<0.05$) between TB patients at different stages of treatment and the control groups.

Table 5 shows the distribution of BMI of TB patients. The proportion of low BMI (<18.5 kg/m^2) was higher in TB patients (67%) compared to healthy control (22.9%) before starting treatment. However, it was 58.9% and 49.9% in TB patients at two months and after treatment, still higher than healthy control groups (22.9%). Table 6 shows the distribution of MUAC of patients and control. Nearly half of the TB patients (42.2%) had MUAC <22 cm and it was the highest among the patients before starting

treatment followed by after two months (39%), and at the completion of treatment (34%) compared to control group initially (9%). Distribution of BMI and MUAC of both sexes is given in annex (Table 14-17).

Table 2. Socioeconomic profile of TB patients by sex (%)

	Male	Female	All	p value
Patient types				
Sputum positive	75.8	59.9	69.2	0.000
Sputum negative	11.4	12.2	11.7	
Extra-pulmonary	12.8	27.9	19.1	
Age				
≤35	57.2	74.7	64.5	0.000
>35	42.8	25.3	35.5	
School education				
Yes	63.9	66.2	64.9	0.443
No	36.1	33.8	35.1	
Duration of illness				
≤6 weeks	58.7	60.6	59.5	0.526
>6 weeks	41.3	39.4	40.5	
Employment status				
Working	81.4	36.0	62.5	0.000
Not working	18.6	64.0	37.5	
Household income				
<6000	41.2	45.5	43.0	0.161
≥ 6000	58.8	54.5	57.0	
Religion				
Muslim	97.1	94.1	95.9	
Non-muslim	2.9	5.9	4.1	0.016
Marital status				
Married	72.3	72.5	72.4	
Unmarried	26.6	20.3	24.0	0.000
Divorced/widow	1.1	7.2	3.7	
Immediate family size				
≤5	70.8	79.6	74.5	0.001
>5	29.2	20.4	25.5	
N	624	444	1068	

Table 3. Anthropometric information of TB patient (N=1066) and healthy control (N=910)

Time	Weight (kg), Mean ±SD			Height (cm), Mean ± SD			MUAC (cm), Mean ± SD			BMI (kg/m^2), Mean ± SD		
	Patient	Control	t-test*	Patient	Control	t-test	Patient	Control	t-test	Patient	Control	t-test
Before treatment	44.4 ± 8.8	51.3 ± 6.4	0.0001	157.9 ± 9.7	159. 0 ± 7.50	0.005	22.6 ± 3.4	24.9 ± 2.3	0.0001	17.8 ± 3.2	20.3 ± 2.5	0.0001
At two months	45.6 ± 8.2		0.0001	157.92 ± 9.6		0.005	22.8 ± 3.3		0.0001	18.3 ± 3.1		0.0001
After treatment	47.4 ± 8.3		0.0001	158.2 ± 9.6		0.005	23.3 ± 3.3		0.0001	19.0 ± 3.1		0.0001
F-test*	458.3				3.3		145.11			256.6		

t-test=between patient and control before treatment (baseline), between patient at two months of treatment and control of baseline, between patients at six months of treatment and control of baseline

Table 4. Value of 't' test with significance in anthropometric indicators of BMI and MUAC at different times

Subjects	t-value for MUAC*	t-value for BMI*
Control group and Before treatment	17.92	19.57
Control group and two months of treatment	15.01	16.01
Control group and after completion of treatment	11.45	10.24
Before treatment and two months of treatment	4.01	10.481
Before treatment and after completion of treatment	8.40	23.123
Two months of treatment and after completion	6.70	23.985

*t-value obtained from t-test: The p value is less than 0.05.

Table 5. Distribution of CED of TB patients and health control based on BMI in different treatment periods (%)

Patients	n	CED III	CED II	CED I	Total CED	Normal	Overweight
BMI (kg/m$^{2)}$		<16	16.0-16.9	17.0-18.4	<18.5	≥18.5	>25.0
Before treatment	1065	29.5	15.8	21.9	67.1	29.0	3.8
Two months of treatment	1065	20.0	16.6	22.3	58.9	37.2	3.9
After completion of treatment	1065	12.1	13.1	24.6	49.9	45.3	4.9
Control group	907	2.5	4.4	16.0	22.9	73.1	4.4

CED=Chronic Energy Deficiency

Table 6. Distribution of MUAC of TB patients and healthy control in different treatment periods (MUAC) (%)

Patients	n	MUAC <22.0 cm	MUAC ≥ 22.0 cm
Before treatment	1066	42.2	57.6
Two months of treatment	1066	38.9	61.1
After completion of treatment	1066	33.5	66.5
Control group	910	8.6	91.4

MUAC=Mid Upper Arm Circumference

Table 7 shows that malnutrition (BMI <18.5 kg/m2) was higher among sputum-positive patients (75%), male TB patients (73%), patients with longer duration of TB symptoms (> 6 weeks) (75%), worker (72%), illiterate (73%), households had low income (<Tk. 6,000 per month) (71%), and unmarried TB patients (77%) before starting treatment and such factors are strongly associated with malnutrition or low BMI (significance at 1% level) ($p<0.001$). However, a great majority of TB patients (77.3%) improved BMI at the end of two months. Those who improved (824 TB patients), 67.7% had an increase of 0.01-0.99 kg/m^2, 24.7% increased 1.01-1.99 kg/m^2, 4.1% increased 2.0-2.99 kg/m^2, and 3.5% increased >3 kg/m^2 (data not shown). Change in BMI was significantly associated with sputum-positive TB patients and workers ($p<0.05$). However, after completion of treatment, 90% improved BMI (kg/m^2). But half of the TB patients (49.9%) still had low BMI (<18.5 kg/m^2). However, the proportion of severe malnutrition decreased from 29.5% to 12.1% at the end of treatment (Table 5).

Table 7. Status of malnutrition and sociodemographic characteristics and changes in BMI of tuberculosis patients at different time period (row %)

Variables	Before starting			Two months				After completing treatment			
	Normal BMI	Mal-nutrition	*P -Value	Increase in BMI	Decrease in BMI	No change	*P -Value	Increase in BMI	Decrease in BMI	No change	*P -Value
All patients	32.9	67.1	0.000	77.3	15.6	7.1		90.2	8.2	1.7	
Patient types											
Positive	25.1	74.9	0.0001	79.6	13.9	6.5	0.005	91.3	6.8	1.9	0.004
Negative	32.3	67.7		78.2	12.1	9.7		93.5	5.6	0.8	
Extra pulmonary	61.6	38.4		68.6	23.5	7.8		83.7	14.8	1.5	
Sex											
Male	27.3	72.7	0.0001	78.8	13.6	7.5	0.109	91.0	7.5	1.4	0.497
Female	40.6	59.4		75.2	18.3	6.5		88.9	9.0	2.0	
Age in years											
≤35	32.6	67.4	0.786	77.8	16.1	6.1	0.192	90.8	7.6	1.6	0.580
>35	33.4	66.6		76.5	14.6	9.0		88.9	9.3	1.9	
Duration of illness											
6 weeks	28.4	61.6	0.001	76.4	16.9	6.8	0.344	89.7	9.0	1.3	0.219
>6 weeks	24.8	75.2		78.7	13.7	7.6		90.7	6.9	2.3	
Employment status											
Worker	27.6	72.4	0.0001	79.7	12.9	7.4	0.009	92.2	6.5	1.4	0.015
Not worker	41.6	58.4		73.3	20.0	6.7		86.8	11.0	2.2	
School education											
Yes	36.1	63.9	0.002	77.3	15.6	7.1	0.996	90.3	8.5	1.2	0.161
No	26.8	73.2		77.3	15.5	7.2		89.8	7.5	2.7	
Family size											
≤5 members	33.7	66.3	0.533	76.4	16.6	7.0	0.340	91.0	7.4	1.7	0.211
>5 members	31.6	68.4		80.4	13.0	6.7		87.4	10.7	1.9	
Household income per month (Tk)											
<6000	28.6	71.4	0.006	78.0	15.9	6.1	0.524	90.6	8.1	1.3	0.696
≥ 6000	36.1	63.9		76.8	15.3	7.9		89.8	8.2	2.0	

(Table 7 continued...)

(... continued Table 7)

Variables	Before starting			Two months				After completing treatment			
	Normal BMI	Mal-nutrition	*P -Value	Increase in BMI	Decrease in BMI	No change	*P -Value	Increase in BMI	Decrease in BMI	No change	*P -Value
Religion											
Muslim	32.6	67.4	0.405	77.1	15.9	6.9	0.171	89.9	8.4	1.7	0.355
Non-muslim	38.6	61.4		81.8	6.8	11.4		95.5	2.3	2.3	
Marital status											
Married	36.2	63.8	0.001	76.8	15.9	7.3	0.861	89.8	8.5	1.7	0.913
Unmarried	23.4	76.6		79.3	14.5	6.2		91.0	7.4	1.6	
Divorced/widow	28.2	71.8		74.4	15.4	10.3		92.1	5.3	2.6	

Normal BMI=≥18.5 kg/m^2) and Malnutrition (BMI <18.5 kg/m^2)*chi-square

KNOWLEDGE ABOUT NUTRITION AND NUTRITION CARE

Majority of the TB patients did not have correct knowledge on nutrition. The mostly described meaning of nutrition is the food which gives energy in the body. Majority of the patients reported three types of foods such as animal protein (milk, meat, egg and fish), sweet fruits and leafy vegetables that are essential for TB patients. They perceived that these foods had more energy. A female TB patient reported, “I always say if you want to get good health, you must take green leafy vegetables.” A male patient reported, “Milk, meat, and fish have much energy. This energy is required to fight against TB.” The study also explored that almost all patients could not mention about the clinical signs and symptoms of malnutrition in patients. They were not aware of essential micro-nutrients, and could not mention the names of micro-nutrients (except vitamin A) and quantity of calorie requirements for TB patients in a day for healthy life.

All the study respondents reported that they would require adequate nutritional care for healthy life. When they were asked to describe the meaning of adequate nutritional care, the most replied that one should have taken meat, milk, fish, apple, grapes, banana, orange and leafy vegetables frequently during illness. Further, they reported that nutritional care was essential for improving the weakness, reducing the side effects of TB drugs in the body, and recovering the illness quickly, and making body fit for work. One male patient reported, “I need milk, meat, apple, vegetables in my meal every day. I take powerful medicine as treatment of TB. It makes my body so weak.”

BARRIERS IN ACCESSING NUTRITION CARE

Lists of barriers were cited by respondents that hampered TB patients in accessing adequate food. There are described below:

Economic barrier

Financial crisis was reported as a main barrier of TB patients in accessing adequate nutritional care. One male patient reported, “I was the main income earner. During the last few months I could not work due to my illness. We often have to fast. Is it possible for me to have more food when other family members are on starvation? Furthermore, sudden increase in food price often affected consumption of food by patients. One female TB patient stated, “I need to take milk every day. Last week, the price of one liter of milk has changed (went up), so that I could not buy milk for me and could not drink milk. Even, I could not buy eggs and vegetables due to same reason.”

Social barrier

We found that social isolation during illness affected food consumption of patients. This isolation mainly affected the female patients. A female patient reported, “My family members asked me to sleep and to take food separately. No one comes to me and talks to me while taking food. My sons and my husband become afraid of my illness. They do not touch my food, my plates, my bed, etc. Often I lose my interests in taking food and I want to die.”

Some patients reported about food taboos existed in their community that acted as barrier in consuming some nutritious foods. Duck, Hilsa fish, sour fruits, beef, banana, eggs, and milk were prohibited for TB patients during illness. They reported that these foods could have aggravated the diseases. A male patient reported, “You

know, banana is not a good food for me. As I eat banana regularly, thus, my cough is not cured. My mother also told me that banana is a cold food, and it aggravates my disease."

We also found that TB impacted on marital status, ultimately it affected on food consumption. One female patient stated, "When I got TB, my husband started scalding me, even for last 10 days he did not talk to me. I understand he avoids me. My home does not have enough food. I need food to get energy, I ask my husband to buy some fruits and milk for me, he does not listen to me. Moreover, I was told to go to my parents' house. I stopped taking food as I want to die."

Furthermore, majority of female TB patients had to share food (the foods that were bought from outside) with other members of family that affected on adequate consumption. One female reported, "When my husband brings food from outside for me, I have to share it with my mother-in-law and sister-in-law. My mother–in-law starts scalding me if I do not share food with her."

Lack of family support or negative attitudes towards TB patients hampered TB patients in accessing adequate nutritional care. One female stated, "My mother-in law cooks food at home. Often, she does not provide me with sufficient food. She does not like me after my illness. Yesterday, I was so hungry, and requested her to provide me with adequate food. She scalded me a lot."

Illness barrier

Maximum male and female respondents reported that their illness affected consumption of sufficient food. They mainly reported about loss of appetite. One male patient stated, "TB germ destroyed my stomach, thus, I lost my appetite. I started taking medicines. The medicine will kill the germ in my stomach. Then I will start taking more food." One female patient stated, "I have been suffering from cough and fever for three months. I am so weak that often I could not walk and move. Even I could not go to kitchen to make my food. This morning, I could not make my breakfast and did not have it." One female patient reported, "People told me to have milk, meat, and eggs frequently, but I got pain (gas) in my abdomen while taking them." One male patient reported, "When I take eggs, small fish, vegetables, and fruits, they caused itching in my skin. I stopped taking those." They further added that severe cough along with vomiting, mental impairment hampered taking food frequently during illness.

Inadequate knowledge of providers

We also found that improper recommendation of informal doctors (village doctors, drug sellers, spiritual healers, etc.) regarding food intake by TB patients misguided patients in taking sufficient foods (reported by some male patients). One male patient reported, "I consulted a village doctor about nutritious food to recover my illness quickly. He often says to have *Bashuk* leaves. If I take it, I lose my appetite and cannot take my daily food. I am tired of taking of *Bashuk* leaves and day by day I became weaker." Another male patient stated, "My doctor told me to take pigeon meat, apples, and grapes everyday. I took apples and grapes three times a day but my health condition did not change. Later, I went to a drug seller. He said to have *Bashuk* leaves only as main food. I started taking."

Geographical barrier

Geographical distance was identified as a barrier for patients (reported by some female respondents). One female stated, “My house is far from the market. Whenever I want to take some fruits for my illness, I need to go to market. But I cannot have fruits frequently as I am too weak to walk.”

Overcoming the barriers

We found that majority of TB patients did not take initiatives to improve their nutritional situation due to different reasons - financial crisis being the main reason. However, some had taken initiatives in different ways. Young male patients often bought food (mainly snacks and fruits) from shops. A male patient reported, “When I go to market place, I often buy apple, orange, cakes, etc. I understand these foods could fight against TB and recover my illness quickly. Thus, I borrow money from my relatives to spend for buying foods.” One female patient reported, “My mother-in-law cooks food and supervises the kitchen. I do not have control on food at my home. I go to kitchen to have food hidden when she is sleeping.” The situation was critical for older patients. Some parents promised their children to give them properties (lands), savings, etc. in lieu of providing them with sufficient food. One old male patient reported, “I have TB, I need more food for improving my weakness. I do not earn. I have to stay with my son. My son does not look after me sincerely. I have to fast often. He pushed me to give him my lands; otherwise he will not provide me with food.” One female patient reported, “Everyday early morning I go outside for collecting stale rice from my neighbour. The stale rice has foul smell. I could not eat directly. I dry it under the sun light. Then fry it with oil. My son does not give me food.”

PATIENTS’ SUGGESTIONS ON NUTRITIONAL CARE

Community supports

Majority of the TB patients focused on community support in terms of creating community fund and food bank, building nutrition awareness, and giving emotional support to improve their nutritional status. One male patient stated, “Household members or neighbours can create a temporary fund for TB patients to buy sufficient amount of food during his illness.” One female patient reported, “Community members could develop a food bank with their leftover foods from households or restaurants. Someone can collect the food from households and restaurants and give it to patients.” They also reported that fish/vegetable seller could provide patients with unsold fish/vegetables at low prices.” One male patient reported, “Doctors could make aware or motivate community people about adequate nutrition and importance of nutritional care during illness, and could inform about appropriate nutritious food at low prices.”

Community programmes

Majority of the TB patients perceived that community-based food supplementary programmes of NGOs could have supported patients for improving nutritional situation. One male TB patient stated, “BRAC is working to help poor people, I heard it. BRAC could establish food shops or centers for TB patients in our community. They could provide *Khichuri, ruti, muri, etc.* to patients during their illness at free of cost or at low price. Even, BRAC could motivate household members, and provide technical and financial assistance to TB patients for making home garden to produce seasonal vegetables and fruits for patients. So, patients do not need to buy food from outside.”

Foods for work programme and microcredit programme were also reported by the respondents.

FOOD SECURITY OF HOUSEHOLDS OF TB PATIENTS

Food security status assessed in terms of frequency of food intake in the last 7 days (Table 8), access to enough food (quantity), dependency on food in the last month, changes in food consumption during crisis period, and overall food sufficiency status as perceived by the respondents. Around 12% (7.5%+4.6%) of the respondents reported that their households could not afford at least two meals/day in the last week. One-fifth of the TB patients' households (14.2%+5.0%) had to eat only rice once or more times a week. However, around 14% (9.9%+3.9%) had to borrow rice/wheat once or more times a week from others to make meal at households in the last month. Regarding food security status in the last year, we found that 39% of the households had to change both quality and quantity of food during crisis period (lean period, price hike, etc). Forty nine percent of the households (30.7%+17.8%) reported that their households had occasional to always food deficit in the last year. One-third of the patients' households (32%) purchased rice/wheat 3 times or more a week. Members of the one-third of the households were able to eat fish/meat 3-4 times a week. Members of about 60% of the households never took snacks between two meals.

Table 8. Food consumption and food security status of households reported by sex (%)

Item	Sex		All	p value
	Male	Female		
Weekly food consumption by households				
Purchase rice/wheat at households				
Produce own	1.3	2.0	1.7	0.616
1-3 times/month	35.1	39.6	37.3	
1-2 times /week	27.3	30.2	28.7	
≥3 times/week	36.4	28.1	32.3	
Fish/meat consumption				
Every day	9.7	9.4	9.6	
3-4 times/week	33.0	29.0	31.0	0.195
1-2 times/week	40.3	51.0	45.5	
1-2 times in month	16.9	10.0	13.6	
Snacks				
Everyday	5.8	8.7	7.3	0.882
3-4 times/week	14.9	13.4	14.2	
1-2 times/week	18.2	19.5	18.8	
not all or once a month	61.1	58.4	59.8	

(Table 8 continued...)

(... continued Table 8)

Item	Sex		All	p value
	Male	Female		
Monthly food security status of household				
Meal frequency for most of the time in last month				
Could afford two meals/day	67.1	76.0	71.5	
Could not afford two meals 1-2 times/month	18.7	14.0	16.4	0.254
Could not afford two meals 1-2 times /week	9.0	6.0	7.5	
Could not afford two meals ≥3 times /week	5.1	4.0	4.6	
Access to enough (quantity) food in the last month				
Not once had to eat only rice	59.1	61.1	60.1	0.218
Had to eat only rice 1-3 times/month	24.0	17.4	20.8	
Had to eat only rice 1-2 times /week	12.3	16.1	14.2	
Had to eat only rice ≥3 times/week	4.5	5.4	5.0	
Dependency on food				
Not once had to borrow rice/wheat	56.0	66.0	61.0	0.176
Had to borrow rice/wheat 1-3 times/month	29.9	20.8	25.4	
Had to borrow rice/wheat 1-2 times /week	11.7	8.1	9.9	
Had to borrow rice/wheat ≥3 times/week	2.5	5.4	3.9	
Year round food security status of household				
Changes in food consumption during crisis period				
No change	61.0	61.1	61.1	0.081
Change	39.0	38.9	38.9	
Food sufficiency in the last year				
Surplus	18.2	13.4	15.8	
Neither surplus nor deficit	34.4	36.9	35.6	0.641
Occasional deficit	31.2	30.2	30.7	
Always deficit	16.2	19.5	17.8	
N	155	149	304	

DAILY FOOD CONSUMPTION BY TB PATIENTS

Majority of the patients could not eat egg (47.4%), milk (48.8 %), meat (44.7%), big fish (49%), and fruits (49.3) once a week (Table 9). Gender difference was not observed widely. The male patients consumed more food (549.08 g) compared to female (482.28 g) (Table 18). About half of the consumed food was cereal-based. The consumption of cereals, pulse, animal protein, fruits, and oil differed by sex. A great majority of male and female (50%) TB patients consumed 5 types of food in the last three days (Table 19). One-third (36%) consumed 6 types.

Table 9. Food consumption status in a week by sex (%)

	Sex			
	Male	Female	All	p valus
Egg				
Could eat ≥ 3 times/week	16.1	24.2	20.1	
Could eat only 1-2 times/week	34.2	30.9	32.6	0.217
Could not eat once/week	49.7	45.0	47.4	
Milk				
Could eat ≥ 3 times/week	29.0	28.4	28.7	0.986
Could eat only 1-2 times/week	22.6	22.3	22.4	
Could not eat once/week	48.4	49.3	48.8	
Meat				
Could eat ≥ 3 times/week	5.2	4.0	4.6	
Could eat only 1-2 times/week	52.3	49.0	50.7	0.704
Could not eat once/week	42.6	47.0	44.7	
Fish (Big)				
Could eat ≥ 3 times/week	13.5	12.1	12.8	0.348
Could eat only 1-2 times/week	34.2	42.3	38.2	
Could not eat once/week	52.3	45.6	49.0	
Fish (Small)				
Could eat ≥ 3 times/week	27.1	26.8	27.0	0.951
Could eat only 1-2 times/week	54.2	53.0	53.6	
Could not eat once/week	18.7	20.1	19.4	
Green leafy vegetables				
Could eat ≥ 3 times/week	50.3	47.0	48.7	
Could eat only 1-2 times/week	39.4	42.3	40.8	0.841
Could not eat once/week	10.3	10.7	105	
Fruits				
Could eat ≥ 3 times/week	12.3	12.8	12.5	
Could eat only 1-2 times/week	35.5	40.9	38.2	0.562
Could not eat once/week	52.3	46.3	49.3	
n	155	149	304	

DISCUSSION

Simultaneous existence of TB and malnutrition in patients hampers their speedy recovery during treatment. So, due importance should be given in the management of TB patients. Knowledge gaps exist in this regard in Bangladesh. This study tried to explore the level of malnutrition problem in Bangladeshi TB patients, its association with socioeconomic and demographic factors, and also explore barriers to get better nutrition during treatment. Findings reveal that many TB patients were malnourished compared to healthy controls before treatment. The patients from all socioeconomic strata improved their BMI at different time during treatment, but a great majority remained malnourished (BMI <18.5 kg/m^2) after treatment. The underlying reasons and their implications for TB DOTS programme are discussed.

We found that marked impairment of nutritional status (BMI<18.5) of TB patients exists before starting treatment. This is consistent with the findings from both developed and under-developed countries (Zachariah *et al.* 2002, Onwubalili 1988, Kennedy *et al.* 1996, van Lettow *et al.* 2004, Harries *et al.* 1988, Miller *et al.* 2000, Metcalfe 2004). However, the situation is worse if compared to low-income countries such as Ghana and Malawi (Dodor 2008, Zachariah *et al*. 2002). This draws our attention to take measures to improve nutrition of the TB patients during DOTS treatment, both for sustained recovery and reduce the risk of re-infection. This is especially true for male patients, who were found more malnourished than the females, and who continued to work hard despite their illness.

The TB patients started improving their BMI after initiation of treatment which continued to the end of treatment, but many of them remained malnourished (BMI <18.5 Kg/m2). Improvement of nutritional status with treatment was shown in other studies (Onwubalili *et al.* 1988, Kennedy *et al.* 1996, Harries *et al.* 1988). After initiation of treatment, maybe, the appetite increases and patients gain weight. However, the improvement of nutritional situation was not up to the expected level when compared with healthy controls. To achieve the expected level of nutrition, measures for long-term nutrition intervention in TB DOTS programme should be considered. As an option, weekly ration may be introduced for poor TB patients in TB control programme. The ration may include rice, lentils, oil, sugar, etc. and supplemented by nutrition education.

Although the relationship between malnutrition and TB has been recognized long before, we focused on the influence of socioeconomic factors on BMI. We found that poor and illiterate patients were more nutritionally vulnerable. It is obvious that poverty could prevent accessing adequate food; moreover, illiterates may be lacking adequate knowledge on nutrition. However, male patients, and patients with long history of illness were strongly associated with malnutrition. The programme may think of providing nutrition supplementation to this group urgently.

Nutritional knowledge is essential, especially for better management of patients' nutrition (Wardle *et al.* 2000). The TB patients under study lacked knowledge on nutrition which is a common phenomenon globally, Bangladesh is not an exception (Heaney *et al.* 2011, Alam *et al.* 2010, Choudhury and Jalal 2009). Thus, educating patients and their family members/care-givers on nutritional requirements of TB patients is essential and programme need to start thinking on this issue. It is

challenging because despite awareness and knowledge, poverty impedes the application of knowledge in real life situations (Chowdhury and Jalal 2009). Thus, nutrition education alone will not be sufficient in poverty situations including food price-hike situations (Sulaiman *et al*. 2009). Prioritizing the need of TB patients while allocating food in the household should be emphasized in nutrition education.

CONCLUSION

Malnutrition is a serious problem among TB patients in peri-urban areas of Dhaka city. Maintenance of good nutrition is essential for rapid and sustained recovery during DOTS regimen. BRAC programme needs to pay special attention to this and address it with innovative interventions such as nutrition education and support for nutrition supplementation during treatment.

REFERENCES

Abul HT, Abul AI, al Athary EA, Behbehani AE, Khadadah ME, Dashti HM (1995). Interleukin-1 alpha (IL-1 alpha) production by alveolar macrophages in patients with acute lung diseases: the influence of zinc supplementation. *Molecular and Cellular Biochemistry* 146:39–45.

Alam N, Roy SK, Ahmed T, Ahmed ASM (2010). Nutritional status, dietary intake, and relevant knowledge of adolescent girls in rural Bangladesh. *Journal of Health, Population and Nutrition* 28(1):86-94.

Armojos RX, Weigel MM, Chacon R, Flores L, Campos A (2010). Adjunctive micronutrient supplementation for pulmonary tuberculosis. *Salud Publica de Mexico* 52 (3):185-9.

Cegielski JP and McMurry DN (2004). The relationship between malnutrition and tuberculosis: evidence from studies in human and experimental animal. *International Journal of Tuberculosis & Lung Disease* 8(3):286-98.

Choudhury N and Jalal CSB (2009). Maternal nutritional knowledge and child nutritional status. *In:* Pathways out of extreme poverty: findings from round I survey of CFPR phase II. Dhaka: BRAC.

Dodor EA (2008). Evaluation of nutritional status of new tuberculosis patients at the effia-Nkwanta regional hospital. *Ghana medical Journal* 42(1):22-7.

Farmer P, Robin S, Ramilus L ST, Kim JY (1991). Tuberculosis, poverty, and compliances: lessons from rural Haiti. *Seminars in Respiratory Infections* 6(4):254-60.

Frongillo EA, Chowdhuary N, Ekstrom EC, Naved RT (2003). Understanding the experience of household food insecurity in rural Bangladesh leads to a measure different from that used in other countries. *Journal of Nutrition* 133:4158-62.

Heaney S, O'Connor H, Micheal S, Gifford J, Naughton G (2011). Nutrition knowledge in athletes: a systematic review. *International Journal of Sports Nutrition and Excercise Metabolism* 21(3) :248-61.

Harries AD, Nkoma WA, Thompson PJ, Nyangulu DS, Wirima JJ (1988). Nutritional status in Malawian patients with pulmonary tuberculosis and response to chemotherapy. *European Journal of Clinical Nutrition* 42:445-50.

Islam QS, Karim F, Islam MA, Salim AH (2009). Barriers to accessing tuberculosis care through the lens of the informal healthcare providers in rural Bangladesh*. In:* Karim F (Editor). Socioeconomic divides in tuberculosis control: study of smear-positive TB prevalence, care seeking behaviour and role of informal healthcare providers. Dhaka: BRAC.

Jalal CSB, Choudhury N, Sulaiman M (2009). Food consumption pattern and dietary diversity. *In:* Findings from round I survey of CFPR phase II. Dhaka: BRAC

Jahnavi G and Sudha CH (2010). Randomised controlled trial of food supplements in patients with newly diagnosed tuberculosis and wasting. *Singapore Medical Journal* 51(12):957-62.

James WPT, Ferro Luzzi A, Waterlow JC (1988). Definition of chronic energy deficiency in adults*. European Journal of Clinical Nutrition* 42:969–98.

James WP, Mascie-Taylor GC, Norgan NG, Bistrian BR, Shetty PS, Ferro-Luzzi A (1994). The value of arm circumference measurements in assessing chronic energy deficiency in third world adults. *European Journal of Clinical Nutrition* 48:883–94.

Karyadi West CE, Schultin RW, Nelwan RHH, Gross R, Amin Z, Dolmans WMV *et al.* (2002). 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. *American Journal of Clinical Nutrition* 75:720-7.

Kennedy N, Ramsay A, Uiso L, Gutmann J, Ngowi FI, Gillespie SH (1996). Nutritional status and weight gain in patients with pulmonary tuberculosis in Tanzania. *Transactions of the royal society of tropical Medicine & Hygiene* 90:162-6.

Karyadi E, Schultink W, Nelwan RHH, Gross R, Amin Z, Dolmans WMV, vander Meer JWM, Hautvast JGAJ and West CE (2000). Poor micronutrient status of active pulmonary tuberculosis patients in Indonesia. *Journal of Nutrition* 130:2953-58.

Leyton GB and Camb MA (1946). Effects of slow starvation. *Lancet* 1946; 20: 73–9

Macallan DC (1999). Malnutrition in tuberculosis. *Diagnostic Microbiology & infectious Disease* 34:153-7.

Marrero DG, Kraft SK, Mayfield J, Wheeler ML, Fineberg N (2000). Nutrition management of type 2 diabetes by primary care physicians. *Journal of General Internal Medicine* 15:818-21

Metcalfe N (2004). A study of tuberculosis, malnutrition and gender in Sri Lanka. *Transactions of the Royal Society of Tropical Medicine & Hygiene* 99:115-9.

Miller LG, *et al.* (2000). A population-based survey of tuberculosis symptoms: how atypical are atypical presentations? *Clinical Infectious Diseases* 30:293-9.

Onwubalili JK (1988). Malnutrition among tuberculosis patients in Harrow, England. European Journal of clinical nutrition. *European Journal of Clinical Nutrition* 42(4):363-6.

Pakasi TA, Karyadi E, Dolmans WM, van der Meer JW, van der Velden K (2009). Malnutrition and socio-demographic factors associated with pulmonary tuberculosis in Timor and Rote Islands, Indonesia. *International Journal of tuberculosis and Lung Disease* 13(6):755-9.

Paton NI, Castello-Branco LRR, Jennings G et al. (1999). Impact of tuberculosis on the body composition of HIV-infected men in Brazil. *Journal of Acquired Immune Deficiency Syndromes* 20:265-71.

Paton NI, Ng YM, Chee CBE, Persuad C, Jackson AA (2003). The effects of tuberculosis and HIV infection on whole body protein metabolism during feeding measured by the glycine method. *The American Journal of Clinical Nutrition* 78:319-25.

Paton NI, Chua Y-K, Earnest A, Chee CBE (2004). Randomized controlled trial of nutritional supplementation in patients with newly diagnosed tuberculosis and wasting. *American Journal of Clinical Nutrition* 80:460-5.

Perveen M (2009). Food Security and Nutritional Status. *In*: Pathways out of Extreme Poverty. Findings from round I survey of CFPR phase II. BRAC: Dhaka.

PrayGod G, Range N, Faurholt-Jepsen D, Jeremiah K, Faurholt-Jepsen M, Aabye MG, Jensen L, Jensen AV, Grewal HM, Magnussen P, Changalucha J, Andersen AB, Friis H (2011). Daily multi-micronutrient supplementation during tuberculosis treatment increases wiight and grip strength among HIV-uninfected but not HIV-infected patients in Mwanza, Tanzania. *Journal of Nutrition* 141(4):685-91.

Ramakrishan CV, Rajendran K, Jacob PG, Fox W, Radhakrishana S(1961). 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 WHO* 25:339–59.

Raviglione MC, Snider DE Jr, Kochi A (1995). Global epidemiology of tuberculosis morbidity and mortality of a world wide epidemic. *JAMA: the Journal of the American Medical Association* 273:220-6.

Rosenberg IH (1998). Nutrition and nutritional requirement. *In:* Isselbacher J, Braunwald E, J.D. W, Martin JB, Fauci AS, Kaper DN, (Editors). Principal and Practice of Medicine. 13th edi. UAS:Harrison's, 1998.

Rwangabwoba JM, Fischman H, Semba RD (1998). Serum vitamin A levels during tuberculosis and human immunodeficiency virus infection. *International Journal of tuberculosis and Lung Disease* 2:771–3.

Schaible UE, Kaufmann SHE (2007). Malnutrition and infection: complex mechanisms and global impacts. *Public library of Science Medicine* 4(5): 806-12.

Semba RD (1998). The role of vitamin A and related retinoids in immune function. *Nutrition reviews* 56:S38-48

Sulaiman M, Parvin M, Das NC (2009). Impact of the food price hike on nutritional status of women and children. Dhaka: BRAC. (Research monograph series no.38)

USAID (2006). Understanding nutrition data and the causes of malnutrition in Niger. A special report by the Femine early Warning System Network (FEWS NET). June 2006.

Van Lettow M, *et al.* (2004). Micronutrient malnutrition and wasting in adults with pulmonary tuberculosis with and without HIV co-infection in Malawi. *BMC Infectious Diseases* 4(61):doi:10.1186/1471-2334-4-61

Wardle J, Permenter K, Waller J (2000). Nutrition knowledge and food intake. *Appetite* 34(3):269-75.

Weiner JS and Lourie JA (1981). Practical human biology. London: Academic Press.

Wilkinson RJ, Liewalyn M, Toossi Z, Patel P, Pasvol G, Lalvani A (2000). Influence of vitamin D deficiency and vitamin D receptor polymorphisms on tuberculosis among Gujarati Asians in West London: a case control study. *Lancet* 355:618–21.

WHO (1995). Physical status: the use and interpretation of anthropometry. Technical report series no 854. World Health Organization, Geneva.

WHO (2008). WHO report 2008. Global tuberculosis control, surveillance, planning, financing. WHO/HTM?TB/2008.393. Geneva, Switzerland: WHO. HO/HTM?TB/publications/global_report/2008.

World Health Organization (2010).WHO report 2010.

Zachariah R, Spielmann MP, Harries AD, Salaponi FML (2002). Moderate to severe malnutrition in patients with tuberculosis is a risk factor associated with early death. *Transactions of the royal society of tropical medicine & hygiene* 96:291-4.

ANNEX

Table 10. Anthropometric information of male TB patient and health control

Patients	n	Weight (kg) Mean ±SD	Height (cm) Mean ± SD	MUAC Mean ± SD	BMI (kg/m^2) Mean ± SD
BST	624	46.4 ±8.53	162.5±7.62	22.8±2.99	17.5±3.10
2 MOT	624	47.7±7.84	162.4±8.23	23.1±3.15	18.0±2.84
ACT	624	49.5±7.84	162.5±8.40	23.5±3.14	18.7±2.84
CG	553	53.4 ±6.02	162.9±6.01	25.1±2.25	20.15±2.39

Table 11. Anthropometric information of female TB patient and health control

Patients	n	Weight (kg) Mean ±SD	Height (cm) Mean ± SD	MUAC Mean ± SD	BMI (kg/m^2) Mean ± SD
BST	443	41.6 ±8.42	151.4±8.6	22.2±3.50	18.1±3.50
2 MOT	443	42.8±8.10	151.6±7.5	22.5±3.42	18.7±3.43
ACT	443	44.6±8.01	151.9±7.4	22.9±3.41	19.5±3.40
CG	356	48.1±5.6	152.9±5.3	24.5±2.23	20.6±2.7

Table 12. Value of t- test with significance in anthropometric indicators of chronic energy deficiency between different groups of male patients

Subjects	MUAC	BMI
CG & BST	15.42	16.36
CG & 2MOT	11.9	13.8
CG & ACT	8.81	9.2
BST & 2 MOT	3.6	7.10
BST & ACT	7.18	15.9
2MOT & ACT	5.1	15.8

BMI=Body Mass Index

Table 13. Value of t- test with significance in anthropometric indicators of chronic energy deficiency between different groups of female patients

Subjects	MUAC	BMI
CG & BST	9.34	11.41
CG & 2MOT	9.44	8.99
CG & ACT	3.2	5.4
BST & 2 MOT	2.007	8.3
BST & ACT	4.6	17.5
2MOT & ACT	4.4	19.9

Table 14. Distribution of male patients according to nutritional status based on BMI (%)

Subject	n	CEDIII	CEDII	CEDI	Total CED	Normal	Overweight
BST	622	30.9	17.2	24.6	72.7	23.8	3.5
2 MOT	623	20.4	18.3	24.1	62.8	34.3	2.9
ACT	623	11.9	14.1	28.4	54.4	41.9	3.7
CG	551	2.4	4.7	17.8	24.9	71.7	3.4

CED=Chronic Energy Deficiency

Table 15. Distribution of female patients according to nutritional status based on BMI (%)

Subject	n	CEDIII	CEDII	CEDI	Total CED	Normal	Overweight
BST	443	27.5	13.8	18.1	59.4	36.3	4.3
2 MOT	442	19.5	14.3	19.7	53.4	41.2	5.4
ACT	442	12.2	11.3	19.5	43.0	50.5	6.6
CG	356	2.8	3.9	13.2	19.9	75.3	4.8

Table 16. Distribution of male patients according to nutritional status based on mid upper arm circumference (MUAC)

Subject	N	MUAC <22.0 cm	MUAC ≥ 22.0 cm
BST	622	37.6	62.4
2 MOT	622	33.6	66.4
ACT	622	27.9	72.1
CG	553	7.1	92.9

BST=Before starting treatment, 2MOT=2 Month of treatment, ACT= After completion of treatment, CG=Control group

Table 17. Distribution of female patients according to nutritional status based on mid upper arm circumference (MUAC)

Subject	n	MUAC <22.0 cm	MUAC ≥ 22.0 cm
BST	442	49.2	50.8
2 MOT	442	46.0	54.0
ACT	442	41.1	58.9
CG	356	11.0	89.0

MUAC=Mid-upper arm circumference

Table 18. Mean per capita per day amount of daily food consumption by sex %

Name of consumed foods (g)	Consumption by sex		All	p-value
	Male	Female		
Total	549.08	482.28	516.19	
Cereals	289.13	248.42	269.11	0.001
Pulse	38.72	26.51	32.71	0.1698
Animal protein	87.29	80.6	83.96	0.866
Fish	25.29	25.36	25.32	0.982
Meat	7.54	6.1	6.81	0.315
Eggs	7.83	8.1	7.95	0.875
Milk	46.63	41.04	43.88	0.501
Vegetables	69.49	69.64	69.57	0.562
Green leafy vegetables	18.39	17.74	18.07	0.778
Other vegetables	51.1	51.9	51.5	0.857
Fruits	34.12	28.87	31.54	0.384
Oil	27.32	23.76	25.57	0.080
Others	3.01	4.48	3.73	0.664
% from cereals	52.6	51.5	52.1	
n	155	150	305	

Table 19. Food diversity of patients in last three days

	Sex		All	p value
	Male	Female		
Food diversity				
≤3 types	1.2	1.3	1.2	0.04
4 types	7.1	18.1	12.5	
5 types	52.3	48.3	50.3	
6 types+	39.4	31.8	36.0	
N	155	149	304	