Beyond drugs: tuberculosis patients in Bangladesh need nutritional support during convalescence

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Settings: All sputum microscopy laboratories under the BRAC Tuberculosis Programme in Dhaka City.

Objectives: To study the nutritional status of tuberculosis (TB) patients attending microscopy laboratories during convalescence following DOTS.

Design: The study included 1068 TB patients registered for treatment at 10 laboratories from May 2010 to December 2011, and 910 healthy neighbourhood controls. Weight (in kg), height (in cm) and mid-upper arm circumference (MUAC; in cm) were measured before, at 2 months and immediately after completion of treatment. Body mass index (BMI) < 18.5 kg/m² and MUAC < 22.0 cm were taken as cut-offs for defining malnourishment.

Results: Two thirds of the patients (67%) had a low BMI (<18.5 kg/m²) before treatment, compared to only 23% among the healthy controls. At the end of treatment, 50% of the patients still had a low BMI, including 12% who had severe malnourishment (BMI ≤ 16 kg/m²). MUAC < 22.0 cm was higher among patients before (42%), at 2 months (39%) and immediately after completion of treatment (34%) compared to the control group (9%).

Conclusions: Malnutrition is a serious problem among TB patients in peri-urban areas of Dhaka City. Under the circumstances, additional nutritional supplements, combined with education on nutrition, are expected to contribute to rapid and sustained recovery during DOTS-based treatment.

Adequate nutrition is essential for normal health and proper functioning of all body systems. Malnutrition in tuberculosis (TB) patients is common in both industrialised and developing countries.^{1–4} Bangladesh is no exception, as both TB and malnutrition are major public health problems. In Bangladesh, around 186 individuals die of TB every day and around 68 000 per year.⁵ However, we do not have any substantive data on how many of these TB patients die of nutritional deficiency.

Poor nutrition is a strong risk factor for contracting TB and mortality.^{4,6,7} While there is not enough evidence that nutritional support can improve TB treatment response and outcomes, there is evidence to suggest that it can improve nutritional rehabilitation in persons with TB.⁸ Food supplementation has been found to improve body weight and quality of life of TB patients,⁹ and accelerate the beneficial therapeutic effect of chemotherapy.^{10,11} Demand for the integration of nutritional interventions into TB control programmes is increasing, particularly in countries with a

high TB burden.^{2,6,12} The effective management of TB therefore requires a detailed evaluation of nutritional status, as this can help to prevent or modify many complications of the disease.

Significant improvement has been achieved in TB control in Bangladesh in the last few years.¹³ The government of Bangladesh, in partnership with different non-government organisations, including BRAC, has been implementing a community-based National Tuberculosis Control Programme (NTP) based on the DOTS strategy since 1993.¹⁴ As data on the nutritional status of TB patients are scarce and unreliable in Bangladesh, the BRAC Research and Evaluation Division (RED) initiated a study to explore the nutritional status of TB patients attending peri-urban BRAC sputum microscopy laboratories during the various stages of convalescence before, at 2 months and immediately after completion of DOTS-based treatment.

The present study will help fill in this gap in knowledge and help design programme interventions for better management of nutrition for TB patients in the country.

METHODS

Study settings

The study was conducted among TB patients from peri-urban populations registered for treatment at BRAC TB sputum microscopy laboratories in Dhaka City. Patients with cough of >3 weeks' duration attend the microscopy laboratories for sputum testing free of charge under the NTP. Smear-positive pulmonary TB cases are registered immediately for treatment. Patients with negative microscopy results undergo further investigations and, if found positive, are admitted for treatment at the BRAC laboratory.

Study population and sample size

We included 1110 new TB patients aged >15 years registered at 10 BRAC sputum microscopy laboratories from May 2010 to December 2011. Of these, 42 were excluded (3.9%) as they were not available for interview, had a previous history of TB, were receiving anti-tuberculosis treatment, were pregnant or currently lactating, had diabetes mellitus or had any form of mental disease, as confirmed by physicians. Healthy controls (comparison group) were selected from non-family neighbours of the patients (same socio-economic status), and were matched by age and sex with TB patients (one for each TB case). Around 12% of the controls did not agree to provide information or participate. A final sample of 1068 TB patients (624 males

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KEY WORDS

body mass index; undernutrition; food supplementation

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and 444 females) and 910 healthy controls (554 males and 356 females) was therefore included in the study. The exclusion criteria for controls were the same as for patients.

Data collection

Before starting treatment, information on the TB patients' age, sex, education, income, religion, marital status, TB type, duration of illness, employment status and family size was collected. Anthropometrical measurements (weight, height and mid-upper arm circumference [MUAC]) were taken for both patients and healthy controls, and repeated for patients at 2 months and immediately after completion of treatment. Body weight was measured using a digital weighing scale with a precision of 0.1 kg with minimal clothing and no shoes. The same instruments were used to take the measurements of all the patients. All of the instruments were calibrated each morning to ensure precision. Patient height was measured using a wooden height scale while standing erect without shoes. Height and weight were recorded to two decimal places. MUAC was measured to the nearest 0.1 cm using a flexible plastic tape. All measurements were taken as per the technique described by Weiner and Lourie.¹⁵ Body mass index (BMI) was calculated as kg/m².

To explore barriers that prevented TB patients from accessing adequate food during convalescence, a subsample of 40/1068 patients was taken of two males and two females from each laboratory for in-depth interviews.

The laboratory technicians collected related information on anthropometric measurements and socio-demographic characteristics. During the in-depth interviews, two anthropologists collected information using a tape recorder, following a checklist. All those involved in the conduct of the study received intensive training before data collection.

Data analysis and processing

Data were analysed using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). A BMI of <18.5 kg/m² was defined as malnourished (chronic energy deficient [CED]). CED was classified as follows: BMI 17.0–18.4 kg/m², considered as mild malnutrition (CEDI); BMI 16.0–16.9 kg/m², moderate malnutrition (CEDII); and BMI ≤16 kg/m², defined as severe malnutrition (CEDIII).¹⁶ Nutritional status was also evaluated following the standard cut-off point for MUAC (undernutrition, MUAC <22.0 cm; normal, MUAC ≥22.0 cm).¹⁷ An *F*-test was used to explore the significance of mean differences at different measurement time periods, and statistical *t*-test was used to calculate the significance of the mean difference of measurement between patients and healthy controls. For the qualitative survey, a matrix was developed to capture themes and sub-themes, followed by content analysis.

Ethical issues

The study was reviewed and approved by the BRAC RED. All respondents were informed that their responses would remain anonymous. All provided informed verbal consent.

RESULTS

The majority of the patients were smear-positive (69%), 19% had extra-pulmonary TB and 12% were smear-negative. The mean age of the patients and controls was around 33 years; two thirds were aged <35 years. One third of the patients (35%) had never been to school. The average monthly family income was 6000 BDT (Bangladeshi taka; equivalent to US\$71). Most of the

TB patients were Muslim (69%), married (72%) and had been diagnosed with TB (60%) within a median 6 weeks of the onset of symptoms (Table 1).

Table 2 shows the means and standard deviations of the weight, height, MUAC and BMI of the patients during the treatment period. The mean values of all the measurements of TB patients were significantly lower than those of the control group before starting treatment (weight: 44.4 vs. 51.3 kg, $P < 0.0001$; MUAC: 22.6 vs. 24.9 cm, $P < 0.0001$; BMI: 17.8 vs. 20.3 kg/m², $P < 0.0001$). All mean values had increased at 2 months and after completion of treatment, but the values were still significantly lower than in the control group (weight: 47.4 vs. 51.3 kg, $P < 0.0001$; MUAC: 23.3 vs. 24.9 cm, $P < 0.0001$; BMI: 19.0 vs. 20.3 kg/m², $P < 0.0001$). Among the patients, there was a significant gap in BMI between males and females (18.7 vs. 19.5 kg/m²), those with education and no education (19.3 vs. 18.5 kg/m²), and those with a perceived deficit and no deficit in the household economy (18.6 vs. 19.5 kg/m²; Table 3).

The distribution of the BMI and MUAC of the TB patients is shown in Table 4. More TB patients than healthy controls had a low BMI (<18.5 kg/m²) before treatment (67% vs. 23%), and although this fell to respectively 59% and 50% in TB patients at

TABLE 1 Background characteristics of TB patients by sex

Characteristic	Male (<i>n</i> = 624) %	Female (<i>n</i> = 444) %	All (<i>n</i> = 1068) %
TB type			
Smear-positive PTB	75.8	59.9	69.2
Smear-negative PTB	11.4	12.2	11.7
Extra-pulmonary TB	12.8	27.9	19.1
Age, years			
≤35	57.2	74.7	64.5
>35	42.8	25.3	35.5
Mean ± SD	35.9 ± 14.8	29.8 ± 13.0	33.4 ± 14.4
School education			
Yes	63.9	66.2	64.9
No	36.1	33.8	35.1
Years of schooling, mean ± SD	4.7 ± 4.2	4.2 ± 3.2	4.4 ± 4.0
Duration of illness at time of diagnosis, weeks			
≤6	58.7	60.6	59.5
>6	41.3	39.4	40.5
Median [range]	6 [109]	7 [59]	6 [103]
Employment status before treatment			
Employed	81.4	36.0	62.5
Unemployed	18.6	64.0	37.5
Monthly household income, BDT*			
<6000	41.2	45.5	43.0
≥6000	58.8	54.5	57.0
Median income	6000	6000	6000
Religion			
Muslim	97.1	94.1	95.9
Non-Muslim	2.9	5.9	4.1
Marital status			
Married	72.3	72.5	72.4
Single	26.6	20.3	24.0
Divorced/widowed	1.1	7.2	3.7
Family size, <i>n</i>			
≤5	70.8	79.6	74.5
>5	29.2	20.4	25.5

* US\$1 = 84 BDT.

TB = tuberculosis; PTB = pulmonary TB; SD = standard deviation; BDT = Bangladeshi taka.

TABLE 2 Anthropometric information for tuberculosis patients ($n = 1068$) and healthy controls ($n = 910$) by different treatment periods

Moment of measurement	Weight, kg mean $\pm$ SD			Height, cm mean $\pm$ SD			MUAC, cm mean $\pm$ SD			BMI, kg/m ² mean $\pm$ SD		
	Patients	Controls	<i>P</i> value*	Patients	Controls	<i>P</i> value*	Patients	Controls	<i>P</i> value*	Patients	Controls	<i>P</i> value*
Before treatment	44.4 $\pm$ 8.8	51.3 $\pm$ 6.4	0.0001	157.9 $\pm$ 9.7	159.0 $\pm$ 7.5	0.005	22.6 $\pm$ 3.4	24.9 $\pm$ 2.3	0.0001	17.8 $\pm$ 3.2	20.3 $\pm$ 2.5	0.0001
At 2 months	45.6 $\pm$ 8.2		0.0001	157.9 $\pm$ 9.6		0.005	22.8 $\pm$ 3.3		0.0001	18.3 $\pm$ 3.1		0.0001
After treatment	47.4 $\pm$ 8.3		0.0001	158.2 $\pm$ 9.6		0.005	23.3 $\pm$ 3.3		0.0001	19.0 $\pm$ 3.1		0.0001
<i>F</i> -test†	458.3			3.3			145.11			256.6		

**t*-test, patients vs. controls.

†Patients at different periods of time.

SD = standard deviation; MUAC = mid-upper arm circumference; BMI = body mass index.

2 months and after treatment, it remained higher than among the controls. Nearly half of the TB patients (42%) had a low MUAC (<22 cm); although this proportion diminished over the treatment period to 34%, it still remained higher than in the control group (9%).

Barriers to and solutions for improving nutrition: perspectives from the qualitative study

Various financial, social, health and other barriers were cited by TB patients that prevented them from accessing sufficient food during their convalescence. Lack of economic solvency in the household was considered a major barrier:

Two of my brothers and I do not have earning activities. My elder brother has to pay 60% of his income for house rent. Is it possible to maintain my nutrition with apple, grapes, banana, pigeons, etc? (TB patient)

TABLE 3 Mean distribution of BMI among TB patients at different treatment periods in relation to socio-economic characteristics

	BMI, mean $\pm$ SD		
	Before treatment	At 2 months	After treatment
All	17.8 $\pm$ 3.3	18.3 $\pm$ 3.1	19.0 $\pm$ 3.1
Sex			
Male ($n = 624$)	17.5 $\pm$ 3.1	18.0 $\pm$ 2.8	18.7 $\pm$ 2.8
Female ($n = 444$)	18.1 $\pm$ 3.5	18.7 $\pm$ 3.5	19.5 $\pm$ 3.4
<i>P</i> value*	0.004	0.001	0.001
Age, years			
≤ 35 ($n = 688$)	17.8 $\pm$ 3.1	18.4 $\pm$ 3.0	19.1 $\pm$ 3.1
> 35 ($n = 380$)	17.8 $\pm$ 3.5	18.2 $\pm$ 3.2	18.4 $\pm$ 3.2
<i>P</i> value*	0.740	0.381	0.138
School education			
Yes ($n = 693$)	18.1 $\pm$ 3.4	18.6 $\pm$ 3.2	19.3 $\pm$ 3.2
No ($n = 375$)	17.2 $\pm$ 2.9	17.8 $\pm$ 2.8	18.5 $\pm$ 2.8
<i>P</i> value*	0.0001	0.0001	0.0001
Employment status before treatment			
Employed ($n = 669$)	17.6 $\pm$ 3.0	18.1 $\pm$ 2.9	18.8 $\pm$ 2.9
Unemployed ($n = 399$)	18.1 $\pm$ 3.6	18.6 $\pm$ 3.4	19.4 $\pm$ 3.2
<i>P</i> value*	0.01	0.01	0.04
Number of household members			
≤ 5 ($n = 788$)	17.8 $\pm$ 3.3	18.4 $\pm$ 3.2	19.1 $\pm$ 3.1
> 5 ($n = 280$)	17.7 $\pm$ 3.2	18.2 $\pm$ 3.1	18.9 $\pm$ 3.5
<i>P</i> value*	0.45	0.52	0.45
Perceived household economy status in last year			
Deficit ($n = 569$)	17.3 $\pm$ 2.9	17.9 $\pm$ 2.8	18.6 $\pm$ 2.8
No deficit ($n = 499$)	18.3 $\pm$ 3.6	18.6 $\pm$ 3.4	19.5 $\pm$ 3.4
<i>P</i> value*	0.0001	0.0001	0.0001

**t*-test.BMI = body mass index (kg/m²); TB = tuberculosis; SD = standard deviation.

The majority of the patients perceived that the situation worsened when food prices fluctuated frequently. Furthermore, the circumstances became complicated when patients had to share food with family members. Social phenomena such as isolation from family and society, lack of family support for patients due to infection and poor conjugal relationships due to TB emotionally affected patients, leading to a significant decrease in food consumption:

My son separated me along with my bed, glass, plates, etc. Even my daughter-in-law and grandsons are not allowed to talk to me. All these make me so unhappy and I want to die, thus I stopped eating my food regularly.

Lack of knowledge about nutritious food among patients and health care providers aggravated the situation, and most patients also reported loss of appetite during their illness. The majority of the patients agreed that community support and increased social participation rather than governmental support or intervention was required for patients to regain a sense of self-respect and acceptance. Community support in mobilising financial aid for patients, creating community food banks, increasing social awareness about nutrition and providing emotional support were deemed necessary. Patients also expressed the view that community members could develop a bank on the basis of voluntary donations and a food bank for TB patients from leftovers or food from rural restaurants. Fish and vegetables sellers could provide patients with unsold fish or vegetables at low prices. The majority of TB patients (both male and female) perceived that community-based food supplement programmes run by non-governmental organisations could help patients and improve the overall nutritional situation.

DISCUSSION

This study aimed to explore the nutritional status of Bangladeshi TB patients, its improvement with treatment and barriers to better nutrition during convalescence. The findings reveal that many TB patients were malnourished before treatment compared to healthy controls. The BMI of patients from all socio-economic groups improved at various points in time during treatment, but the vast majority remained malnourished (BMI < 18.5 kg/m²) at the end of treatment. The underlying reasons for this and its implications for TB DOTS programmes are discussed.

The evidence that poor nutrition is a risk factor for developing TB⁷ is reflected in the wide prevalence of malnutrition among newly diagnosed TB patients, consistent with findings from other studies.^{2-4,12,18} This is especially true for male patients, who were found to be more malnourished than females and often had to continue to work hard despite illness. It is interesting to note that the prevalence of low body weight was high even among the non-patient controls, which is another manifestation of food insecurity among the poor in Bangladesh.¹⁹ Under such circumstances,

TABLE 4 Distribution of CED and MUAC among tuberculosis patients and healthy controls at different treatment periods

Treatment period	Patients <i>n</i>	CED*						MUAC	
		CEDIII (BMI <16 kg/m ²) %	CEDII (BMI 16.0–16.9 kg/m ²) %	CEDI (BMI 17.0–18.4 kg/m ²) %	Total CED (BMI <18.5 kg/m ²) %	Normal (BMI ≥18.5 kg/m ²) %	Overweight (BMI >25.0 kg/m ²) %	<22.0 cm %	≥22.0 cm %
Before treatment	1068	29.5	15.8	21.9	67.1	29.1	3.8	42.2	57.6
At 2 months	1068	20.0	16.6	22.3	58.9	37.2	3.9	38.9	61.1
After treatment	1068	12.1	13.1	24.6	49.9	45.3	4.8	33.5	66.5
Control group	910	2.5	4.4	16.0	22.9	73.1	4.0	8.6	91.4

*Calculated on the basis of the BMI. See text for details.

CED = chronic energy deficient; MUAC = mid-upper arm circumference; BMI = body mass index.

nutritional supplementation may be a worthwhile intervention to improve TB care and control (through general health benefits from improved nutrition), although there is not enough evidence to suggest a causal association between such interventions and improved TB treatment response.⁸ Nutritional supplementation may also improve micronutrient deficiencies in zinc, vitamin A and albumin.¹⁰

It is encouraging to note that the study patients' BMI started to improve after initiation of treatment, and that this continued until the end of treatment, as observed in another study.¹² An increase in appetite was observed after initiation of treatment, and patients gained weight. However, many remained significantly malnourished. To achieve desirable levels of nutrition, measures for long-term nutrition supplementation need to be considered in the DOTS programme. A weekly rations system, for example, could be introduced by TB control programmes for poor TB patients, supplementing food rations such as rice, lentils, oil, sugar, etc., by education on nutrition to create greater awareness. Prioritising the needs of TB patients when allocating food within the family should also be emphasised. A baseline nutritional assessment could be performed prior to the commencement of treatment and monitored to track nutritional recovery. This would help in the customisation of nutritional supplementation according to individual needs.

Nutritional knowledge is essential, particularly for the improved management of patient nutrition.²⁰ Study patients lacked knowledge on nutrition, which is a common phenomenon around the world.^{21–23} Educating patients and their families and care givers about the nutritional requirements of TB patients is therefore essential, and programme policy makers need to consider this issue. Even where there is awareness and knowledge, however, poverty prevents their application in real-life situations. Education on nutrition alone will not suffice in times of financial hardship, such as during food price hikes.²⁴ To reduce long-term prevalence of TB infection, the underlying social determinants of undernutrition need to be addressed.

CONCLUSION

Malnutrition is a serious problem among TB patients in peri-urban areas of Dhaka City. With the commencement of treatment, appetite improves, as does nutrition, but not as rapidly as it should. Various barriers, such as socio-economic status, food habits and intra-household food allocation, in addition to the general food insecurity among the poor in Bangladesh, affect nutrition of TB patients. Additional nutritional supplementation, combined with education about nutritional awareness, could contribute to rapid and sustained recovery during DOTS-based treatment.

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Contextes : Tous les laboratoires d'examen microscopique des crachats du programme de tuberculose (TB) du Bangladesh Rural Advancement Committee (BRAC) dans la ville de Dacca, Bangladesh.

Objectifs : Etudier l'état nutritionnel des patients TB fréquentant les laboratoires de microscopie au cours des différents stades de convalescence faisant suite à un traitement DOTS.

Schéma : L'étude a inclus 1068 patients TB enregistrés pour traitement dans 10 laboratoires entre mai 2010 et décembre 2011, ainsi que 910 sujets-contrôle sains provenant du voisinage. Le poids (kg), la taille (cm) et la circonférence au milieu du bras (MUAC ; cm) ont été mesurés avant, à 2 mois et immédiatement après l'achèvement du traitement. L'index de masse corporelle (BMI) < 18,5 kg/m² et le MUAC < 22 cm ont été choisis comme limites définissant la malnutrition.

Résultats : Le BMI est bas (<18,5 kg/m²) chez deux tiers des patients

(67%) avant traitement alors que ceci n'existe que chez 23% des contrôles sains. A la fin du traitement, 50% des patients ont toujours un BMI faible, y compris 12% chez qui la malnutrition est sévère (BMI ≤ 16 kg/m²). Le MUAC < 22,0 cm est plus fréquent chez les patients TB avant traitement (42%), après 2 mois (39%) et immédiatement après l'achèvement du traitement (34%), par comparaison avec le groupe contrôle (9%).

Conclusions : Dans les zones périurbaines de la ville de Dhaka, la malnutrition constitue un problème grave chez les patients TB. On s'attend dans ces circonstances à ce que des suppléments nutritionnels complémentaires combinés avec une éducation nutritionnelle puissent contribuer à une guérison rapide et durable au cours d'un régime DOTS.

Marco de referencia: Todos los laboratorios que participan en el programa contra la tuberculosis (TB) de la organización Bangladesh Rural Advancement Committee (BRAC) donde se practica el examen microscópico del esputo, en la ciudad de Dhaka en Bangladesh.

Objetivo: Evaluar las condiciones nutricionales de los pacientes con diagnóstico de TB que acuden a los laboratorios de microscopia en diferentes etapas de su convalecencia, en el marco del tratamiento DOTS.

Métodos: Participaron en el estudio 1068 pacientes con diagnóstico de TB y registrados para tratamiento en 10 laboratorios entre mayo del 2010 y diciembre del 2011 y 910 adultos sanos del vecindario, como grupo testigo. Se tomaron las siguientes mediciones antes de comenzar el tratamiento, a los 2 meses e inmediatamente después de haberlo completado: el peso (kg), la estatura (cm) y el perímetro braquial (MUAC; cm). Los criterios que definieron la desnutrición fueron un índice de masa corporal (BMI) < 18,5 kg/m² y un MUAC < 22,0 cm.

Resultados: Dos tercios de los pacientes (67%) presentaron un bajo BMI (<18,5 kg/m²) antes del tratamiento, en comparación con solo 23% de los testigos sanos. Al final del tratamiento, 50% de los pacientes presentaban aun un bajo BMI y en 12% de ellos la desnutrición era grave (≤16 kg/m²). Fue más frecuente observar un MUAC < 22,0 cm en el grupo de pacientes que en el grupo testigo (9%) antes del tratamiento (42%), a los 2 meses (39%) e inmediatamente después de haber completado el régimen terapéutico (34%).

Conclusión: La desnutrición constituye un problema grave en los pacientes aquejados de TB en las zonas periurbanas de la ciudad de Dhaka. En estas circunstancias, se prevé que el suministro de un complemento nutricional, aunado a una educación en materia de nutrición, contribuirá a lograr una recuperación más rápida y estable con el régimen DOTS.