ARTICLE

Served versus actual nutrient intake of hospitalised patients with tuberculosis as compared with energy and nutrient requirements

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Objectives. To assess whether actual nutrient intake of hospitalised patients with tuberculosis differed from that served by the hospital and from that required according to current recommendations.

Design. Descriptive, cross-sectional study.

Setting. Brooklyn Chest Hospital in Brooklyn, Cape Town, Western Cape, South Africa.

Subjects. Thirty patients with pulmonary tuberculosis from Brooklyn Chest Hospital, 23 male, 7 female, were enrolled in the study.

Outcome measures. Assessment included dietary intake in order to calculate energy and nutrient intake, and height and weight at the beginning of the study in order to calculate body mass index (BMI).

Results. Patients were receiving and consuming sufficient macronutrients (with the exception of protein in all patients) and sufficient micronutrients (with the exceptions of calcium, iodine, folate and vitamin E in all patients, beta-carotene, vitamin C and vitamin D in male patients, and selenium and pantothenate in female patients). Actual intake consumed in the hospital did not differ from that served by the hospital in the case of male patients, with the exception of iodine; for female patients, however, owing to significant plate wastage, consumed intake was less than that served by the hospital (with the exceptions of vitamin C and vitamin K). A total of 52% of the male patients and 71% of the female patients were normally nourished, according to their BMI. The remainder were mildly to severely malnourished on the basis of their BMI.

Conclusions. According to current recommendations, the patients institutionalised at Brooklyn Chest Hospital for tuberculosis were receiving inadequate protein and a number of micronutrients (calcium, iodine, folate and vitamin E in all patients, beta-carotene, vitamin C and vitamin D in male patients, and selenium and pantothenate in female patients). Intervention programmes should therefore be introduced as an adjunct to antituberculosis therapy in order to rectify inadequate nutrient intake and to target malnourished patients.

Tuberculosis (TB) is caused by *Mycobacterium tuberculosis*, an intracellular pathogen that affects the lungs (pulmonary TB) and/or other parts of the body, such as the lymph nodes, skin and bones. Pulmonary tuberculosis (PTB) is generally transmitted from infected people who expectorate the tubercle bacilli. Symptoms of PTB include fever, fatigue, loss of appetite and weight, night sweats, persistent cough and chest pain. A diagnosis of TB is made after finding a sputum smear from the suspected person to be positive for acid-fast bacilli. TB is treated with various regimens of drugs in combination.[1,2]

South Africa is burdened with one of the worst TB epidemics in the world, with disease rates more than double those observed in other developing countries and up to 60 times higher than those currently seen in the USA or Western Europe.[3] From 1970 to 1976 the mortality rate for TB in the coloured and black populations of South Africa far exceeded that for whites, with TB ranking third among the mortality rates for the then leading causes of death in persons of mixed ethnic origin, and accounting for 8% of all deaths.[4] Estimates by the Medical Research Council (MRC) National Tuberculosis Programme indicate that the current trends in the epidemic, projected to result in 3.5 million new cases of TB in South Africa over the next decade and at least 90 000 deaths, will continue unless effective control is achieved.[5] Some progress is being made in certain provinces in South Africa, with the Western Cape already showing dramatic improvements in cure rates owing to disciplined implementation of the directly observed treatment short-course (DOTS) strategy of the World Health Organization (WHO).

In a review by Neumann *et al.*[6] it was noted that many researchers have recognised the high prevalence, long duration and complications of infections in malnourished individuals, and the very severe course that infections, which are ordinarily mild, follow in a malnourished population. It was also noted that not only do infections adversely affect nutritional status, but malnutrition adversely affects the ability of the host to withstand infection.

Coetzee[7] found that the nutritional status of pre-treatment adolescent PTB outpatients was poorer than that of matched controls, and improved during treatment. Despite the higher reported intake of nutrients in these cases compared with the Recommended Dietary Allowance (RDA), poor nutritional status investigated at a clinical, anthropometric and biochemical level was found to be present in all the TB patient groups studied.

The link between TB and malnutrition has been recognised for many years and although, in an era of effective antituberculosis chemotherapy, it may be argued that there is no longer a need to be concerned about malnutrition and TB, the role of nutritional support as an adjunctive treatment for TB is vitally important, not only to support weight gain but also to expedite healing.[8] Nutritional status determines normal health and functioning of the immune system, which is responsible for host resistance to various infectious diseases, including TB.[9]

Recommendations for nutrient and energy requirements for hypercatabolic and undernourished patients have been published.[10,11] However, it is not known whether institutions are adhering to these recommendations, or, if a hospital does supply patients with an adequate and balanced diet, they are actually taking advantage of this opportunity. The aim of the study, therefore, was to address the current paucity of the data on this issue.

Methodology

Study type

A descriptive, cross-sectional study was performed at Brooklyn Chest Hospital, Cape Town, South Africa.

Objectives

This study aimed to compare the actual nutrient intake of hospitalised patients with TB both with that served by the hospital and with that currently recommended, in order to gain insight into whether or not nutritional requirements were being met. The study also aimed to determine the nutritional status of the patients with the BMI, in order to assess their state of nourishment.

The null hypotheses were therefore:

1. The energy and nutrient intake served by the hospital does not differ significantly from that currently recommended.

2. The actual energy and nutrient intake of hospitalised patients with TB does not differ significantly from that served by the hospital.

3. The actual energy and nutrient intake of hospitalised patients with TB does not differ significantly from that currently recommended.

Study population

The majority of patients admitted to Brooklyn Chest Hospital are impoverished, of mixed ethnic origin, and from areas of the Western Cape with a high prevalence of TB. Most of the patients were referred to the hospital for supervised treatment owing to the severity of their infection, based on clinical and radiological assessments. Table I lists the anthropometric and socio-demographic details of the patients.

Patients received a standard drug regimen as part of the directly observed treatment short-course (DOTS) strategy, modified according to response to treatment, severity of disease and presence of multiple drug resistance (MDR). The DOTS strategy involves a combination of antituberculosis drugs, and every capsule is seen to be swallowed.[2] Treatment at Brooklyn Chest Hospital was administered, and observed to be taken daily, by the nursing staff.

Inclusion criteria for the study were a confirmed diagnosis of active TB, age between 19 and 50 years, and consumption of the standard hospital meals. Exclusion criteria included any disease (including HIV/AIDS) other than TB, MDR TB, and any patient on a therapeutic diet, including the use of enteral or parenteral nutrition therapy. This information was gained from the patient's record file and checked with

Table I. Mean anthropometric and socio-demographic information of patients ($N = 30$)

	Patients
Gender (N (%))	
Male	23 (77)
Female	7 (23)
Mean age (yrs) (range)	
Male	35 (28 - 44)
Female	31 (22 - 39)
Race (%)	
Black	31
Coloured	69
BMI (mean, range)	
Male	18.2 (14.9 - 23.1)
Female	20.4 (17.8 - 22.7)
Education level (%)	
None	8
< grade 7	33
Grade 7 - < matric	10
Matric	18
Tertiary	0
Current employment*	
Yes (%)	23
Housing (%)	
Shack	24
Flat	11
House	65
Mean number living in lodging	
Children	3
Adults	4

*Employment to which the patient can return upon hospital discharge.

the head ward nurse. Informed consent from patients to gain access to their record files and to investigate the above criteria (including HIV status) was obtained from each patient.

There were 7 wards at Brooklyn Chest Hospital, namely wards A to F and a surgical ward, each housing between 40 and 45 patients with TB. Ward B housed babies and toddlers and therefore this and the surgical ward were excluded from the study. Ward D was also excluded as the patients were over 50 years old. Of the wards included, A, C and E were for males and F for females. Consequently there were proportionately more male than female subjects both in the hospital and in the study.

A list of all the patients from each included ward satisfying the above inclusion criteria was formulated. This gave a total of 3 patients from ward A, 8 from ward C, 12 from ward E and 7 from ward F, with a total available sample size of 30 patients. No sampling was necessary as all patients satisfying the inclusion criteria were included in and agreed to participate in the study.

Methods of data collection

Data collection was performed from 23 September 2002 to 20 October 2002 (4 weeks). All data (including socio-demographic, dietary and anthropometric data) were collected by the investigator at Brooklyn Chest Hospital. Sociodemographic data recorded included age, gender, race, level of education, employment status, housing type and number of children and adults living in the household.

The standard diet supplied to the patients included 3 main meals, a late-night snack and in-between liquid refreshments. Meals, of standard portion sizes, were dished onto plates by the ward nurse(s).

Dietary assessment included a 3-day semi-weighed food record. Two non-consecutive week days and a weekend day were included per week.[12-14] Each of the four wards was consecutively assessed over a period of 1 week. The time period of 24 hours began at 18h00 and ended the following day at 18h00. A dietary recall was used to record intake from after dinner (about 17h00) to before breakfast the following day (about 8h00), while a weighed food record was used to record intake from breakfast to dinner.

The food scale used for weighing food (CAS computing scale, AD series, accurate to within ± 0.01 g) was calibrated both before the study and after every 20 measurements. It was ensured that the instrument was measuring accurately (the true reading) and reliably (the instrument had a reproducibility to within 0.1 of a gram). A known weight weighing 1 kg was weighed on the scale (to determine accuracy) twice (to determine reliability).

The researcher was present in the respective ward, observing the patients, from breakfast to dinner. The kitchen staff were asked to prepare extra food on the days of the study so that three extra plates of food could be dished up by the ward nurse(s). Three of the plates of food were randomly chosen from the total number of plates dished up for the ward and used to weigh served portions. The kitchen supervisor was questioned on the preparation methods and recipes used. An average weight of these three extra meals was taken to serve as an indication of the standard weighed food record details before consumption. Wastage of individual foods was weighed from each of the selected patients' meals after eating. All three meals (breakfast, lunch and dinner) were weighed in this manner. Any food consumed from outside the hospital between breakfast and dinner was also recorded, either by weighing it directly or recording the household measurement. A recall was used to ascertain what consumption, if any, occurred overnight from dinner the previous day to breakfast that morning, and recorded as a household measurement. All beverages (including alcohol consumed in the hospital) and food from inside and outside the hospital were included.

Use of nutritional supplements, including dose, frequency and composition, was also recorded.[12] Patients' files were checked for any vitamin and/or mineral prescriptions. Supplements supplied by the hospital included vitamin C (500 mg daily), pyridoxine (25 mg daily) and vitamin B complex (2 tablets daily). The vitamin B complex supplement provided included 10 mg thiamin, 2 mg riboflavin, 5 mg pyridoxine and 5 mg of pantothenate. Not all patients received a supplement prescription, as supplements were prescribed at the discretion of the doctor responsible for the management of the patient.

Anthropometric data measured included weight and height measurements in order to calculate the body mass index (BMI) for determination of nutritional status. The WHO[15] has defined BMI (kg/m^2) categories as follows: < 16.0 = severe malnutrition, 16.0 - 16.9 = moderate malnutrition, 17.0 - 18.4 = mild malnutrition, 18.5 - 24.9 = average or normal range, 25.0 - 29.9 = pre-obese, 30.0 - 34.9 = obese class 1, 35.0 - 39.9 = obese class 2, and ≥ 40.0 = obese class 3.

Weight was measured on an electronic scale to the nearest 0.1 kg in the morning, before breakfast and after voiding urine, with the patients wearing minimal clothing and no shoes. The electronic beam scale (A&D Company Precision Health scale, UC-300, accurate to within 50 g) was placed on a flat hard surface for all measurements and was calibrated before the study and once a week thereafter. It was ensured that the instrument was measuring accurately (the true reading) and reliably (the instrument had reproducibility to within 0.1 kg). A known weight of 1 kg was measured on the scale (to determine accuracy) twice (to determine reliability).[16]

Height was measured using a stadiometer, with the patient standing up straight against a skirting-board-free wall and on a flat, hard surface. No shoes were worn and the patient stood upright with the head positioned in the Frankfort horizontal plane. The patient was positioned so that his/her heels were together, arms at sides, legs straight, shoulders relaxed and head in line with the spine so that the plane was horizontal. In this position the heels, buttocks, scapulas and back of head were against the vertical board of the stadiometer. While the patient was maintaining this erect posture, the headboard was lowered upon the highest point of the head, with enough pressure to compress the hair, and the measurement read to the nearest 0.1 cm after maximum inspiration, at eye level with the headboard to avoid errors due to parallax. For both weight and height measurements, two measurements each were taken which agreed to within 0.1 kg and 0.5 cm, respectively. An average of these two measurements was taken as the final recording.[16]

A pilot study was performed just before the main study in order to optimise the methodology. A simple random selection of patients (N = 6) was done, choosing 3 patients each from wards A and D. These patients were not included in the main study.

Ethics

The study received approval from the Research Ethics Committee of the Faculty of Health Sciences, Stellenbosch University. The superintendent at Brooklyn Chest Hospital also granted permission to perform the study subject to the patients' consent. All information gained about the patients was kept private and confidential.

Analysis of data

A biostatistician was consulted for the most appropriate statistical methodology to be used. Food intake data were calculated as energy and nutrient intake using Food Finder, version 2 (MRC, 1991). The Food Finder program is a software program used to calculate nutrient intake from dietary intake and lists the RDA alongside the results. It does not contain recommendations specifically for patients with TB. The results of this and the sociodemographic and anthropometric data were captured using the Microsoft Excel computer package. The nutritional status of the patients was categorised according to the BMI. A Fisher's exact two-tailed test was performed on the BMI results with the null hypotheses stating that the number of malnourished male and female patients were equal. Statistics were also performed on the dietary intake data, in order to calculate the mean, standard deviation (SD) and confidence interval (CI), set at 95%, for each nutrient. The recommended intake did not differ from that served, eaten in the hospital or consumed in total, if it fell within the CI. In addition, a paired t-test was used in order to compare served intake, food eaten in the hospital and that consumed in total. There are no recommendations specifically for the coloured population of the Cape Province or South African Africans, and therefore recommendations were based on those required in a state of hypermetabolism, for energy and protein,[10,11] and on the dietary reference intakes (DRIs) for the remaining nutrients.[17]

Daily energy and nutrient intake was divided into the following categories:

- Recommended intake, defined as that required by the patients according to current recommendations.
- Served intake, defined as food served to the patients by the hospital catering service.
- Actual intake, defined as food actually consumed by the patients. This was further divided into the following categories:
    - Actual intake from food served in the hospital, defined as only that portion of meals consumed by patients from the served food, excluding plate waste and including consumption of second helpings, if any.

- Actual food wastage and/or intake of second helpings, defined as the difference between served food and actual intake from food eaten in the hospital (defined above). Food wastage was therefore a loss of served intake, whereas intake of second helpings was an extra consumption of served intake.
- Actual intake from food brought in to the hospital or brought from outside the hospital, defined as only that portion consumed from a source not supplied by the hospital.
- Actual total intake, defined as the sum of actual intake from food served by the hospital (defined above) and that brought from the outside.
- Some patients were given a micronutrient supplement prescription and therefore an additional category was included for these supplemented micronutrients. This was described as the actual total intake, including supplements, and defined as the sum of the actual total intake (defined above) and the supplement prescription.

Results

Body mass index

Although only 52% of the males were normally nourished compared with 71% of the females (Fig. 1), there was no significant difference in the nutritional status of male and female patients ($p > 0.05$). There were mildly (22%), moderately (17%) and severely (9%) malnourished male patients but only mildly (29%) malnourished female patients.

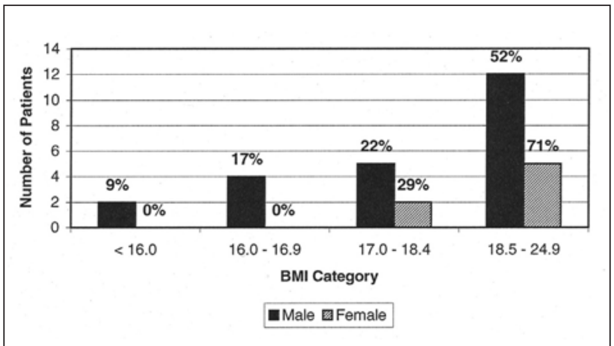

Fig. 1. BMI profile of patients (N = 30) for both males (N = 23) and females (N = 7) There was no significant difference between males and females (p = 0.4268).

Energy distribution

For both males (Fig. 2) and females (Fig. 3), served intake, served intake consumed, and total intake met the energy distribution requirement for carbohydrate but exceeded that for fat, while the requirement for protein was met only for males. In contrast, food brought from the outside did not meet the energy distribution requirement for either protein or carbohydrate but vastly exceeded that for fat for both males and females.

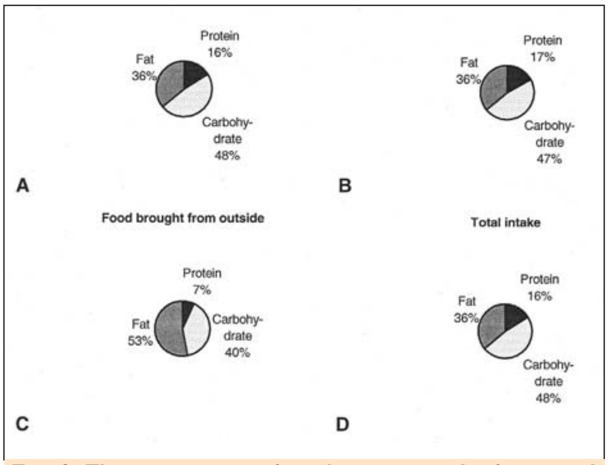

Fig. 2. The percentage of total energy intake for served and actual macronutrient intakes for males (N = 23). The recommended energy distribution is such that 15 - 35% of total energy intake (TEI) should come from protein, 45 - 65 % of TEI from carbohydrate and 20 - 35% of TEI from fat.[17] Thus served intake (A), food eaten in the hospital (B) and total intake (D) met the requirements for protein and carbohydrate but slightly exceeded the requirement for fat. Food brought from the outside (C) did not meet the requirements for protein and carbohydrate but vastly exceeded the requirement for fat.

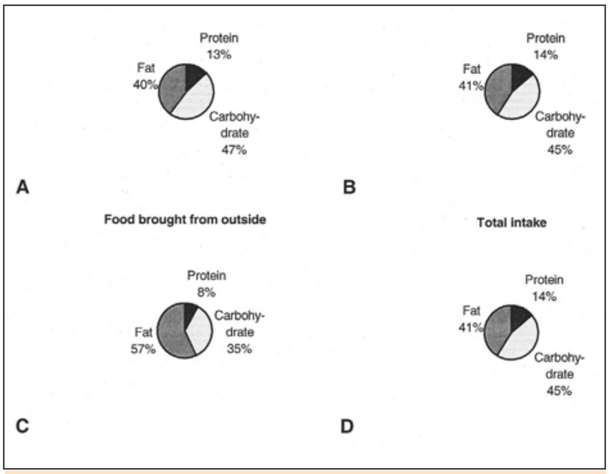

Fig. 3. The percentage of total energy intake for served and actual macronutrient intakes for females (N = 7) The recommended energy distribution is such that 15 - 35 % of total energy intake (TEI) should come from protein, 45 - 65% of TEI from carbohydrate and 20 - 35% of TEI from fat.[17] Thus served intake (A), food eaten in the hospital (B) and total intake (D) did not meet the requirement for protein, met the requirement for carbohydrate and exceeded the requirement for fat. Food brought from the outside (C) did not meet the requirements for protein or carbohydrate but vastly exceeded the requirement for fat.

Dietary intake

Tables II and III depict the energy and nutrient intakes for both males and females, respectively. The values calculated using ideal body weight were used for comparative purposes in this study. However, it should be noted that using ideal body weight in macronutrient calculations for underweight patients may lead to overfeeding. The recommended intake was said to 'meet' or 'exceed' recommendations if it fell within or above the CI, respectively, or 'not to meet' recommendations if it fell below the CI, for served food, served food eaten and total intake. In addition, served intake, served food eaten and total intake were compared using the *t*-test and underlined to illustrate a significant difference.

Macronutrient intake

Energy, protein and carbohydrate intake from served food consumed by males (Table II) met, did not meet and exceeded recommendations, respectively. This was because served intake met, did not meet and exceeded recommendations, respectively. For males, macronutrient intake consumed as served food reflected that served, since both nutrient losses due to plate wastage and the intake from second helpings were too small to cause a significant change in intake. Total macronutrient intake exceeded that from served food eaten, and therefore food brought from the outside raised energy, protein and carbohydrate intake significantly ($p < 0.05$). This is supported by Fig. 4, which illustrates that there were a larger number of male patients consuming less than 67% of recommended macronutrient intake from food served by the hospital than from total food and, similarly, a larger number consuming more than 100% of recommended macronutrient intake from total food than from food served by the hospital alone. All 23 male patients consumed food served by the hospital, 10 exhibited plate waste, 11 consumed second helpings and 16 brought food from the outside.

Similarly, for females (Table III) energy, protein and carbohydrate intake from served food consumed by females met, did not meet and exceeded recommendations, respectively. However, while as for men, served intake exceeded recommendations for energy and carbohydrate intake, and did not meet recommendations for protein intake, the amount served to women was more than that actually consumed, due to the fact that plate wastage caused a significant nutrient loss ($p < 0.05$). Total intake only exceeded intake from food served for carbohydrate, and therefore, while energy and protein brought from the outside did not raise intake significantly, carbohydrate brought from the outside did. Although energy and protein intake brought from the outside did not raise intake significantly, Fig. 5 illustrates that there were a greater number of female patients consuming less than 67% of recommended protein intake from food served by the hospital than in total, and, a greater percentage consuming more than 100% of recommended energy intake in total than from food served by the hospital. All 7 female patients consumed food served by the hospital and exhibited plate waste, none consumed second helpings, and 4 brought food from the outside.

Micronutrient intake

Minerals

Calcium and iodine intake for males from food served and from served food actually eaten (Table II) did not meet recommendations, iron, phosphorus, zinc and selenium intakes exceeded recommendations, and magnesium intake met recommendations. For males, actual mineral intake in the hospital reflected what was served, as both nutrient loss due to plate wastage and intake from second helpings were too small to change intake significantly, with the exception of iodine, where the consumption of second helpings raised intake significantly. Total intake exceeded that from served food eaten, with the exception of selenium, and therefore food brought from the outside raised mineral intake significantly (with the exception of selenium). This is supported by Fig. 4, which illustrates that there were more male patients consuming less than 67% of recommended calcium and magnesium intake from food served by the hospital than from food in total and, similarly, more consuming more than 100% of recommended calcium, magnesium, phosphorus, zinc and even selenium intake from food in total than from food served by the hospital alone. Fig. 4 also illustrates that all male patients were consuming less than 67% of the calcium and iodine recommended.

For females, neither the served amount of calcium, selenium or iodine nor that from served food actually eaten (Table III) met recommendations, iron intake met recommendations, and phosphorus and zinc intakes exceeded recommendations. The amount of magnesium in food served exceeded recommended intake, but magnesium actually consumed did not meet recommendations. For females, minerals in food served exceeded that in served food consumed due to the fact that plate wastage caused a significant mineral intake loss. Total intake did not exceed that from hospital food consumed, with the exception of calcium, and therefore food brought from the outside only raised calcium intake significantly. Although mineral intake from food brought from the outside did not raise intake significantly, Fig. 5 illustrates that there were more female patients consuming less than 67% of recommended magnesium and selenium intakes from food served by the hospital than from food in total, and greater percentage consuming more than 100% of recommended iron, magnesium and zinc intakes from food in total than from the hospital food. Fig. 5 also illustrates that all female patients were consuming less than 76% of the calcium and iodine recommended.

Vitamins

Served vitamin A, thiamin, pantothenate and vitamin K intake and that actually consumed in the hospital by males (Table II) met recommendations; beta-carotene,

Table II. Recommended, served and actual daily energy and nutrient intakes for males (N = 23)

	Daily intake (mean, (SD), [CI])						
			Actually consumed				
Macronutrients	**Recommended**	**Served***	**Food eaten in hospital†**	**Wastage‡**	**Second helping‡**	**Food brought from outside§**	**Total‖**
Energy (kcal)¶	1 900 - 2 280 (IBW) 1 361 - 1 633 (ABW)	2 069 (87) [2032 - 2107]	2 074 (355) [1 921 - 2 228]	0	5	253 (349) [103 - 404]	2 328 (321) [2 189 - 2 466]
Protein (g)¶	114 (IBW) 81.6 (ABW)	83 (10) [78 - 87]	84 (18) [77 - 92]	0	1	7 (11) [2 - 12]	91 (16) [85 - 98]
Carbohydrate (g)**	100	263 (15) [256 - 269]	258 (43) [240 - 277]	5	0	35 (47) [15 - 55]	294 (38) [277 - 310]
Micronutrients**							
Minerals							
Ca (mg)	*1 000*	501 (91) [462 - 541]	505 (110) [457 - 552]	0	4	95 (152) [30 - 161]	600 (155) [533 - 667]
Fe (mg)	6	11.8 (1.4) [11.2 - 12.4]	11.7 (2.5) [10.7 – 12.8]	0.1	0	3.3 (6.8) [0.4 - 6.3]	15.0 (7.2) [11.9 - 18.2]
Mg (mg)	345.7	323 (19) [315 - 331]	320 (64) [293 - 348]	3	0	21 (30) [8 - 34]	341 (54) [318 - 365]
P (mg)	580	1 166 (142) [1104 - 1227]	1 165 (226) [1 067 - 1 263]	1	0	91 (134) [33 - 149]	1 256 (201) [1 169 - 1 343]
Zn (mg)	9.4	13.2 (0.9) [12.8 - 13.6]	13.4 (2.6) [12.2 - 14.5]	0	0.2	0.8 (1.3) [0.3 - 1.3]	14.2 (2.2) [13.2 - 15.1]
Se (µg)	45	70 (30) [57 - 84]	66 (31) [53 - 80]	4	0	5 (12) [0 - 10]	71 (32) [57 - 85]
I (µg)	95	33 (4) [31 - 34]	35 (7) [32 - 38]	0	2	2 (3) [0 - 3]	37 (7) [34 - 40]
Vitamins							
Vitamin A (µg)	625	674 (61) [648 - 700]	673 (142) [611 - 735]	1	0	15 (28) [3 - 27]	688 (137) [629 - 747]
β-carotene (µg)	3 000 - 6 000	2 286 (201) [2 199 - 2 373]	2 362 (680) [2 068 - 2 656]	0	76	27 (88) [0 - 65]	2 389 (682) [2 094 - 2 683]
Thiamin (mg)	1	1.1 (0.1) [1.1 - 1.1]	1.1 (0.2) [1.0 - 1.2]	0	0	0.2 (0.2) [0.1 - 0.3]	1.3 (0.3) [1.1 - 1.4]
Riboflavin (mg)	1.1	1.9 (0.7) [1.6 - 2.2]	1.8 (0.7) [1.5 - 2.1]	0.1	0	0.2 (0.4) [0 - 0.4]	2.0 (0.7) [1.7 - 2.3]
Niacin (mg)	12	18.7 (3.8) [17.1 - 20.4]	18.7 (5.0) [16.5 - 20.9]	0	0	2.8 (4.4) [0.9 - 4.7]	21.5 (5.8) [19.0 - 24.0]
Vitamin B_6 (mg)	1.1	1.4 (0.2) [1.3 - 1.5]	1.4 (0.3) [1.3 - 1.6]	0	0	0.2 (0.3) [0.1 - 0.3]	1.6 (0.4) [1.4 - 1.8]
Folate (µg)	320	215 (20) [206 - 223]	209 (39) [193 – 227]	6	0	22 (41) [5 - 40]	232 (46) [212 - 252]
Vitamin B_{12} (µg)	2	13.8 (6.8) [10.9 - 16.8]	12.4 (7.1) [9.4 - 15.5]	1.4	0	0.2 (0.4) [0 - 0.3]	12.6 (7.0) [9.6 - 15.6]
Pantothenate (mg)	*5*	5.4 (1.6) [4.7 - 6.1]	5.4 (1.7) [4.7 - 6.1]	0	0	0.4 (0.7) [0.1 - 0.7]	5.8 (1.6) [5.1 - 6.5]
Biotin (µg)	30	47 (10) [43 - 52]	44 (12) [39 - 50]	3	0	2 (2) [1 - 3]	47 (12) [41 - 52]
Vitamin C (mg)	75	51 (3) [50 - 52]	53 (18) [46 - 61]	0	2	9 (17) [1 - 17]	63 (27) [51 - 74]
Vitamin D (µg)	5	3.3 (1.2) [2.8 - 3.9]	3.4 (1.4) [2.8 - 4.0]	0	0.1	0 (0.1) [0 - 0.1]	3.5 (1.3) [2.9 - 4.0]
Vitamin E (mg)	12	4.0 (1.0) [3.6 - 4.4]	4.1 (1.3) [3.5 - 4.6]	0	0.1	0.6 (0.8) [0.2 - 1.0]	4.7 (1.2) [4.1 - 5.2]
Vitamin K (µg)	120	91 (69) [62 - 121]	106 (109) [58 - 153]	0	15	1 (1) [0 - 1]	106 (109) [59 - 153]

A statistically significant difference ($p < 0.05$) between served intake, food eaten in the hospital and that eaten in total is illustrated by underlining of the values.

*Served intake was defined as food served to the patients by the hospital catering service. This was calculated using the mean served intake over 3 non-consecutive days for each male patient. Three different male wards were studied.

†Food eaten in the hospital was defined as only that portion of intake consumed by patients from served intake alone. All male patients ($N = 23$) consumed food in the hospital.

‡Food wastage or second helpings were defined as the difference between served intake and intake from food eaten in the hospital. Only 2 male patients consumed the served intake with no plate waste or second helping, 10 male patients exhibited wastage and 11 consumed second helpings. Values represent the mean.

§Food brought from the outside was defined as only that portion of intake consumed from a source not supplied by the hospital. 16 of the 23 male patients brought food from the outside.

‖Total intake was defined as the sum of the intake from food eaten in the hospital and brought from the outside.

¶Reference for recommended intake calculated using both IBW and ABW from 25 - 30 kcal/d of energy and 1.5 g/d of protein required in a state of hypermetabolism.[10,11] The value calculated using IBW was used for comparison purposes.

**Reference for recommended intake taken from the dietary reference intakes (DRI) using the estimated average requirements (EAR) and the adequate intake (AI) (*italics*) when the EAR is not defined.[17] Only the value for magnesium required adjustment for age.

IBW = ideal body weight (76 kg for males[10]); ABW = actual body weight.

Table III. Recommended, served and actual daily energy and nutrient intakes for females ($N = 7$)

	Daily intake (mean, (SD), [CI])						
			Actually consumed				
Macronutrients	**Recommended**	**Served***	**Food eaten in hospital†**	**Wastage‡**	**Second helping‡**	**Food brought from outside§**	**Total‖**
Energy (kcal)¶	1 525 - 1 830 (IBW) 1 329 - 1 595 (ABW)	2 059 (0) [2 059 - 2 059]	1 587 (259) [1 348 - 1 826]	472	0	207 (266) [0 - 453]	1 794 (198) [1 611 - 1 977]
Protein (g)¶	91.5 (IBW) 79.7 (ABW)	67 (0) [67 - 67]	54 (10) [44 - 63]	13	0	8 (12) [0 - 19]	62 (10) [53 - 71]
Carbohydrate (g)**	100	257 (0) [257 - 257]	189 (31) [161 - 218]	68	0	20 (19) [2 - 38]	209 (18) [192 - 225]
Micronutrients**							
Minerals							
Ca (mg)	*1 000*	615 (0) [615 - 615]	513 (47) [470 – 556]	102	0	31 (33) [1 - 62]	544 (36) [511 - 577]
Fe (mg)	8.1	9.6 (0) [9.6 - 9.6]	7.7 (1.5) [6.3 - 9.1]	1.9	0	1.0 (1.3) [0 - 2.2]	8.7 (0.9) [7.9 - 9.5]
Mg (mg)	257.9	278 (0) [278 – 278]	209 (44) [169 – 249]	69	0	23 (33) [0 - 54]	233 (33) [202 - 263]
P (mg)	580	1 036 (0) [1 036 - 1 036]	813 (126) [696 - 930]	223	0	92 (127) [0 - 210]	905 (106) [808 - 1 003]
Zn (mg)	6.8	11.6 (0) [11.6 – 11.6]	9.1 (2.3) [7.0 - 11.2]	2.5	0	1.0 (1.6) [0 - 2.4]	10.1 (1.3) [8.9 - 11.2]
Se (µg)	45	34 (0) [34 - 34]	28 (5) [24 - 32]	6	0	2 (4) [0 - 5]	30 (3) [27 - 32]
I (µg)	95	46 (0) [46 - 46]	39 (4) [35 - 43]	7	0	2 (3) [0 - 5]	41 (3) [38 - 44]
Vitamins							
Vitamin A (µg)	500	1 077 (0) [1 077 - 1 077]	875 (191) [698 – 1 052]	202	0	17 (27) [0 - 43]	893 (197) [710 - 1 075]
β-carotene (µg)	3 000 - 6 000	4 369 (0) [4 369 - 4 369]	3 466 (900) [2 633 - 4 299]	903	0	56 (116) [0 - 163]	3 522 (909) [2 681 - 4 363]
Thiamin (mg)	0.9	1.0 (0) [1.0]	0.8 (0.1) [0.6 - 0.9]	0.2	0	0.1 (0.2) [0 - 0.3]	0.9 (0.1) [0.8 - 1.0]
Riboflavin (mg)	0.9	1.1 (0) [1.1 – 1.1]	0.9 (0.1) [0.9 - 1.0]	0.2	0	0.1 (0.1) [0 - 0.2]	1.0 (0.1) [1.0 - 1.1]
Niacin (mg)	11	11.7 (0) [11.7 - 11.7]	8.8 (2.3) [6.7 - 11.0]	2.9	0	0.2 (0.3) [0.1 - 0.3]	11.1 (2.7) [8.6 - 13.7]
Vitamin B_6 (mg)	1.1	1.1 (0) [1.1 - 1.1]	0.9 (0.2) [0.7 - 1.1]	0.2	0	0.3 (0.6) [0 - 0.9]	1.2 (0.5) [0.8 - 1.6]
Folate (µg)	320	221 (0) [221 - 221]	177 (36) [144 – 210]	44	0	16 (18) [0 - 33]	193 (20) [175 - 212]
Vitamin B_{12} (µg)	2	4.1 (0) [4.1 - 4.1]	3.5 (0.4) [3.1 - 3.9]	0.6	0	0.6 (1.1) [0 - 1.6]	4.0 (1.1) [3.0 - 5.1]
Pantothenate (mg)	*5*	3.6 (0) [3.6 - 3.6]	2.9 (0.3) [2.6 - 3.2]	0.7	0	0.4 (0.4) [0 - 0.8]	3.3 (0.3) [3.0 - 3.6]
Biotin (µg)	30	33 (0) [33 - 33]	27 (3) [24 - 30]	6	0	2 (2) [0 - 4]	29 (3) [27 - 32]
Vitamin C (mg)	60	102 (0) [102 - 102]	92 (14) [80 - 105]	10	0	15 (17) [0 - 31]	108 (17) [92 - 123]
Vitamin D (µg)	5	5.3 (0) [5.3 - 5.3]	4.5 (0.8) [3.8 - 5.2]	0.8	0	0.1 (0.1) [0 - 0.2]	4.6 (0.7) [3.9 - 5.3]
Vitamin E (mg)	12	6.8 (0) [6.8 - 6.8]	5.8 (0.6) [5.2 - 6.3]	1	0	0.8 (1) [0 - 1.7]	6.5 (0.9) [5.7 - 7.4]
Vitamin K (µg)	90	150 (0) [150 - 150]	147 (28) [121 - 174]	3	0	1 (2) [0 - 2]	148 (28) [122 - 174]

A statistically significant difference ($p < 0.05$) between served intake, food eaten in the hospital and that eaten in total is illustrated by underlining of the values.

*Served intake was defined as food served to the patients by the hospital catering service. This was calculated using the mean served intake over 3 non-consecutive days for each female patient. Only one female ward was studied.

†Food eaten in the hospital was defined as only that portion of intake consumed by patients from served intake alone. All female patients ($N = 7$) consumed food in the hospital.

‡Food wastage or second helpings were defined as the difference between served intake and intake from food eaten in the hospital. All 7 female patients exhibited wastage of food but none consumed seconds helpings. Values represent the mean.

§Food brought from the outside was defined as only that portion of intake consumed from a source not supplied by the hospital. Four of the 7 female patients brought food from the outside.

‖Total intake was defined as the sum of the intake from food eaten in the hospital and brought from the outside.

¶Reference for recommended intake calculated using both IBW and ABW from 25 - 30 kcal/d of energy and 1.5 g/d of protein required in a state of hypermetabolism.[10,11] The value calculated using IBW was used for comparison purposes.

**Reference for recommended intake taken from the dietary reference intakes (DRI) using the estimated average requirements (EAR) and the adequate intake (AI) (*italics*) when the EAR is not defined.[17] Only the value for magnesium required adjustment for age.

IBW = ideal body weight (61 kg for females[10]); ABW = actual body weight.

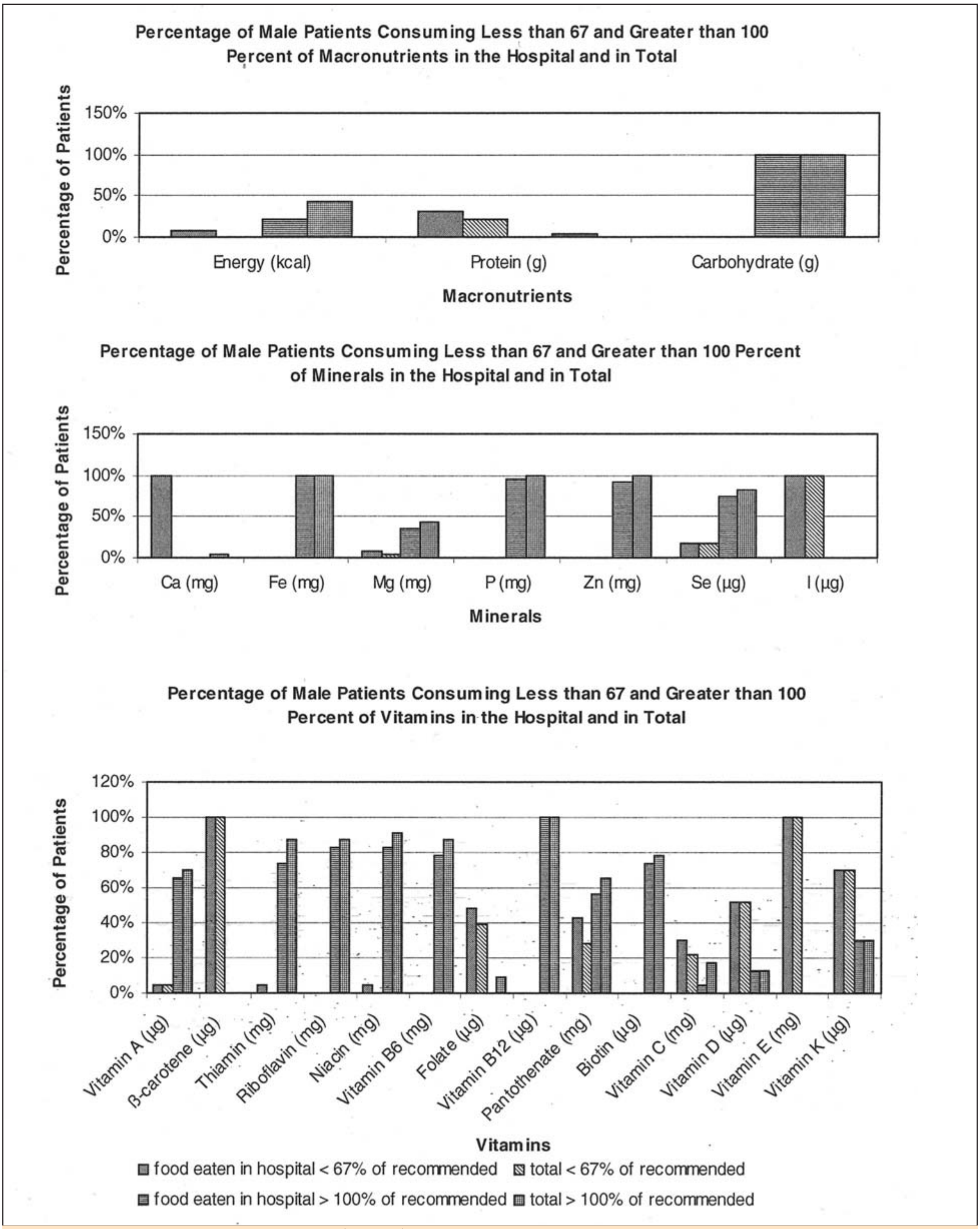

Fig. 4. The percentage of male patients (N = 23) consuming less than 67% and greater than 100% of recommended energy and nutrient intakes. When the recommended intake was indicated by a range (as for energy and beta-carotene), the upper value was used for comparative purposes so as to ensure adequacy of intake.

folate, vitamin C, vitamin D and vitamin E intakes did not meet recommendations; and riboflavin, niacin, vitamin B_6, vitamin B_{12} and biotin intakes exceeded recommendations. For males, vitamins consumed in the hospital reflected what was served, as both nutrient loss due to plate wastage and intake of second helpings were too small to change intake significantly. Total intake exceeded that from hospital food eaten, with the exceptions of beta-carotene, vitamin B_{12} and vitamin D, and vitamins in food brought from the outside therefore only raised the intakes of beta-carotene, vitamin B_{12} and vitamin D significantly. This is supported by Fig. 4, which illustrates that there were more male patients consuming less than 67% of recommended thiamin,

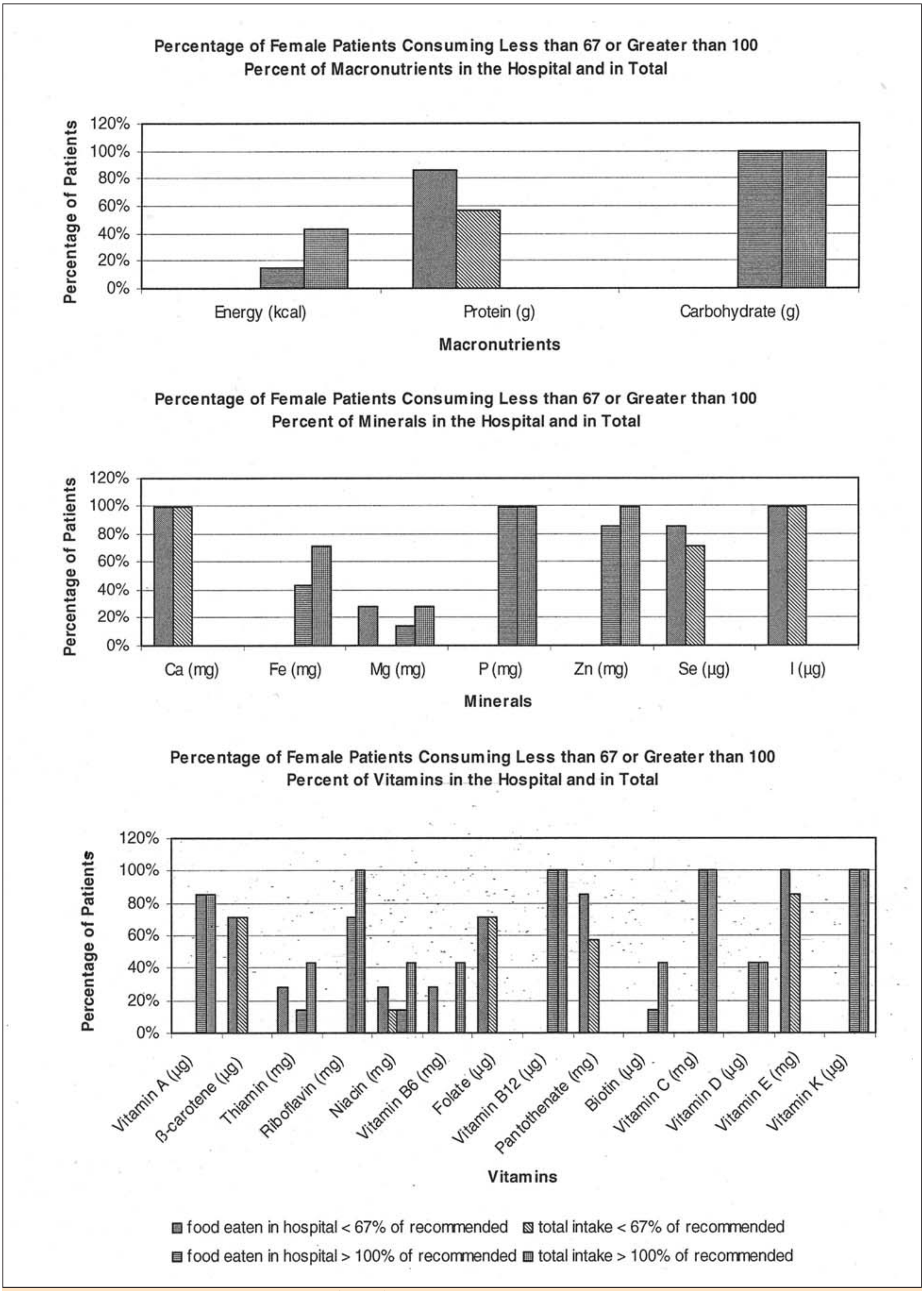

Fig. 5. The percentage of female patients (N = 7) consuming less than 67% and greater than 100% of recommended energy and nutrient intakes. When the recommended intake was indicated by a range (as for energy and beta-carotene), the upper value was used for comparative purposes so as to ensure adequacy of intake.

niacin, vitamin B_6, folate, pantothenate and vitamin C intakes from food served by the hospital than from food in total and, similarly, a greater number consuming more than 100% of recommended vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folate, pantothenate, biotin and vitamin C intakes from food in total than from hospital food. Fig. 4 also illustrates that all male patients were consuming less than 67% of the beta-carotene and vitamin E recommended.

For females, vitamin A, vitamin B_{12}, vitamin C and vitamin K in both hospital food served and that consumed exceeded recommendations (Table III); beta-carotene, thiamin, riboflavin, niacin, vitamin B_6, biotin and vitamin D intakes met recommendations; and folate, pantothenate and vitamin E intakes did not meet recommendations. For females, vitamins in food served exceeded that consumed, with the exceptions of vitamin C and vitamin K, as nutrient loss due to plate wastage caused a significant vitamin loss (with the exceptions of vitamins C and vitamin K). Total intake did not exceed intake from hospital food consumed, and therefore vitamins brought from the outside did not raise vitamin intake significantly. Despite this, Fig. 5 illustrates that there were more female patients consuming less than 67% of recommended thiamin, niacin, vitamin B_6, pantothenate and vitamin E intakes from hospital food than from total food and, a greater percentage consuming more than 100% of recommended thiamin, riboflavin, niacin, vitamin B_6 and biotin intakes from total foodf than from hospital food. Fig. 5 also illustrates that all female patients were consuming less than 67% of the recommended intake of vitamin E.

Micronutrient supplementation

Tables IV and V compare total intakes, including supplementation, with recommended intake, amount served, served amount consumed, and amount consumed in total, excluding supplements. For males (Table IV), thiamin, riboflavin and vitamin C supplementation did not significantly raise intake, whereas vitamin B_6 supplementation did. Similarly, for females (Table V) thiamin, riboflavin and pantothenate supplementation did not significantly raise intake above that recommended, served, consumed in hospital food or consumed in total, whereas vitamin B_6 supplementation did.

Table IV. Recommended, served and actual daily intakes, including that eaten in the hospital, that brought from the outside and that consumed in total, both excluding and including supplement prescription, of male patients (N = 23) for the supplemented nutrients only

		Daily intake				
			Actually consumed (mean, (SD), [CI])			
Nutrients*	**Recommended†**	**Served‡**	**Food eaten in hospital§**	**Food brought from outside**	**Total excluding supplements‖**	**Total including supplements¶**
Thiamin (mg)	1	1.1 (0.1) [1.1 - 1.1]	1.1 (0.2) [1.0 - 1.2]	0.2 (0.2) [0.1 - 0.3]	1.3 (0.3) [1.1 - 1.4]	3.0 (5.7) [0.5 - 5.5]
Riboflavin (mg)	1.1	1.9 (0.7) [1.6 - 2.2]	1.8 (0.7) [1.5 - 2.1]	0.2 (0.4) [0 - 0.4]	2.0 (0.7) [1.7 - 2.3]	2.4 (1.3) [1.8 - 2.9]
Vitamin B_6 (mg)	1.1	1.4 (0.2) [1.3 - 1.5]	1.4 (0.3) [1.3 - 1.6]	0.2 (0.3) [0.1 - 0.3]	1.6 (0.4) [1.4 - 1.8] *	18.8 (13.1) [13.1 - 24.4]
Pantothenate (mg)	5	5.4 (1.6) [4.7 - 6.1]	5.4 (1.7) [4.7 - 6.1]	0.4 (0.7) [0.1 - 0.7]	5.8 (1.6) [5.1 - 6.5]	6.7 (3.1) [5.3 – 8.1]
Vitamin C (mg)	75	51 (3) [50 - 52]	53 (18) [46 - 61]	9 (17) [1 - 17]	63 (27) [51 - 74]	84 (107) [38 - 131]

A statistically significant difference ($p < 0.05$) between served intake, food eaten in the hospital and that eaten in total is illustrated by underlining of the values. In addition, a statistically significant difference ($p < 0.05$) between total intakes excluding and including supplements is illustrated with a * between the values.

*Vitamin B_6, vitamin B complex (containing thiamin, riboflavin, vitamin B_6 and pantothenate) and vitamin C were served in a tablet form to the patients by the hospital doctor. Vitamin B_6 was served to 78% of male patients, vitamin B complex to 14% of male patients and vitamin C to 11% of male patients.

†Reference for recommended intake taken from the dietary reference intakes (DRI) using the estimated average requirements (EAR) and the adequate in-take (AI) (*italics*) when the EAR is not defined.[17]

‡Served intake was defined as food served to the patients by the hospital catering service. This was calculated using the mean served intake over 3 non-consecutive days for each male patient. Three different male wards were studied.

§Food eaten in the hospital was defined as only that portion of intake consumed by patients from served intake alone. All male patients (N = 23) consumed food in the hospital.

‖Total intake (excluding supplements) was defined as the sum of the intake from food eaten in the hospital and brought from the outside (Table II).

¶Total intake including supplements was calculated using the values from the sum of the total intake (excluding supplements) and the supplement prescription for each male patient.

Discussion

This study has shown that the served food consumed in the hospital by patients with TB, i.e. the actual nutrient intake, differed from that recommended in the case of protein, calcium, iodine, folate and vitamin E intake for males and females, beta-carotene, vitamin C and vitamin D intake for males, and selenium and pantothenate intake for females. In addition, while the amount of magnesium in food served met

Table V. Recommended, served and actual daily intakes, including that eaten in the hospital, that brought from the outside and that consumed in total, both excluding and including supplement prescription, of female patients (N = 7) for the supplemented nutrients only

Nutrients*	Recommended†	Served‡	Food eaten in hospital§	Food brought from outside	Total excluding supplements‖	Total including supplements¶
		Daily intake				
			Actually consumed (mean, (SD), [CI])			
Thiamin (mg)	0.9	1.0 (0) [1.0]	0.8 (0.1) [0.6 - 0.9]	0.1 (0.2) [0 - 0.3]	0.9 (0.1) [0.8 - 1.0]	6.6 (9.7) [0 - 15.6]
Riboflavin (mg)	0.9	1.1 (0) [1.1 – 1.1]	0.9 (0.1) [0.9 - 1.0]	0.1 (0.1) [0 - 0.2]	1.0 (0.1) [1.0 - 1.1]	2.2 (2.0) [0.4 - 4.0]
Vitamin B_6 (mg)	1.1	1.1 (0) [1.1 – 1.1]	0.9 (0.2) [0.7 - 1.1]	0.3 (0.6) [0 - 0.9]	1.2 (0.5) [0.8 - 1.6] *	14.8 (14.5) [1.4 - 28.2]
Pantothenate (mg)	5	3.6 (0) [3.6 – 3.6]	2.9 (0.3) [2.6 - 3.2]	0.4 (0.4) [0 - 0.8]	3.3 (0.3) [3.0 - 3.6]	6.1 (4.9) [1.6 – 10.7]
Vitamin C (mg)	60	102 (0) [102 - 102]	92 (14) [80 - 105]	15 (17) [0 - 31]	108 (17) [92 - 123]	108 (17) [92 - 123]

A statistically significant difference ($p < 0.05$) between served intake, food eaten in the hospital and that eaten in total is illustrated by underlining of the values. In addition, a statistically significant difference ($p < 0.05$) between total intakes excluding and including supplements is illustrated with a * between the values.

*Vitamin B_6 and vitamin B complex (containing thiamin, riboflavin, vitamin B_6 and biotin) were served in a supplement form to the patients by the hospital doctor. No female patients received a vitamin C supplement. Vitamin B_6 was served to 43% of female patients and vitamin B complex to 29% of female patients.

†Reference for recommended intake taken from the dietary reference intakes (DRI) using the estimated average requirements (EAR) and the adequate intake (AI) (*italics*) when the EAR is not defined.[17]

‡Served intake was defined as food served to the patients by the hospital catering service. This was calculated using the mean served intake over 3 non-consecutive days for each female patient. Only one female ward was studied.

§Food eaten in the hospital was defined as only that portion of intake consumed by patients from served intake alone. All female patients (N = 7) consumed food in the hospital.

‖Total intake (excluding supplements) was defined as the sum of the intake from food eaten in the hospital and brought from the outside (Table III).

¶Total intake including supplements was calculated using the values from the sum of the total intake (excluding supplements) and the supplement prescription for each female patient.

recommendations, the amount consumed in that food by females did not. The study also shows that for male patients actual nutrient intake from hospital food did not differ significantly from that served, with the exception of iodine, but that intake for females was significantly less than that served, with the exceptions of vitamin C and vitamin K, due to nutrient loss from plate wastage. Furthermore, food from outside sources raised intake significantly for males, with the exceptions of selenium, beta-carotene, vitamin B_{12} and vitamin D, whereas that consumed by females only raised the intake of carbohydrate and calcium significantly.

It would therefore appear that these institutionalised patients relied on the food served to them by the hospital to supply their energy and nutrient needs, and that, with the exceptions of protein and a few micronutrients, Brooklyn Chest Hospital was an efficient dietary provider. However, the inadequate protein supply is of concern in this setting. TB treatment (DOTS) is necessary for at least 6 months, which would imply a long-term dietary protein deficit for these patients if hospitalised for this length of time. Inadequate dietary protein has multiple detrimental effects on host resistance to TB by impairing macrophage functions and T-lymphocyte generation and maturation, and by potentiating macrophages to produce higher levels of transforming growth factor (TGF)-beta1, a cytokine implicated as a likely mediator of immunosuppression and immuno-pathogenesis in tuberculosis. Protein-deficient guinea-pigs infected with virulent *M. tuberculosis* cannot mobilise antigen-reactive lymphocytes to infectious primary foci, and those lymphocytes that do accumulate fail to expand clonally, because of either a lack of growth factors (e.g. interleukin (IL)-2) or the presence of suppressive factors (e.g. TGF-beta).[9]

With antituberculosis treatment, nutritional repletion normally occurs and this repletion must be fuelled by increased substrate intake. While resting energy expenditure does not change significantly during treatment, energy intake increases markedly[18] provided that adequate energy supply is available. Before commencement of treatment patients are usually underweight and malnourished, after-effects of the cachectic catabolic state and reduced energy intake having caused wasting. In terms of muscle wasting specifically, utilisation of amino acids for protein synthesis may be impaired by pro-inflammatory cytokines, a phenomenon referred to as 'anabolic block'. Although there is still much to be understood about the pathophysiology of the wasting seen in chronic infections such as tuberculosis, it is clear that, in addition to good antituberculosis therapy, patients need a good supply of nutrients during the treatment/recovery phase in order to support anabolism and immune function, resulting inevitably in decreased morbidity.[8]

Complete nutritional rehabilitation can take 12 months,[8] and even after 6 months of successful antimicrobial chemotherapy PTB is associated with increased oxidative stress, which is unrelated to cigarette smoking and characterised by increased levels of circulating lipid peroxides and low concentrations of plasma vitamin E.[19] In this regard, it is worth noting that inadequate amounts of the antioxidant micronutrients selenium, beta-carotene, vitamin C and vitamin E were served to and consumed by the male and female patients at Brooklyn Chest Hospital. The provision of these micronutrients was therefore insufficient. A lower incidence of TB has been reported among individuals who consume more fruits, vegetables and berries,[20] suggesting that antioxidants, among other chemicals present in these foods, serve a protective role, especially in view of the fact that chemotherapy raises the free-radical burden. Even before chemotherapy, increased circulating levels of free radicals have been found in patients with PTB.[21]

Inadequate amounts of folate (all patients) and beta-carotene (male patients) were served and consumed in the hospital, and it has been found that patients with TB have blood abnormalities including reduced serum and/or red cell folate and serum vitamin A and beta-carotene levels.[22] Inadequate intake may therefore synergistically ensure that these levels remain low. Even though these nutrients may not be able to return to normal, due to drug interactions[23] or the inflammatory process,[8] adequate dietary supply would still provide the best nutritional rehabilitation possible. Although inadequate vitamin D was served to and consumed in the hospital by males, a dietary vitamin D deficiency does not appear to alter the level of innate or vaccine-induced resistance to virulent *M. tuberculosis* or monocyte/macrophage functioning.[9]

Consumption of food brought from the outside was a significant energy and nutrient source for males, with the exceptions of selenium, beta-carotene, vitamin B_{12} and vitamin D, but only a significant carbohydrate and calcium source for females. Although this external food source raised the intakes of those nutrients that did not meet recommendations, with the exceptions of beta-carotene and vitamin D for males and calcium for females, it did not raise intakes of these nutrients sufficiently to meet recommendations. As far as energy distribution is concerned it is also worth noting that the macronutrients from an outside source were low in protein and carbohydrate and high in fat. In contrast, the energy distribution of macronutrients both served by and consumed in the hospital was more balanced. This suggests that the patients either prefer less nutritious, higher-fat food choices when given the option of purchasing food or that this is the only choice of food available at the hospital tuck shop. Intervention to educate patients on the importance of nutrition, not only for general health but for immunological and nutritional rehabilitation, is therefore highly recommended. The hospital tuck shop should also be encouraged to stock healthier alternatives.

The amount of nutrients in the food served by the hospital, with the exceptions of protein and the micronutrients mentioned, is deemed sufficient for these patients with TB. However, the male patients did not lose a significant amount of nutrients due to plate wastage, and also consumed a significant quantity of food from an outside source, which may suggest that the current recommendations do not prescribe an adequate quantity of food for them. In contrast, the female patients seemed to have more than enough food served to them, with a significant loss of food due to plate wastage and also less consumption of food from an outside source. Although plate wastage among female patients caused significant intake loss, magnesium was the only nutrient for which intake fell below the hospital recommendation, and even this would have been adequate had plate waste not occurred.

Though the body mass index represents the patients' nutritional status at varying stages of recovery rather than at diagnosis or full rehabilitation, and a certain percentage would therefore be expected to be malnourished, the presence of severely malnourished patients especially is still a concern, and they should be targeted for nutritional intervention programmes. Patients with active TB become malnourished due to wasting caused by the infection itself, but by the same token a malnourished state further promotes infection by increasing morbidity and susceptibility and by impairing immune function.[8] Patients admitted to hospital with active TB have significant reductions in BMI, skinfold thickness, arm muscle circumference and proportion of fat, compared with healthy controls.[24,25] During chemotherapy, however, progressive nutritional recovery is achieved with restoration of these indices.[24] Weight or BMI measurements from diagnosis until hospital discharge could have given a true reflection of nutritional rehabilitation, but as this was a cross-sectional study a weight history was not recorded, and weight determination over the 1-week study period may not have been meaningful.

In addition to the hospital supplying food to the patients, the hospital doctor(s) also routinely prescribed micronutrient supplementation in the form of pyridoxine and vitamin B complex (containing thiamin, riboflavin, pyridoxine and pantothenate) to selected patients. In addition, one severely malnourished man received a vitamin C supplement. Supplementation with vitamin B complex did not raise overall average intake of thiamin, riboflavin or pantothenate significantly, but this was probably because only 14% of male and 29% of female patients received a B complex supplement. Supplementation with pyridoxine, however, caused a significant increase in average intake, probably because a much higher percentage of patients received this supplement (78% of males and 43% of females). With the exception of pantothenate intake by females, B-vitamin supplementation was unnecessary to achieve recommended intake as both hospital food served and that consumed achieved recommendations. It could therefore be suggested that the money spent on vitamin B complex supplementation should rather be channelled into the catering budget, for example to increase the supply of protein, or used to purchase more necessary supplements such as micronutrients, of which the amount served was inadequate (especially calcium, iodine and vitamin E for all patients and beta-carotene for males, with an intake below 67% of that recommended).

Pyridoxine is routinely prescribed to patients receiving isonicotinic acid hydrazide (INH) or isoniazid as part of the DOTS programme. This is because INH complexes with pyridoxine in the body, interfering with its metabolism at several points and rendering it unavailable for use.[23] However, the Department of Health[2] recommends that it is unnecessary to prescribe pyridoxine routinely and that only those patients who are alcohol abusers, pregnant, diabetic or epileptic should receive a protective dose of 10 - 25 mg of pyridoxine per day. While none of our subjects fitted these criteria, the hospital doctor(s) may have prescribed pyridoxine to patients receiving INH because it behaves as a pyridoxine antagonist in patients on this drug.

In summary, Brooklyn Chest Hospital served a relatively balanced and nutritious diet to its patients with TB. However, an increase in the supply of protein, calcium, iodine, folate and vitamin E to all patients; beta-carotene, vitamin C and vitamin D to males; and selenium and pantothenate to females is still suggested, together with nutritional intervention programmes targeting at least the malnourished patients. That said, the data acquired were based on a very small sample of 30 patients in total, with only 7 females, and recommendations should therefore be confirmed by larger studies. A larger sample size would also allow subdivision of data in order to investigate the intakes of the patients with low BMI. Furthermore, the study was conducted in only one hospital and as far as the researcher is aware is the only study of this type, and it is therefore recommended that this project serve as a pilot for further larger studies.

Conclusions and recommendations

Nutritional intervention programmes may include the following:

- Increased protein supply within financial constraints. Less costly alternatives include pulses, with soy beans providing a good option as they contain all the essential amino acids.
- Increased supply of fresh and/or dried fruit.
- Micronutrient supplementation with calcium, iodine and vitamin E at least and also folate supplementation to all patients; beta-carotene, vitamin C and vitamin D to male patients; and selenium to female patients, as financial constraints dictate.
- Introduction of educational posters at the hospital so that the patients can learn the importance of good nutrition, not only for general health but also to support the healing process. This will encourage healthier choices of food from an outside source.

In conclusion, although with the exceptions of protein and the few micronutrients mentioned above Brooklyn Chest Hospital was an efficient energy and nutrient provider, intervention is still suggested in order to elevate the supply of protein and the necessary micronutrients and to target malnourished patients. This will ensure that nutritional rehabilitation serves its rightful role as an adjunctive treatment to antituberculosis chemotherapy.

Many thanks to the supervisor of, and the staff at, Brooklyn Chest Hospital, for allowing me to perform the study there, to my study supervisors and to Dr S Fellingham for his statistical advice.

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