Served versus actual nutrient intake

of hospitalized patients with tuberculosis.

Teri Roberts

Thesis

presented to the Department of Human Nutrition

of the University of Stellenbosch

in partial fulfillment of the requirements for the degree of

Masters in Nutrition

Supervisors: Prof D Labadarios and Prof M Herselman

December 2003

Declaration

Hereby I, Teri Roberts, declare that this thesis is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

Signed:

August 2003

ABSTRACT

Objectives: To assess whether actual nutrient intake of hospitalized 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, the Western Cape, South Africa.

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

Outcome measures: Assessment included dietary intake in order to calculate energy and nutrient intake and requirements, and height and weight at the beginning of the study in order to calculate BMI.

Results: Patients were receiving and consuming sufficient macronutrients with the exception of protein in all patients, and 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, however, due to significant plate wastage by female patients, 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 of the patients were mildly to severely malnourished on the basis of their BMI.

Conclusions: According to current recommendations, the patients institutionalized at Brooklyn Chest Hospital for tuberculosis were receiving inadequate protein and selected 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). Therefore intervention programs, which serve as an adjunct to anti-tuberculosis therapy, should be introduced in order to rectify inadequate nutrient intake and to target malnourished patients.

OPSOMMING

Doelstellings: Om te bepaal of die werklike voedingstofinname van gehospitaliseerde pasiënte met tuberkulose verskil van dit wat deur die hospitaal voorgeskryf word, en dit wat huidiglik aanbeveel word.

Ontwerp: 'n Beskrywende, dwarssnit studie.

Milieu: Brooklyn Chest Hospitaal, te Brooklyn, Kaapstad, Westelike Provinsie, Suid Afrika.

Studie groep: Dertig pasiënte met pulmonale tuberkulose van Brooklyn Chest Hospitaal (23 manlik, en sewe vroulik) is ingesluit in die studie.

Toets parameters: Ondersoeke het ingesluit dieëtinname met die doel om energie en voedingstofinname en behoeftes te bereken, asook lengte en gewig meetings aan die begin van die studie om liggaamsmassaindex (LMI) te bereken.

Resultate: Pasiënte het genoegsame hoeveelhede makro-voedingstowwe ontvang en ingeneem, met die uitsondering van proteïene by alle pasiënte, asook mikro-voedingstowwe, met die uitsondering van kalsium, jodium, folaat, en vitamine E by alle pasiënte, beta-karoteen, vitamine C en vitamine D by manlike pasiënte en selenium en pantoteensuur by vroulike pasiënte. Die werklike inname van voedsel in die hospitaal het nie verskil van dit wat deur die hospitaal voorgeskryf is in die geval van manlike pasiënte nie, met die uitsondering van jodium. As gevolg van beduidende voedselvermorsing deur vroulike pasiënte was werklike inname egter minder as wat deur die hospitaal voorgeskryf is, met die uitsondering van vitamine C en vitamine K. ‘n Totaal van 52% van die manlike pasiënte en 71% van die vroulike pasiënte het ‘n normale voedingstatus gehad volgens hulle LMI. Die oorblywende pasiënte was gering tot ernstig wangevoed op grond van hul LMI.

Gevolgtrekkings: Volgens huidige aanbevelings het pasiënte, wat by Brooklyn Chest Hospitaal gehospitaliseer is vir tuberkulose, nie genoegsame hoeveelhede proteïene of geselekteerde mikro-voedingstowwe ontvang nie (kalsium, jodium, folaat, en vitamine E by alle pasiënte, beta-karoteen, vitamine C en vitamine D by manlike pasiënte, en selenium en pantoteensuur by vroulike pasiënte). Daarom word intervensie programme voorgestel om te dien as ‘n toevoeging tot anti-tuberkulose behandeling, met die doel om onvoldoende voedingstof innames reg te stel en om ondervoede pasiënte te teiken.

TITLE

Served versus actual nutrient intake of hospitalized patients with tuberculosis.

AUTHORS

1. **Teri Roberts BSc (Biochem and Microbiol)**

   Contribution: Conception and design of project, data collection, analysis and interpretation, drafting of article.

2. **Prof M Herselman BSc (Physiol and Diet), MNutr, PhD**

   Contribution: Study design, revising the article critically for important intellectual content and final approval of the version to be published.

3. **D Marais BNutr, MNutr**

   Contribution: Study design, revising the article critically for important intellectual content and final approval of the version to be published.

4. **Prof D Labadarios, BSc (Hon) (Nutr), SRD, PhD (Biochem), MS, MBChB, FACN**

   Contribution: Conception and design of study, revising the article critically for important intellectual content and final approval of the version to be published.

Institution:

Department of Human Nutrition, Faculty of Health Sciences, University of Stellenbosch.

Address all correspondence to Teri Roberts:

Address:	Dept of Medical Biochemistry, Faculty of Health Sciences, University of Stellenbosch, Francie van Zyl drive, Parow, 7505.
E-mail:	teri@sun.ac.za
Tel:	(021) 938 9069 / 083 539 5554

ACKNOWLEDGEMENTS

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 Fellingham for his statistical advice.

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INTRODUCTION

Tuberculosis (TB) is caused by *Mycobacterium tuberculosis*, an intracellular pathogen, which 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 other 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 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 sixty 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 of 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 eight percent 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 three and a half million new cases of TB in South Africa over the next decade and at least ninety thousand 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 due 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 recognized the high prevalence, long duration and complications of infections in malnourished individuals, and on 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 that malnutrition adversely affects the ability of the host to withstand infection.

Coetzee[7] found that the nutritional status of pre-treatment adolescent pulmonary TB out-patients was poorer than that of matched controls, and improved during treatment. Despite the higher reported intake of nutrients in these cases compared to the RDA, poor nutritional status investigated at a clinical, anthropometrical and biochemical level was found to be present in all the TB patient groups studied.

The link between tuberculosis and malnutrition has been recognized for many years and although, in an era of effective anti-tuberculosis chemotherapy, it may be argued that there is no longer a need to be concerned about malnutrition and tuberculosis, the role of nutritional support as an adjunctive treatment for tuberculosis 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 neither known whether institutions are adhering to these recommendations, nor even if a hospital supplies an adequate and balanced diet for the patients, these patients 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 hospitalized 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 using 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 to that currently recommended.
2. The actual energy and nutrient intake of hospitalized patients with TB does not differ significantly from that served by the hospital.
3. The actual energy and nutrient intake of hospitalized 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 (DOTS) due to the severity of their infection based on clinical and radiological assessments. Table 1 lists the anthropometric and sociodemographic details of the patients.

Patients received a standard drug regime as part of the directly observed treatment short-course (DOTS) strategy, modified accordingly depending on response to treatment, severity of disease and presence of multiple drug resistance (MDR). The DOTS strategy involves a combination of anti-tuberculosis 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, an age of 19 to 50 years and consumption of the standard hospital meals. Exclusion criteria included any disease (including HIV/AIDS) other than TB, multiple drug resistant (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 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 (Addendum A).

There were 7 wards at Brooklyn Chest Hospital, namely wards A to F and a surgical ward, housing between 40 and 45 patients with TB each. 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. The included wards, A, C and E, were for males and ward F, for females. Consequently therefore, 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-mentioned inclusion criteria was formulated. This gave a total of three patients from ward A, eight patients from ward C, 12 patients from ward E and seven patients 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) was collected by the researcher (TR) at Brooklyn Chest Hospital. Socio-demographic data recorded included age, gender, race, level of education, employment status, housing type and number of children and adults living in the household (Addendum B).

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 three-day semi-weighed food record. Two non-consecutive week days and a weekend day were included per week[12,13,14]. Each of the four wards was consecutively assessed over a period of one 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 (Addendum B).

The food scale used for weighing food (CAS computing scale, AD series, accurate to within ±0.01g) was calibrated both prior to 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 over night 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 (Addendum B).

Use of nutritional supplements, including dose, frequency and composition, were also recorded[12]. Patients' files were checked for any vitamin and/or mineral prescriptions (Addendum B). 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 served 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 BMI (Body Mass Index) for determination of nutritional status (Addendum B).

The WHO[15] have 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
- >/= 40.0 = obese class 3

Weight was measured on an electronic scale to the nearest 0.1 kg, in the morning, before breakfast, 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 prior to 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)[7,16].

Height was measured using a stadiometer, with the patient standing perpendicularly 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 heels, buttocks, scapulae 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, eyelevel 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 2 measurements was taken as the final recording[7,16].

A pilot study was performed just prior to the main study in order to optimize the methodology. A simple random selection of patients (n = 6) was done, choosing three 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, University of Stellenbosch. The superintendent at Brooklyn Chest Hospital also granted permission to perform the study subject to the patients' consent (Addendum A). 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 was 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 socio-demographic and anthropometric data were captured using the Microsoft Excel computer package. The nutritional status of the patients was categorized according to the BMI. A Fischer'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 Cape Coloureds or South African Africans and therefore recommendations were based on those required in a state of hypermetabolism, for energy and protein, and on the dietary reference intakes (DRI's) for the remaining nutrients.

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 that served to the patients by the hospital catering service.
- Actual intake, defined as that actually consumed by the patients. This was further divided into the following categories:
    - Actual intake from food eaten in the hospital, defined as only that portion of meals consumed by patients from the served intake, 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 intake 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 eaten in 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

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

Energy Distribution

Figures 2 and 3 illustrate the percentage contribution to energy from each macronutrient for males and females, respectively. For both males (Figure 2) and females (Figure 3), served intake, food consumed in the hospital, and total intake met the energy distribution requirement for carbohydrate but exceeded that for fat, while that 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.

Dietary Intake

Tables 2 and 3 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 to “not meet recommendations” if it fell below the CI, for served intake, food eaten in the hospital and total intake. In addition, served intake, food eaten in the hospital and total intake were compared using the T test and underlined to illustrate a significant difference. Figures 4 and 5 represent those male and female patients, respectively, consuming less than 67%, and greater than 100%, of energy and each nutrient eaten in the hospital and in total.

Macronutrient Intake

Energy, protein and carbohydrate intake consumed in the hospital by males (Table 2) met, did not meet and exceeded recommendations, respectively. This is due to the fact that served intake met, did not meet and exceeded recommendations, respectively. For males, macronutrient intake consumed in the hospital 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 eaten in the hospital and therefore food brought from the outside raised energy, protein and carbohydrate intake significantly ($p < 0.05$). This is supported by figure 4 which illustrates that there are a greater number of male patients consuming less than 67% of recommended macronutrient intake inside the hospital than in total and, similarly, a greater number consuming greater than 100% of recommended macronutrient intake in total than in the hospital. All 23 male patients consumed food in the hospital, ten exhibited plate waste, 11 consumed second helpings and 16 brought food from the outside.

Similarly for females (Table 3), energy, protein and carbohydrate intake consumed in the hospital met, did not meet and exceeded recommendations, respectively. However, while served intake similarly exceeded recommendations for energy and carbohydrate intake, and did not meet recommendations for protein intake, served intake was always above that consumed in the hospital. Thus, macronutrient intake consumed in the hospital by females did not reflect that served due to the fact that plate wastage caused a significant nutrient loss ($p < 0.05$). Total intake only exceeded carbohydrate eaten in the hospital 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, figure 5 illustrates that there are a greater number of female patients consuming less than 67% of recommended protein intake inside the hospital than in total, and, a greater percentage consuming greater than 100% of recommended energy intake in total than in the hospital. All seven female patients consumed food in the hospital and exhibited plate waste, none consumed second helpings and four brought food from the outside.

Micronutrient Intake

Minerals

Served calcium and iodine intake and that eaten in the hospital by males (Table 2) did not meet recommendations, iron, phosphorus, zinc and selenium intakes exceeded recommendations and magnesium intake met recommendations. For males, minerals eaten in the hospital reflected that served as both nutrient loss due to plate wastage and the intake from second helpings were too small to change intake significantly, with the exception of iodine intake where the intake of second helpings raised iodine intake significantly. Total intake exceeded that eaten in the hospital, 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 figure 4 which illustrates that there are a greater number of male patients consuming less than 67% of recommended calcium and magnesium intake inside the hospital than in total and, similarly, a greater number consuming greater than 100% of recommended calcium, magnesium, phosphorus, zinc and even selenium intake in total than in the hospital. Figure 4 also illustrates that all male patients were consuming calcium and iodine below 67% of that recommended.

Neither the served intake of calcium, selenium nor iodine nor that eaten in the hospital by females (Table 3) met recommendations, iron intake met recommendations and phosphorus and zinc intakes exceeded recommendations. Served magnesium intake exceeded that recommended however magnesium consumed in the hospital did not meet recommendations. For females, served minerals exceeded that consumed in the hospital due to the fact that nutrient loss due to plate wastage caused a significant mineral intake loss. Total intake did not exceed that eaten in the hospital, with the exception of calcium, and therefore food brought from the outside only raised calcium intake significantly. Although mineral intake brought from the outside did not raise intake significantly, figure 5 illustrates that there are a greater number of female patients consuming less than 67% of recommended magnesium and selenium intakes inside the hospital than in total, and, a greater percentage consuming greater than 100% of recommended iron, magnesium and zinc intakes in total than in the hospital. Figure 5 also illustrates that all female patients were consuming calcium and iodine below 67% of that recommended.

Vitamins

Served vitamin A, thiamin, pantothenate and vitamin K intake and that consumed in the hospital by males (Table 2) met recommendations; beta-carotene, folate, vitamin C, vitamin D and vitamin E intakes did not meet recommendations; and riboflavin, niacin, vitamin B6, vitamin B12 and biotin intakes exceeded recommendations. For males, vitamins eaten in the hospital reflected that served as both the nutrient loss due to plate wastage and intake of second helpings were too small to change intake significantly. Total intake exceeded that eaten in the hospital with the exceptions of beta-carotene, vitamin B12 and vitamin D intakes, and therefore vitamins brought from the outside only raised the intakes of beta-carotene, vitamin B12 and vitamin D significantly. This is supported by figure 4 which illustrates that there are a greater number of male patients consuming less than 67% of recommended thiamin, niacin, vitamin B6, folate, pantothenate and vitamin C intakes inside the hospital than in total and, similarly, a greater number consuming greater than 100% of recommended vitamin A, thiamin, riboflavin, niacin, vitamin B6, folate, pantothenate, biotin and vitamin C intakes in total than in the hospital. Figure 4 also illustrates that all male patients were consuming beta-carotene and vitamin E below 67% of that recommended.

Vitamin A, vitamin B12, vitamin C and vitamin K consumed by females (Table 3) in the hospital and that served exceeded recommendations; beta-carotene, thiamin, riboflavin, niacin, vitamin B6, biotin and vitamin D intakes met recommendations; and neither folate, pantothenate nor vitamin E intakes met recommendations. For females, served vitamins exceeded that consumed in the hospital, with the exceptions of vitamin C and vitamin K, due to the fact that nutrient loss due to plate wastage caused a significant vitamin loss, with the exceptions of vitamin C and vitamin K. Total intake did not exceed food consumed in the hospital and therefore vitamins brought from the outside did not raise vitamin intake significantly. Although vitamin intake brought from the outside did not raise intake significantly, figure 5 illustrates that there are a greater number of female patients consuming less than 67% of recommended thiamin, niacin, vitamin B6, pantothenate and vitamin E intakes inside the hospital than in total, and, a greater percentage consuming greater than 100% of recommended thiamin, riboflavin, niacin, vitamin B6 and biotin intakes in total than in the hospital. Figure 5 also illustrates that all female patients were consuming vitamin E below 67% of that recommended.

Micronutrient Supplementation

Tables 4 and 5 list the total intakes including supplementation for both males and females, respectively, as compared to that recommended, served, consumed in the hospital and in total, excluding supplements. For males (Table 4), thiamin, riboflavin and vitamin C supplementation did not significantly raise intake whereas vitamin B6 supplementation did. Similarly, for females (Table 5), thiamin, riboflavin and pantothenate supplementation did not significantly raise intake above that recommended, served, consumed in the hospital or in total, whereas vitamin B6 supplementation did.

DISCUSSION

This study has shown that neither the served intake consumed in the hospital by patients with TB, nor the actual nutrient intake, differed from that recommended with the exceptions of protein, calcium, iodine, folate and vitamin E intakes by males and females, beta-carotene, vitamin C and vitamin D intakes by males, and selenium and pantothenate intakes by females. In addition, while served magnesium intake met recommendations, that consumed in the hospital by females did not. This study has also shown that the actual nutrient intake consumed in the hospital by patients with TB did not differ significantly from that served in the case of males, with the exception of iodine, but was significantly less than that served in the case of females, with the exceptions of vitamin C and vitamin K, due to plate wastage causing nutrient loss. Furthermore, food consumed from an outside source by males raised intake significantly, with the exceptions of selenium, beta-carotene, vitamin B12 and vitamin D, whereas that consumed by females only raised the intake of carbohydrate and calcium significantly.

It would thus appear that these institutionalized patients relied on the food served to them by the hospital in order to supply their energy and nutrient needs and that, with the exceptions of protein and a few above mentioned micronutrients, Brooklyn Chest Hospital was an efficient dietary provider. However, the inadequate protein supply is of concern in this rehabilitative setting. Treatment (DOTS), is necessary for 6 months at least, and therefore, if hospitalized for this length of time, a dietary protein deficit in the presence of disease would be long-term. Dietary protein inadequacy leads to multiple detrimental effects on host anti-tuberculosis resistance 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 *Mycobacterium tuberculosis* cannot mobilize antigen-reactive lymphocytes to infectious primary foci, and those lymphocytes that do accumulate fail to expand clonally, either due to a lack of growth factors (e.g.interleukin (IL)-2) or the presence of suppressive factors (e.g. TGF-beta)[9].

With anti-tuberculosis treatment, nutritional repletion normally occurs and this repletion must be fueled by increased substrate intake[8]. While resting energy expenditure does not change significantly during treatment, energy intake increases markedly[17] provided that adequate energy supply is available. Prior to 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, utilization 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 anti-tuberculosis 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 characterized by increased levels of circulating lipid peroxides and low concentrations of plasma vitamin E[18]. In this regard, it is worth noting that the anti-oxidant micronutrients selenium, beta-carotene, vitamin C and vitamin E were inadequately served to and consumed by the male and/or female patients at Brooklyn Chest Hospital. The provision of these micronutrients was thus insufficient. Lower tuberculosis incidence has been reported among individuals who consume more fruits, vegetables and berries[19] suggesting that anti-oxidants, among other chemicals, present in these foods serve a protective role, especially in light of the fact that chemotherapy raises free-radical burden. Even before chemotherapy, there are increased circulating levels of free-radicals found in patients with PTB[20].

Folate (by all patients) and beta-carotene (by male patients) were inadequately served and consumed in the hospital and it has been found that there exist blood abnormalities in patients with TB, including reduced serum and/or red cell folate and serum vitamin A and beta-carotene levels[21]. 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[22] or the inflammatory process[8], adequate dietary supply would still provide the highest nutritional rehabilitation possible. Although inadequate vitamin D was served 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 B12 and vitamin D, but only a significant carbohydrate and calcium source for females. Although this external food source raised the intakes of those nutrients not meeting recommendations for males, with the exceptions of beta-carotene and vitamin D, and calcium not meeting recommendations for females, it did not raise intakes of these nutrients sufficiently enough to meet recommendations. It is also worth noting that the energy distribution of macronutrients consumed from an outside source was low in protein and carbohydrate and high in fat. This was in contrast to the energy distribution of macronutrients both served by and consumed in the hospital, which was more balanced in comparison. 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 is thus highly recommended in order to educate patients on the importance of nutrition, not only for general health, but for immunological and nutritional rehabilitation too. The hospital tuck shop should also be encouraged to stock healthier alternatives.

The served intake, with the exceptions of protein and the micronutrients mentioned, are deemed sufficient for these patients with TB, this is contradicted, however, by the fact that the male patients did not show a significant loss of nutrients caused by plate wastage and who also consumed a significant quantity of food from an outside source. This may suggest that the current recommendations do not prescribe an adequate quantity of food for male patients with TB. This contrasts with the female patients who seemed to have more than enough food served to them with the significant loss of food caused by plate wastage and who also had an insignificant outside food source. Although plate wastage among female patients caused significant intake loss, the intake of magnesium was the only nutrient consumed below the recommendation in the hospital, and even this would have been adequately consumed from the served intake had plate waste not occurred.

Though the body mass index represents the patients' nutritional status at varying stages of recovery rather than at diagnoses or full rehabilitation specifically, and a certain percentage of malnourished patients would therefore be expected, the presence of severely malnourished patients especially is still a concern, and these patients should be targeted for nutritional intervention programs. Patients with active TB become malnourished due to the infection itself causing wasting 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 to healthy controls[23,24]. During chemotherapy, however, progressive nutritional recovery is achieved with restoration of these indices[23]. A true reflection of weight recovery would have been elucidated had retreatment weight or BMI measurements from diagnosis until hospital discharge been taken in order to gauge whether or not sufficient nutritional rehabilitation had been achieved. Considering this was a cross-sectional study, a weight history was not recorded. However, in view of the fact that the study duration was one week long, weight determination over this time 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 male patient 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 due to the fact that only 14% of male patients and 29% of female patients received a B complex supplement. Supplementation with pyridoxine, however, caused a significant increase in average intake, probably due to the fact that 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 served intake and that consumed in the hospital achieved recommendations already. Thus it may be suggested that the money spent on vitamin B complex supplementation should rather be channeled into the catering budget to increase the supply of, for example, protein, or used to purchase more necessary supplements, such as micronutrients which were inadequately served, especially those where no patients consumed above 67% of that recommended which included calcium, iodine and vitamin E for all patients and beta-carotene for males.

Pyridoxine is routinely prescribed to patients receiving isonicotinic acid hydrazide (INH) or isoniazid as part of the DOTS program. This is due to the fact that INH complexes with pyridoxine in the body, interfering with its metabolism at several points, and rendering it unavailable for use[22]. However, the Department of Health[2] recommend 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 the patients included in this study fitted these criteria, the hospital doctor(s) may have prescribed pyridoxine to patients receiving INH due to the fact that it behaves as a pyridoxine antagonist in all patients receiving 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 programs targeting the malnourished patients at least. That said, the data acquired was based on a very small sample size of 30 patients in total, with only seven female patients, 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 only conducted in 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 programs 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 fresh and/or dried fruit supply;

- 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 may learn the importance of good nutrition, not only for general health, but also to support the healing process. This will encourage healthier food choices brought from an outside source.

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

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Table 1: Mean anthropometric and socio-demographic information of patients (n = 30)

		Number of Patients
Gender	male	77% (n = 23)
	female	23% (n = 7)
Mean age (years)	male	35 (28 – 44)
	female	31 (22 – 39)
Race	Black	31%
	Coloured	69%
Mean BMI	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.

Table 2: 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* II
Energy (kcal)¶	1900 - 2280 (IBW) 1361 - 1633 (ABW)	2069 (87) [2032 - 2107]	2074 (355) [1921 - 2228]	0	5	253 (349) [103 - 404]	2328 (321) [2189 - 2466]
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)	*1000*	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	1166 (142) [1104 - 1227]	1165 (226) [1067 - 1263]	1	0	91 (134) [33 - 149]	1256 (201) [1169 - 1343]
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]
ß-carotene (µg)	3000 - 6000	2286 (201) [2199 - 2373]	2362 (680) [2068 - 2656]	0	76	27 (88) [0 - 65]	2389 (682) [2094 - 2683]
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 B6 (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 B12 (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]

Abbreviations: IBW: Ideal body weight (76 kg for males[10]); ABW: actual body weight

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 that served to the patients by the hospital catering service. This was calculated using the mean served intake over three nonconsecutive 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 two male patients consumed the served intake with no plate waste or second helping, ten 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.

IITotal 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[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[10]. Only the value for magnesium required adjustment for age

Table 3: 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* II
Energy (kcal)¶	1525 - 1830 (IBW) 1329 - 1595 (ABW)	2059 (0) [2059 - 2059]	1587 (259) [1348 - 1826]	472	0	207 (266) [0 - 453]	1794 (198) [1611 - 1977]
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)	*1000*	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	1036 (0) [1036 - 1036]	813 (126) [696 - 930]	223	0	92 (127) [0 - 210]	905 (106) [808 - 1003]
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	1077 (0) [1077 - 1077]	875 (191) [698 – 1052]	202	0	17 (27) [0 - 43]	893 (197) [710 - 1075]
ß-carotene (µg)	3000 - 6000	4369 (0) [4369 - 4369]	3466 (900) [2633 - 4299]	903	0	56 (116) [0 - 163]	3522 (909) [2681 - 4363]
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 B6 (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 B12 (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]

Abbreviations: IBW: Ideal body weight (61 kg for females[10]); ABW: actual body weight

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 that served to the patients by the hospital catering service. This was calculated using the mean served intake over three nonconsecutive 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 seven 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 seven female patients brought food from the outside.

IITotal 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[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[10]. Only the value for magnesium required adjustment for age.

Table 4: 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 supplementsII*		*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 B6 (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 B6, vitamin B complex (containing thiamin, riboflavin, vitamin B6 and pantothenate) and vitamin C were served in a tablet form to the patients by the hospital doctor. Vitamin B6 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 intake (AI) (*italics*) when the EAR is not defined[10].

‡Served intake was defined as that served to the patients by the hospital catering service. This was calculated using the mean served intake over three nonconsecutive 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.

IITotal intake (excluding supplements) was defined as the sum of the intake from food eaten in the hospital and brought from the outside (Table 2).

¶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.

Table 5: 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

	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)	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 B6 (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 B6 and vitamin B complex (containing thiamin, riboflavin, vitamin B6 and biotin) were served in a supplement form to the patients by the hospital doctor. No female patients received a vitamin C supplement. Vitamin B6 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[10].

‡Served intake was defined as that served to the patients by the hospital catering service. This was calculated using the mean served intake over three nonconsecutive 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 3).

¶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.

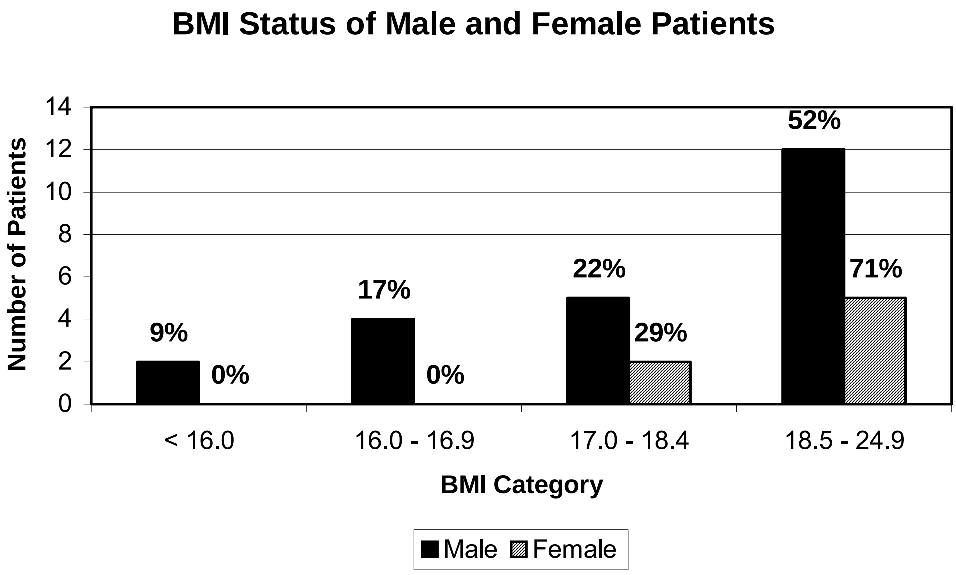


Figure 1: BMI profile of patients (n = 30) for both males (n = 23) and females (n = 7)
There was no significant difference between males and females ($p = 0.4268$).

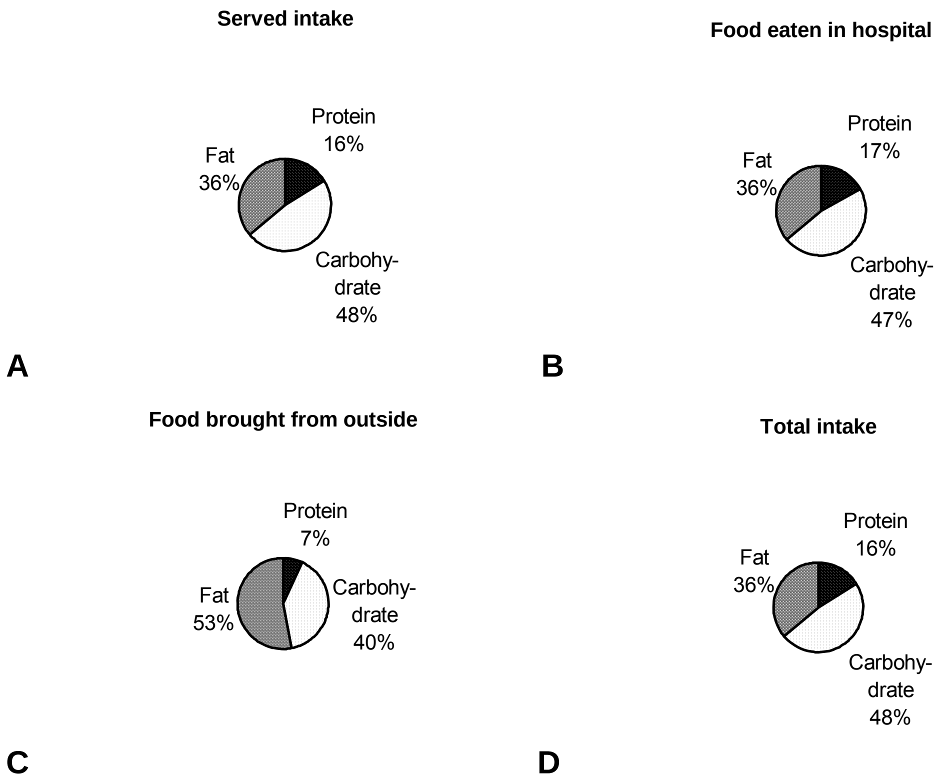
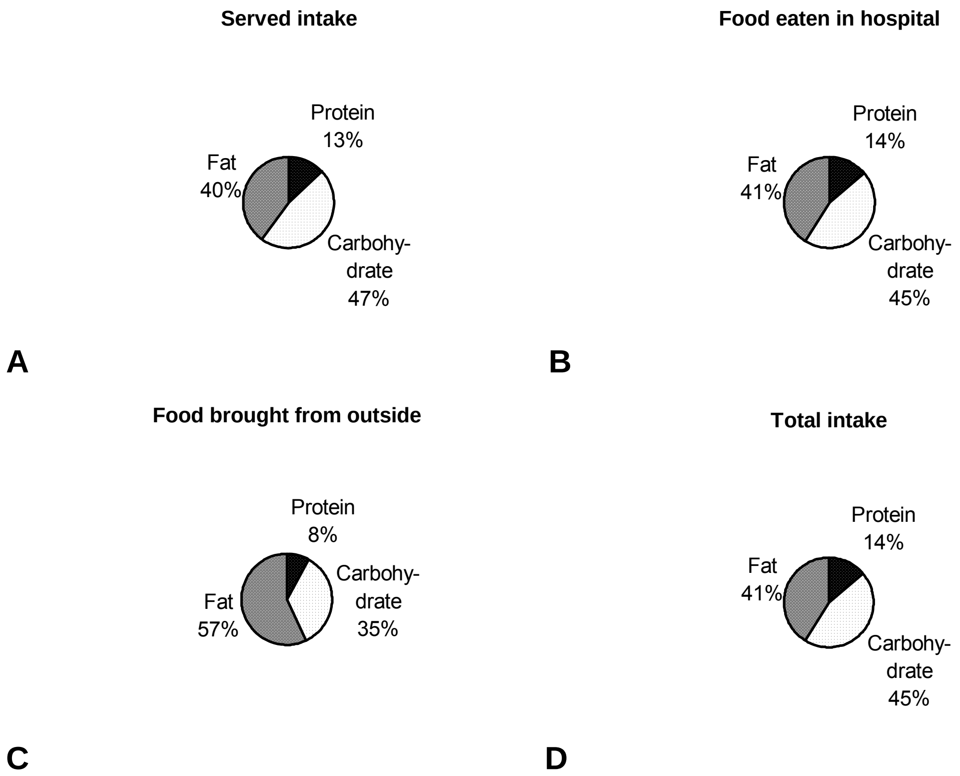
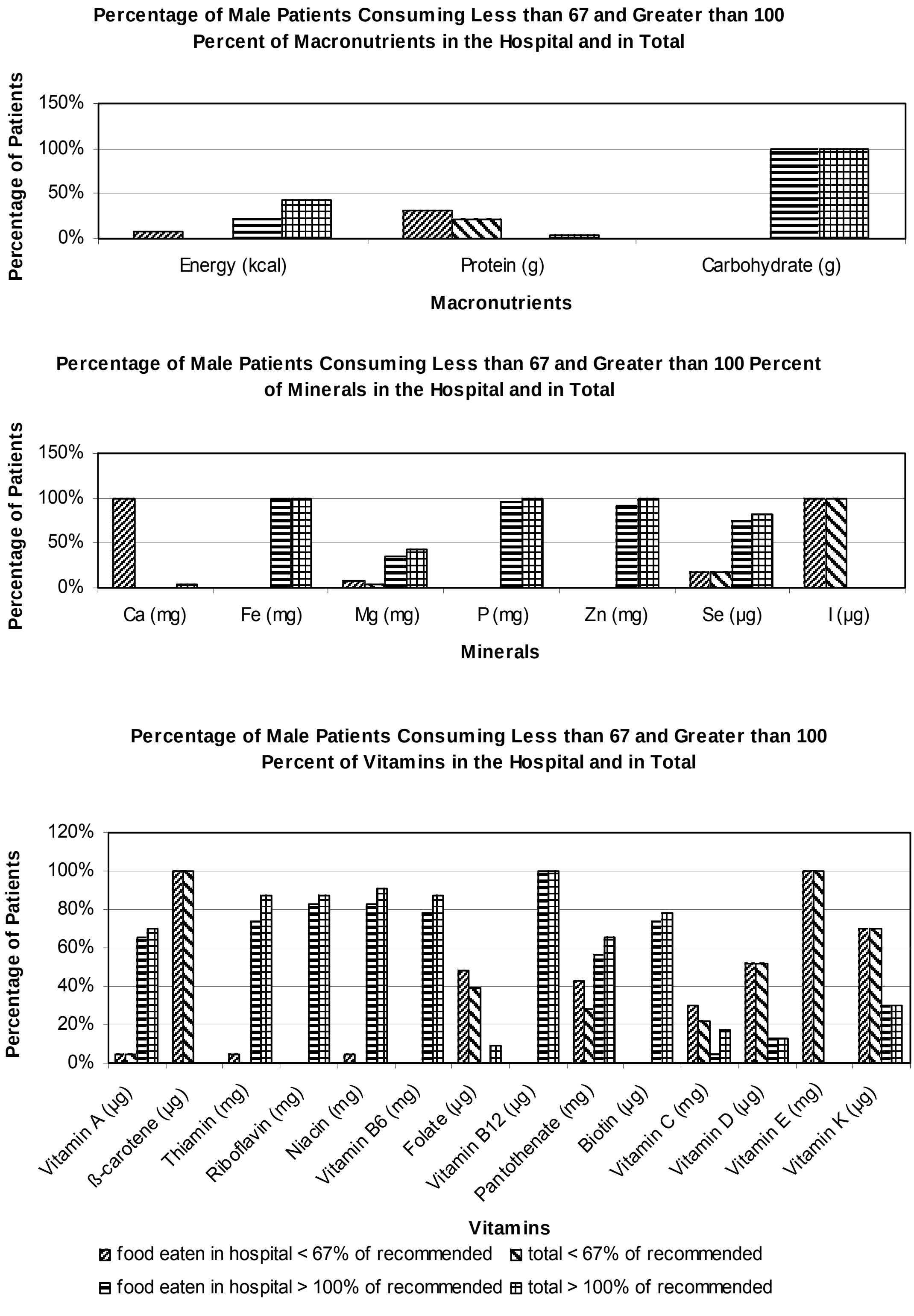


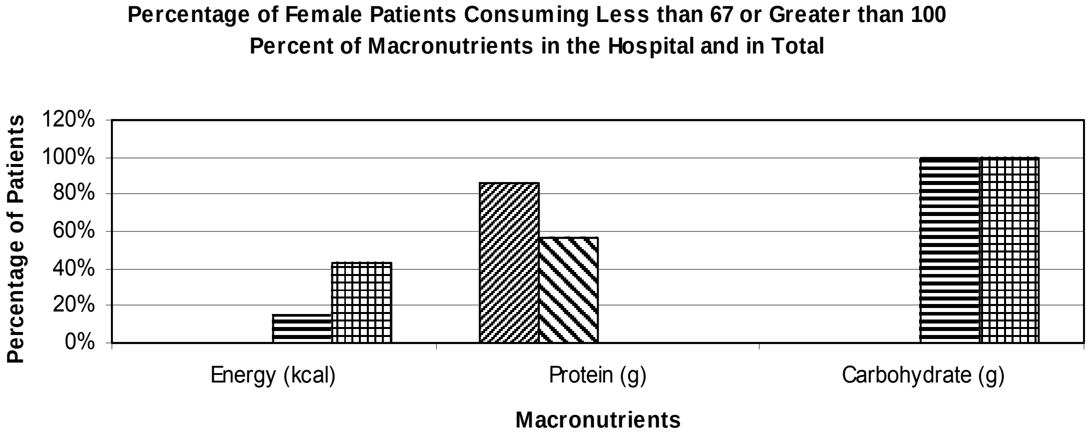
Figure 2: The percentage of total energy intake for served and actual macronutrient intakes for males (n = 23) The recommended energy distribution is such that 15 – 35 % of total energy intake (TEI) should come from protein, 45 – 65 % of TEI from carbohydrate and 20 – 35 % of TEI from fat[10]. Thus served 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.

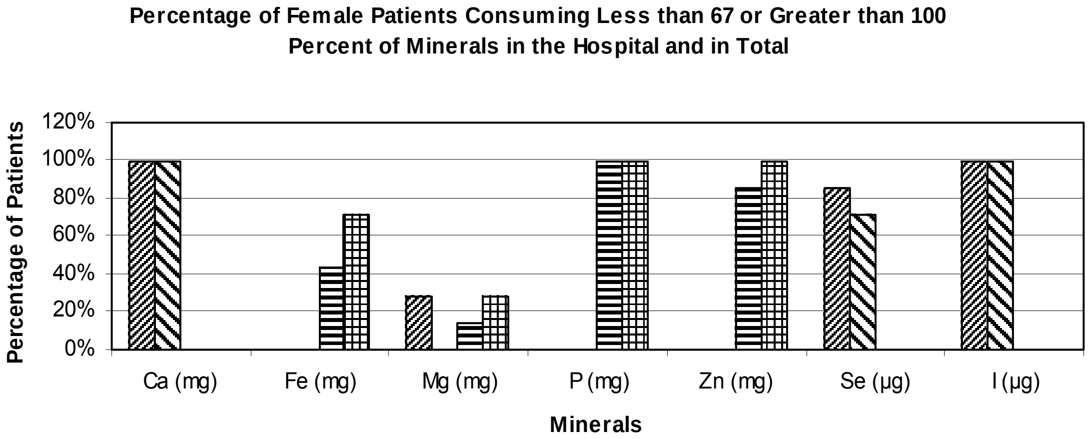


<u>Figure 3: The percentage of total energy intake for served and actual macronutrient intakes for females (n = 7)</u> The recommended energy distribution is such that 15 – 35 % of total energy intake (TEI) should come from protein, 45 – 65 % of TEI from carbohydrate and 20 – 35 % of TEI from fat[10]. 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.



<u>Figure 4: The percentage of male patients (n = 23) consuming less than 67% and greater than 100% of recommended energy and nutrient intakes.</u> 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.





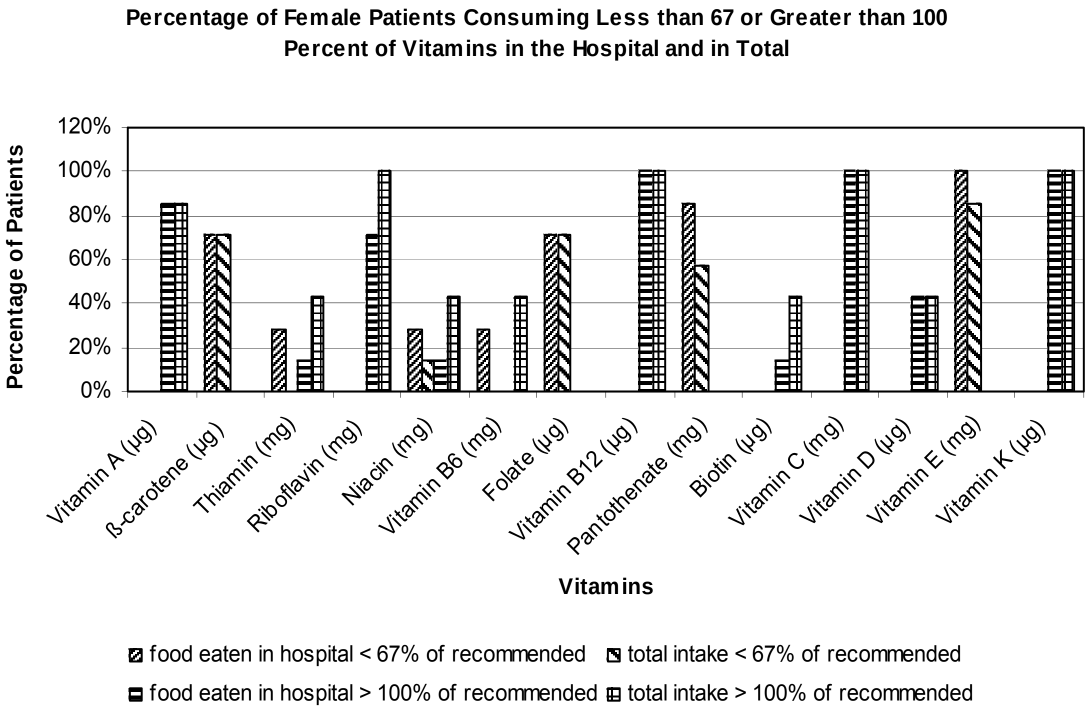


Figure 5: The percentage of female patients (n = 7) consuming less than 67% and greater than 100% of recommended energy and nutrient intakes. When the recommended intake was indicated by a range (as for energy and beta-carotene), the upper value was used for comparative purposes so as to ensure adequacy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

ADDENDUM A

INFORMATION AND PERMISSION DOCUMENT

Actual nutrient consumption of institutionalized tuberculosis patients compared to that supplied and that required by the patient.

(referral number 2002/C083)

Declaration by patient or patient representative:

I, the undersigned, ____

[ID ____], the patient,

or in my position as ______________________________________ of the patient,

from (address) ____

A. Confirm that

I / the patient am invited to take part in the above mentioned research project undertaken by the Department of Human Nutrition from the University of Stellenbosch.

1. It was explained that:

Before being included in the study, the researcher will investigate the patient's hospital file to check for inclusion and exclusion criteria data. This will include HIV/AIDS status. The researcher will ask the ward nurse and hospital doctor to verify the enclosed information and supply missing information. Patients with any other disease (including HIV/AIDS) or condition besides TB will be excluded.

The actual nutrient and energy intake of the patients consenting to take part in this project will be compared to that supplied by the hospital itself and that recommended to investigate whether any significant differences are present and why. Other variables will include birth date, gender, race, level of education, employment status, housing type and number of children and adults living in the household. Height and weight will also be measured.

Three standard meals will be weighed in the kitchen before mealtimes. Food wastage will be weighed after patients have finished their meal. Any food or beverage consumed from an external source will also be weighed. It will also be asked if the patient is unable to consume his/her usual amount and why this is so.

A total of 50 patients will be recruited (10 from each ward A, C, D, E and F).

Data capture will occur at Brooklyn Chest Hospital during September and October 2002 on 3 days out of a week for each patient.

2. The researcher is responsible for any inconveniences, discomforts or risks the patient may suffer due the above mentioned investigation.

3. It was further explained that the patients and the hospital itself will have full access to all the results and conclusions based on these investigations. The hospital may also be able to act on the results, as they so wish.

4. I am informed that the information collected is handled confidentially and will be implemented as the following:

Submitted as an article in a scientific journal and as a presentation at a scientific congress.

5. I / the patient during / after completion of the project will have full access to all the information and results found in the project, without any pre-requisites.

6. I am informed that I may refuse to take part / to allow the patient to take part in this project (and that I / the patient may terminate participation at any time) and that so-called refusal or termination won't prejudice my / the patient's current / future treatment by this institution. I also understand that the researcher may withdraw me / the patient from the project if it is in my / the patient's best interest.

7. The information mentioned above was explained by the researcher in English and/or Afrikaans. I have a good understanding of the language and had an opportunity to ask questions, all of which were satisfactorily answered.

8. I was not obligated or forced to participate in this project and I realize that I / the patient can terminate participation at any time without any penalties.

9. Participation in the project holds no costs for me / the patient.

B. I agree / the patient agrees, free-willingly, to participate in the above mentioned project

Signature of ___________________________________ on ____ / ____ / ____

Patient's / representative of patient's signature or right thrumb print

---

Witness ____

Declaration by researcher or researcher representative

I, the researcher, confirm that I have:

1. Explained the information included in this document to the patient and/or his/her representative.
2. Requested that he/she/they ask questions when anything was unclear.
3. Conducted this conversation in English and/or Afrikaans and that no interpreter was used.

Signature of the researcher ______________________ on ____ / ____ / ____

Witness ____

Important information

Dear patient / representative of the patient. Thank you kindly for your / the patient's participation in this study. Please contact me on the number (021) 938 9259 if there is at any time during the project:

1. An emergency situation as a result of the research,
2. you require any further information about the project, or
3. you have to terminate your participation in the project prematurely, due to discharge from the hospital or for any other reason.

INLIGTINGS- EN TOESTEMMINGSDOKUMENT

Werklike voedings-inname van institusionele tuberkulose pasiënte in vergelyking met wat voorsien word, en wat deur die pasiënt benodig word.

(verv. No. 2002/C083)

Verklaring deur of namens pasiënt

Ek, die ondergetekende, ____

[ID ____], die pasiënt,

of in my hoedanigheid as ________________________________ van die pasiënt,

van (adres) ____

A. Bevestig dat

Ek / die pasiënt uitgenooi is om deel te neem aan bogemelde navorsingsprojek wat deur die Departement Menslike Voeding van die Universiteit van Stellenbosch onderneem word.

1. Daar aan my verduidelik is dat:

1.1 Voordat die pasiënt aan die projek kan deelneem, moet die navorser die pasiënt se hospitaallêer deurwerk en vasstel of die pasiënt voldoen aan die insluitings- of uitsluitings-kriterium. Dit sal MIV/VIGS status insluit. Die narvorser sal by die saalverpleegster en hospitaaldokter vasstel of die inligting korrek is en ontbrekende inligting verkry. Pasiënte met enige ander siekte (MIV/VIGS inbegrepe) of enige ander toestand, behalwe TB, sal uitgesluit wees.

1.2 Die werklike nutriënt en energie inname van die pasiënte wat instem om aan die projek deel te neem sal vergelyk word met dit wat deur die hospitaal voorsien word, en dit wat aanbeveel word, om vas te stel of daar enige betekenisvolle verskille voorkom en waarom. Ander veranderlikes sal insluit geboorte datum, geslag, ras, vlak van opvoeding, beroep status, behuisings tipe, en die aantal kinders en volwasseners woonagtig in die huis. Lengte en gewig sal ook gemeet word.

1.3 Drie standard maaltye sal in die kombuis geweeg word voor maaltye. Oorskiet voedsel sal na die maaltye geweeg word. Enige voedsel en drank afkomsig van eksterne bronne sal ook geweeg word. Daar sal bepaal word of pasiënte minder as hul normale hoeveelheid voedsel kon inneem, en waarom.

1.4 ‘n Totaal van 50 pasiënte sal gewerf word (10 elk van saal A, C, D, E en F).

1.5 Data sal ingesamel word by Brooklyn Chest Hospitaal gedurende September en Oktober 2002 vir 3 dae per week vir elke pasiënt.

2. Die navorser is verantwoordlik vir enige ongerief, ongemak of risikos wat die pasiënt mag ondervind as gevolg van bogenoemde ondersoeke.

3. Daar is verder aan my verduidelik dat die pasiënte en die hospitaal self volledige toegang sal hê tot alle resultate en gevolgtrekkings gebaseer op hierdie ondersoeke. Die hospitaal sal ook geregtig wees om, indien nodig, op die resultate te reageer.

4. Ek is meegedeel dat die inligting wat ingesamel word as vertroulik hanteer sal word, en as volg aangewend sal word:
   As ‘n artikel in ‘n wetenskaplike tydskrif en as ‘n voordrag by ‘n wetenskaplike kongres.

5. Ek / die pasiënt sal tydens / na afloop van die projek volle toegang hê tot alle inligting en uitslae aangaande myself wat tydens hierdie projek versamel is, sonder enige voorwaardes.

6. Ek is meegedeel dat ek / die pasiënt mag weier om deel te neem aan hierdie projek (asook dat ek / die pasiënt enige tyd deelname daaraan mag staak) en dat sodanige weiering of staking my / die pasiënt se huidige / toekomstige behandeling by hierdie inrigting nie op enige manier sal benadeel nie. Ek verstaan ook dat die navorser my / die pasiënt van die projek mag onttrek indien dit in my / die pasiënt se belang geag word.

7. Die inligting hierbo weergegee is deur die navorser aan my in Afrikaans en/of Engels verduidelik. Ek is die taal goed magtig, en is geleentheid gegee om vrae te vra, en al my vrae is bevredigend beantwoord.

8. Daar is geen dwang op my geplaas aan die projek deel te neem nie, en ek besef dat ek / die pasiënt deelname te enige tyd mag staak sonder enige penalisasie.

9. Deelname aan die projek hou geen addisionele kostes vir my / die pasiënt in nie.

<u>B. Ek / die pasiënt stem hiermee vrywillig in om deel te neem aan die bogemelde projek</u>

Handtekening van ________________________________ op ____ / ____ / ____

Pasiënt / verteenwoordiger van pasiënt se handtekening of regter duimafdruk

---

Getuie ____

<u>Verklaring deur of namens navorser</u>

Ek, die narvorser, verklaar dat ek:

1. Die inligting vervat in hierdie dokument aan die pasiënt en/of sy/haar verteenwoordiger verduidelik het.
2. Hom / haar / hulle versoek het om vrae aan my te stel indien daar enigiets onduidelik was.
3. Dat hierdie gesprek in Afrikaans en/of Engels plaasgevind het en dat geen tolk gebruik is nie.

Handtekening van die narvorser ____________________ op ____ / ____ / ____

Getuie ____

Belangrike Inligting

Geagte pasiënt / verteenwoordiger van die pasiënt. Baie dankie vir u / die pasiënt se deelname aan hierdie studie. Kontak my asseblief by die nommer (021) 938 9259 indien daar tydens die duur van die projek:

1. ‘n Noodsituasie ontstaan wat spruit uit die navorsing,
2. u enige verdere inligting aangaande die projek verlang, of
3. u deelname aan die projek moet staak as gevolg van ontslag uit die hospitaal of vir enige ander rede.

ADDENDUM B

KITCHEN DATA CAPTURE SHEET

Date / / **Day** Mon Tues Wed Thurs Fri Sat Sun

WEIGHED RECORD

			Amount (g)			
	Food / Beverage	Preparation details	1	2	3	Ave (net)
Breakfast						
Lunch						

Dinner						

WARD DATA CAPTURE SHEET

Ward A C D E F **Date** / / **Day** Mon Tues Wed Thurs Fri Sat Sun

Patient no. 1 2 3 4 5 6 7 8 9 10 **Patient name**

RECALL

	Food / Beverage	Preparation details	Amount		
			HM*	g	net
6pm - 8am					

* HM Household measurement

WEIGHED RECORD (8am to 6pm)

	Food / Beverage Wastage	**Amount (g)**	**net (g)**
Breakfast	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
Lunch	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
	- -	- -	
Dinner	-	-	

	-	-	
	-	-	
	-	-	
	-	-	
	-	-	
	-	-	
	-	-	
	-	-	
	-	-	
	-	-	

	Additional Food / Beverage	Preparation details	Amount		
			HM*	g	net
Internal	- -	- -			
	- -	- -			
	- -	- -			
	- -	- -			
	- -	- -			
External	- -	- -			
	- -	- -			
	- -	- -			
	- -	- -			
	- -	- -			

* HM Household measurement

USUAL INTAKE

Consuming usual intake today *yes / more / less*

if yes / no,
why anorexia

early satiety

GIT discomfort

weakness

feeling ill

demotivated

depressed

unappetizing hospital food

cold hospital food

culturally unacceptable hospital food

insufficient hospital food

no snacks supplied by hospital

NUTRITIONAL SUPPLEMENT(S) (only collected on day 1 of 3)

Name	**Dosage**	**Frequency**	**Ingredients**
- -	- -	- -	- -
- -	- -	- -	- -
- -	- -	- -	- -
- -	- -	- -	- -
- -	- -	- -	- -

USUAL INTAKE

Consuming usual intake currently (only day 1 of 3) *yes / more / less*

if yes / no, why anorexia

early satiety

GIT discomfort

weakness

feeling ill

demotivated

depressed

eat to take medication

unappetizing hospital food

cold hospital food

culturally unacceptable hospital food

insufficient hospital food

no snacks supplied by hospital

insufficient food at home

SOCIODEMOGRAPHIC AND ANTHROPOMETRICAL INFO (only collected on day 1 of 3)

Age				
Sex	M / F			
Race	C / W / B			
Level of edu	none			
	< grade 7			
	grade 7			
	< grade 10			
	grade 10			
	< matric			
	matric			
	tertiary			
Employment	yes / no (currently)			
Home type	None			
	Shack			
	Flat			
	House			
	Other			
In household	No. children			
	No. adults			
Weight	Reading 1 (kg)	Reading 2 (kg)	Ave (kg)	
				BMI
Height	Reading 1 (cm)	Reading 2 (cm)	Ave (cm)	