South African Journal of Clinical Nutrition 2022; 35(4):133–141
https://doi.org/10.1080/16070658.2021.1997267

SAJCN
ISSN 1607-0658 EISSN 2221-1268

ARTICLE

Patients in public hospitals received insufficient food to meet daily protein and energy requirements: Cape Town Metropole, South Africa

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Objectives: This study aimed to determine the energy and protein content of meals served and consumed by hospitalised patients compared with their needs, to assess patients' food satisfaction and investigate associations with energy and protein intake.
Design: This was an exploratory quantitative cross-sectional study.
Setting: Three public hospitals within the Cape Town metropole were recruited; a central hospital (945 beds), large district hospital (372 beds) and a medium district hospital (172 beds).
Subjects: Adult inpatients 18+ years admitted to medical or surgical wards, on a non-therapeutic/normal hospital diet were recruited by purposive sampling method between 2018 and 2019.
Outcomes measures: Each participant's weight and height were measured to calculate body mass index (BMI) and to determine energy/protein requirements. The Acute Care Hospital Foodservice Patient Satisfaction Questionnaire was administered. Meals were weighed before and after consumption to calculate energy and protein intake per patient/day.
Results: A total of 128 patients (males = 71) participated. Total protein served did not meet patient requirements in any of the hospitals. Consumed energy and protein were significantly below requirements in all hospitals ($p < 0.002$). Perceived food quality ($r = 0.38$, $p = 0.039$) and staff/service issues ($r = 0.39$; $p = 0.035$) were significantly positively correlated with protein intake, while appetite correlated positively ($r = 0.42$, $p = 0.006$; $r = 0.41$, $p = 0.008$) and length of stay (LOS) correlated negatively ($r = -0.46$, $p = 0.002$; $r = -0.42$, $p = 0.008$) with energy and protein intake, respectively.
Conclusion: Energy and protein served was significantly lower than participants' requirements in all three hospitals and none achieved the official ration scale amounts. Nearly 40% reported having a normal appetite and did not receive additional food from family or friends, which may lead to hospital-acquired malnutrition and increased hospital length of stay (LOS). Improved hospital food quality, quantity, mealtimes and staff training should be a focus to improve patient energy and protein intake.

Keywords: hospital-acquired malnutrition, patient food satisfaction, protein and energy, adults, food-service management, hospital staff training, food quality, ACHFPSQ

Introduction

Malnutrition is broadly defined as any imbalance in energy and nutrient intake, ranging from overnutrition to undernutrition. Undernutrition is prevalent in the developing world and is also found in age care facilities and hospitals.[1] According to the definition of the European Society for Enteral and Parenteral Nutrition (ESPEN), undernutrition may be as a result of disease-related weight loss, a protein deficiency or a deficit in specific nutrients.[2] More recently hospital acquired malnutrition has been recognised and defined as malnutrition first diagnosed 14 days after admission.[3]

Undernutrition is a common condition in the acute hospital setting and can develop in patients who have a low dietary intake, poor absorption and excessive nutrient losses or increased needs related to disease states.[2] Undernutrition is associated with higher infection rates,[4] increased muscle loss,[5] impaired wound healing,[6] increased rates of mortality and morbidity[7] and prolonged lengths of hospital stay (LOS)[8] as well as increased readmission rates, which in turn leads to increased hospital costs.[9] Hospital costs due to undernutrition have been estimated in the Netherlands to be as high as 1.9 billion euro or 22 billion South African Rand[a] per year[9] and are responsible for 30–70% higher hospital costs.[10] Low-to-middle-income countries such as South Africa have limited monetary resources, which highlights the need to reduce excessive hospital spending.[7]

The prevalence of undernutrition amongst short-term hospitalised patients has been well documented,[11] with rates in high-income countries ranging from 20% to 40% depending on patient population and diagnosis criteria.[5,12] In South Africa there are limited data regarding the prevalence of undernutrition in adult hospitalised patients, with just a small number of existing studies limited to certain geographical regions. For example, researchers found that in a total of 141 adult hospitalised patients in three urban Eastern Cape hospitals, 45.4% were undernourished at admission, of which 48.2% were at high risk and 24.1% at medium risk of undernutrition.[13] Another South African study, which included two hospitals from Cape Town and one from Johannesburg, revealed an undernutrition rate of 53.7% at admission amongst adult patients and the risk of undernutrition was associated with longer LOS and higher mortality.[7]

[a]1 Euro= 11.88 South African Rand in 2013

Public hospitals in South Africa use a ration scale that was developed by the South African Department of Health to ensure patients receive sufficient energy, macro- and micro-nutrients whilst in hospital.[14] In addition to ensuring that there is sufficient food on a patient's plate, other considerations such as patient food satisfaction may also influence how much food is consumed.[15] Patient satisfaction comprised constructs like quality of food, temperature of food, quality of crockery and cutlery, friendliness and helpfulness of staff, environmental smells or disturbances and meal choice.[16] Management of the staff and finances in the hospital food-service unit may further impact on the quality and quantity of food served.[17] In South Africa, 75% of public hospitals manage their own food-service units, and 25% make use of private catering companies.[18]

In this context and to further the work in this field, the objectives of our study were to determine: (1) the energy and protein quantity of the meals served and consumed compared with the energy and protein needs of patients receiving a normal hospital diet; (2) patients' satisfaction with five food-service constructs; and (3) to investigate correlations between patient satisfaction construct scores with energy and protein intake for future intervention planning.

Materials and methods

An exploratory quantitative cross-sectional study was conducted in three public hospitals in Cape Town, South Africa. Data were collected between July 2018 and June 2019 on three consecutive days at the central hospital (hospital A), the large district hospital (hospital B) and the medium district hospital (hospital C).

The researchers applied for permission to collect data from the National Health Research Database of South Africa.[19] Once each hospital agreed to participate, it was provided with information regarding data collection procedures and meetings were held with relevant management to ensure all parties within the food-service unit, housekeeping and ward personnel were informed of the research taking place.

A purposive sample of a minimum of 35 adult patients, aged older than 18, admitted to medical and surgical wards, who were receiving the normal hospital diet and consumed at least one meal at the hospital prior to interview was obtained after participant screening. Participants were excluded if they were on enteral or parenteral nutrition, received a therapeutic diet, were terminally ill, had feeding difficulties, or were not receiving three meals a day because of fasting, transfer or for medical reasons. Field workers were final-year honours dietetic students who were trained by the primary investigator a day prior to the field work. Field workers provided verbal participant information and gained written consent from each participant.

All three hospitals used a non-selective menu and centralised delivery service, meaning that food was portioned in the food-service unit and then sent to the wards. Only hospital A had a cook-chill food preparation system where food is cooked from raw ingredients, then blast chilled and kept for up to three days before reheating and service. Hospitals B and C used a conventional food preparation system where food is cooked from raw ingredients for each mealtime and served soon after. All three hospitals used in-house catering, meaning that the food-service units were run by the hospitals themselves.

The data collection process involved the following. Participants were identified early in the morning each day. The food was weighed in the kitchen before serving of each meal. The participants' plates of food were then removed once they finished eating. These plates were then cling-wrapped and leftovers taken to the kitchen to weigh. Each food item plated was weighed to ensure the food wasted could be subtracted from each food item served for every meal. Energy and protein requirements were calculated per patient by measuring their weight and height. Data from each patient regarding their age, LOS, appetite and amount of food received from other people (e.g. visiting friends or relatives) were also captured. Each patient was also asked to complete a food satisfaction questionnaire between mealtimes.

Hospital diet energy and protein content analysis

Field workers weighed three sample plates of food, to be served by the hospital, for breakfast, lunch, supper, snacks and drinks, each day, over three consecutive days. All individual food portions (e.g. chicken, rice and vegetables) were weighed by plating food items onto a plate and recording the weight of each food item separately using an electronic digital scale (SF-400A).

The average amount of each food item plated on three plates was used as a reference to calculate the amount of food that was served per mealtime. For mixed dishes such as spaghetti bolognaise, beef stew or macaroni and cheese, each component (protein, carbohydrate, vegetables) was estimated by assessing the hospital's standardised recipes and visually inspecting the final plated dish. For example, if beef stew weighed 300 g, the researcher would allocate an estimated proportion for each component as seen on that day. Beef stew for example consisted of approximately 30% beef, 20% carrots, 20% potatoes and 30% sauce. A weight corresponding to each proportion was then applied to each component of the dish. Therefore, the components of the beef stew were calculated as: beef weighed 90 g, carrots 60 g, potatoes 60 g and sauce 90 g.

These data were used to calculate the average energy and protein composition of the served hospital meals over three consecutive days, using FoodFinder3 software (a South African nutrient analysis software program).[20] The recipes obtained from each hospital were entered into FoodFinder3[20] as cooked food after taking into account cooking losses (e.g. meat/chicken) or increases (e.g. pasta/rice), using cooking estimates for each type of food.[21]

Patient energy and protein intake analysis

Field workers weighed three sample plates of food, to be served by the hospital, for breakfast, lunch, supper, snacks and drinks, each day, over three consecutive days. The average of three plates of food was used as a reference to calculate the amount of food served per mealtime.

All individual food portions (e.g. chicken, rice, and vegetables) were weighed individually using an electronic digital scale (SF-400A). Food consumed was then analysed for all three meals, as were snacks and drinks served by the hospital using the dietary analysis software programme FoodFinder3 to determine the energy, macro- and micronutrient content of the food consumed by each individual over a 24-hour period.[20]

Patient energy and protein requirements

To determine the daily energy requirements for the different age groups and genders, the Oxford equation[22] was used to calculate resting energy expenditure (REE) and multiplied by a factor of 1.3 to account for stress due to illness.[12,23] Protein requirements were calculated using 1.2 g/kg/day.[12] To avoid over- and under-estimation of energy and protein, adjusted bodyweight was determined: for those who had a BMI > 30, bodyweight was adjusted to correspond to a BMI of 27.5; and for those who had a BMI < 20, bodyweight was adjusted to correspond to a BMI of 20.[12]

Anthropometry

Weight

Participants were weighed without shoes using an electronic scale (Seca 3000, Hamburg, Germany), and weight recorded to the nearest 0.5 kg.[24] For patients who were unable to stand upright, the weight recorded in their patient medical folder was used.

Height

Height was measured with a stadiometer (Seca 3000) while the patient's head was positioned in the Frankfort plane with arms hanging down to the side. Values were recorded to the nearest 0.5 cm.[24] Bed length was used for the participants who were unable to stand upright, accounting for 8% of participants.

BMI

Height and weight were used to calculate body mass index (BMI), which was used to categorise patients according to their BMI: underweight (< 18.5 kg/m^2), healthy weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2) and obese (≥ 30 kg/m^2).[25]

Patient information and food service satisfaction questionnaire

An interviewer administered questionnaire was used (Supplementary Material, Appendix 1) to obtain age, current duration of hospital stay (< 1 week, 1–2 weeks, 2–4 weeks, 1–2 months and > 2 months) and food intake compared with normal (less than usual, unchanged, more than usual).

Due to the common practice of family/friends bringing food to patients in South African hospitals, a question was included to determine if family or friends provided food (most of my meals, some of my meals or none). This provided insight into confounding factors such as patients already having eaten, which might have resulted in little or no consumption of their hospital meal.

Additionally, the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ) was used and aimed to accurately measure consumer satisfaction with the food services.[16] The ACHFPSQ has been found to be a valid and reliable patient food service satisfaction questionnaire and showed good construct validity with between 0.61 and 0.89 Cronbach alpha values.[16] The ACHFPSQ took between 15 and 20 minutes to complete and was done at the patient's bedside in as much privacy as a hospital bed would allow. Student field workers speaking languages other than English were asked to translate where possible to accommodate Afrikaans and isiXhosa-speaking participants.

Twenty-two questions were grouped into five constructs, namely 'food quality', 'meal service quality', 'staff/service issues', 'physical environment' and 'meal size and sufficiency'.[16] A five-point Likert scale was applied where response options included: always; often; sometimes; rarely; and never. The ACHFPSQ was amended for the South African hospital food service context (Supplementary Material, Appendix 1). Four questions, namely questions 5, 7, 12 and 14, were removed before statistical analysis due to South African public hospitals' non-selective cycle menu and no cold foods or drinks being served.

Statistical analysis

Sample size was estimated by using the percentage frequency of patients who consumed less than 1.2 g protein/kg body weight/day on a normal hospital diet, which was 92% of hospitalised patients.[12] The sample size estimate was 35 patients per hospital[26] using a confidence level of 95% and confidence limit of 9%.

Statistical analysis was carried out using STATISTICA version 13 (TIBCO Software, Palo Alto, CA, USA).[27] Means, standard deviations, medians and interquartile ranges were calculated using descriptive statistics. Pearson's chi-square test was used to test for differences between categorical data. An independent Student's t-test and ANOVA was used for normally distributed numerical data, while Mann–Whitney U and Kruskal–Wallis ANOVA was used for non-normally distributed data. Correlations were tested using the Spearman rank order test. A p-value of < 0.05 was deemed to reflect significant difference.

Negative statements in the questionnaire were reverse coded as per the tool instructions during statistical analysis (Questions 2, 4, 6, 18, 21, 22 of the ACHFPSQ). An average was calculated for each construct in the ACHFPSQ, by adding all the questions that fall under that construct together and then dividing thus by the total Likert score (e.g. 4 out of 5 = 80%).

Ethical approval

Ethics approval was obtained from the University of Cape Town's Faculty of Health Sciences–Human Research Ethics Committee (UCT FHS–HREC; reference number 161/2018). The study was performed in accordance with the principles of the Declaration of Helsinki,[28] good clinical practice, and the laws of South Africa. Participants were asked at their bedside if they would like to take part in a study. The study was explained, an information sheet was provided and written, informed consent was obtained. Participants were assured that participation was not mandatory. Anonymity and confidentiality were ensured by using only hospital patient numbers and by keeping the bedside curtains drawn when collecting data. De-identified data were kept in a locked office, to which only the primary researcher had access.

Results

In total, 128 patients were recruited: hospital A: $n = 37$, hospital B: $n = 42$ and hospital C: $n = 49$ (Table 1).

Age, BMI, length of stay, appetite and food from family/friends

Hospital B had patients who were significantly older than the other two hospitals ($p = 0.017$), with the majority being over 51 years of age, which may account for hospital B having the longest length of stay (LOS), with 59% of patients staying longer than a week. The median BMI ranged between 23.5 and 25 kg/m^2 and did not differ significantly among the hospitals. Nearly half of the patients in Hospital C reported having an

Table 1: Participant characteristics, length of stay, appetite and food received from family/friends

Characteristics	Total ($N = 128$)	Hospital A ($n = 37$)	Hospital B ($n = 42$)	Hospital C ($n = 49$)	*p*-value
Male, *n* (%)	71 (55)	23 (62)	23 (55)	25 (51)	0.585*
Female, *n* (%)	57 (45)	14 (38)	19 (45)	24 (48)	
Age, years median (IQR)	45 (32–56)	37 (28–49)[a]	49 (36–64)[b]	45 (36–50)[a,b]	0.017**
Age categories, *n* (%):					0.044*
18–30	29 (23)	11 (30)	8 (19)	10 (20)	
31–50	57 (45)	17 (46)	13 (31)	27 (55)	
51–79	42 (33)	9 (24)	21 (50)	12 (25)	
BMI, kg/m^2 median (IQR)	23.8 (21–30)	23.95 (21–29)	25 (21–30)	23.55 (20–30)	0.701**
BMI category, *n* (%):					0.196*
Underweight (< 18.5)	8 (6)	1 (3)	2 (8)	5 (10)	
Healthy (18.5–24.9)	67 (52)	20 (54)	19 (45)	27 (55)	
Overweight (25–30)	23 (18)	10 (27)	10 (24)	4 (8)	
obese (> 30)	30 (23)	6 (16)	11 (26)	13 (27)	
Duration of hospital stay, *n* (%):					< 0.0001*
< one week	79 (62)	17 (46)	17 (41)	45 (92)	
1–2 weeks	37 (29)	14 (38)	22 (52)	1 (2)	
2–4 weeks	4 (3)	2 (5)	2 (5)	0	
1–2 months	8 (6)	4 (11)	1 (2)	3 (6)	
Appetite during hospital stay, *n* (%):					0.236*
Unchanged	47 (37)	12 (32)	12 (29)	23 (47)	
More than usual	15 (12)	3 (8)	5 (12)	7 (14)	
Less than usual	66 (52)	22 (60)	25 (60)	19 (39)	
Food received from family/friends, *n* (%):					0.018*
Most of my meals	10 (8)	6 (16)	3 (7)	1 (2)	
Some of my meals	67 (52)	23 (62)	22 (52)	22 (45)	
None	51 (40)	8 (22)	17 (41)	26 (53)	

Interquartile range (IQR); body mass index (BMI).
*Pearson chi-square test (p value < 0.05 is significant).
**Kruskal–Wallis ANOVA, medians with the same letter (a or b) do not differ significantly using multiple comparisons (p value < 0.05 is significant).

appetite that they would consider as 'usual' and reported a significantly higher prevalence of not receiving food from family and friends than the other two hospitals ($p = 0.018$) (Table 1).

Comparison between energy and protein requirements and actual intake for males and females within each hospital

The total energy requirements were calculated to be between 8255 and 8970 kJ for males, and between 7104 and 7333 kJ for females. Protein requirements were calculated to be between 73 and 87 g for males, and 78–80 g for females. Energy and protein intake of patients in all three hospitals was significantly below patients' energy and protein requirements. Hospital A had the largest discrepancy of 32% and 29% between energy intake and requirements for males and females respectively, while Hospital C had the largest discrepancy of 44% and 45% between protein intake for males and females respectively. All three hospitals showed an intake that was below the patient's needs. Energy intake was 1 305 kJ–2 888 kJ below patients' needs, while protein intake was 25 g–36 g below patients' needs (Table 2).

Comparison between hospitals patients' energy and protein requirements, amount served and actual intake

Energy and protein requirements of patients did not differ significantly between the hospitals (Figures 1 and 2). However, all three hospitals differed significantly regarding the average amount of energy ($p < 0.0001$, Kruskal–Wallis ANOVA) and protein ($p < 0.0001$, Kruskal–Wallis ANOVA) served. Hospital C served the smallest amount of energy and protein. Male patients in hospital C had a significantly lower intake of protein than either of the other two hospitals ($p < 0.0001$, ANOVA).

Meal plan, and average portion served and consumed over three days in three public hospitals

Overall, the average food plate wastage over three days was between 6% and 17%. Hospital B wasted: 17%; Hospital A 14%; and Hospital C 6%. The food item least consumed was fish cakes (52%) served in Hospital B. Hospital C served the lowest energy (6 345 kJ) and protein (40 g) containing menu over three days as reported in Figures 1 and 2. The areas where the menu in Hospital C fell short were that they served fruit only once in three days, one of the lunch main meals contained no animal or vegetable protein, and only a salad, which has a very low energy and protein content, was served with the main meal on one day (Table 3). See Supplementary Material Appendix 2 for more detail on the menus at each hospital and Supplementary Material Appendices 3 and 4 for the nutritional analysis of the menus.

Patient satisfaction with food quality and food service delivery

Hospital B had a significantly higher median score at 83% for the 'food quality' construct than the others, which were at

Table 2: Energy and protein requirements of males and females compared with actual intake in hospitals A, B and C

Hospitals	Energy requirements (kJ)	Energy intake (kJ)	*p*-value	Protein requirements (g)	Protein intake (g)	*p*-value
Hospital A ($n = 37$) Mean ± SD						
Male ($n = 23$)	8 970 ± 1 166	6 082 ± 1 570	< 0.0001*	87 ± 17	58 ± 11	< 0.0001*
Female ($n = 14$)	7 199 ± 728	5 130 ± 2 114	< 0.002*	78 ± 15	44 ± 18	< 0.0001*
Hospital B ($n = 42$) Mean ± SD						
Male ($n = 23$)	8 434 ± 1100	6 735 ± 1505	< 0.0001*	83 ± 16	58 ± 13	< 0.0001*
Female ($n = 19$)	7 104 ± 704	5 799 ± 1847	< 0.007*	79 ± 12	47 ± 19	< 0.0001*
Hospital C ($n = 49$) Median (IQR)						
Male ($n = 25$)	8 255(7930–9 070)	6 099 (5 657–6 321)	< 0.0001**	73 (70–86)	41(30–48)	< 0.0001**
Female ($n = 24$)	7 333(7 130–7 950)	5 729(5 448–6 174)	< 0.0001**	80(69–90)	44(31–48)	< 0.0001**

Kilojoule (kJ); gram (g); standard deviation (SD); interquartile range (IQR).
*t-test for independent variables (p value < 0.05 is significant).
**Mann–Whitney U-test (p value < 0.05 is significant).

67% and 70% respectively. Hospital C scored significantly lower at 87% for the 'staff/service issues' construct than the other hospitals, which scored a median of 100% each. Although only the 'staff/service issues' construct was found to be significantly lower in Hospital C than in the other two hospitals, Hospital C scored the lowest for all six of the constructs across all three hospitals (Table 4).

Correlations between energy and protein intake with patient satisfaction constructs and other variables

Four variables significantly correlated with protein or energy intake, namely 'food quality' construct, 'staff/service issues' construct, length of stay (LOS), and appetite. Hospital A had significant correlations between protein intake and two constructs, namely: 'food quality' ($r = 0.38$) and 'staff/service issues' ($r = 0.39$) (Spearman rank order correlation test; significance set at $p < 0.05$). In hospital B, energy and protein intake negatively correlated with LOS ($r = -0.46$ and $r = -0.42$) and appetite positively correlated ($r = 0.42$ and $r = 0.41$) with energy and protein intake (Spearman rank order correlation test; significance set at $p < 0.05$). Hospital C did not show any significant correlations with protein or energy intake of patients.

Discussion

This is the first study to determine the energy and protein quantity of the meals served in public hospitals in the Cape Town metropole compared with patients' individual energy and protein requirements. In addition, we determined patients' satisfaction with the food service system to identify potential interventions for improved energy and protein intake.

We found that an insufficient amount of food was served to supply energy as well as inadequate protein-containing foods to meet the protein requirements of adult patients in all three public hospitals in the Cape Town metropole. This finding

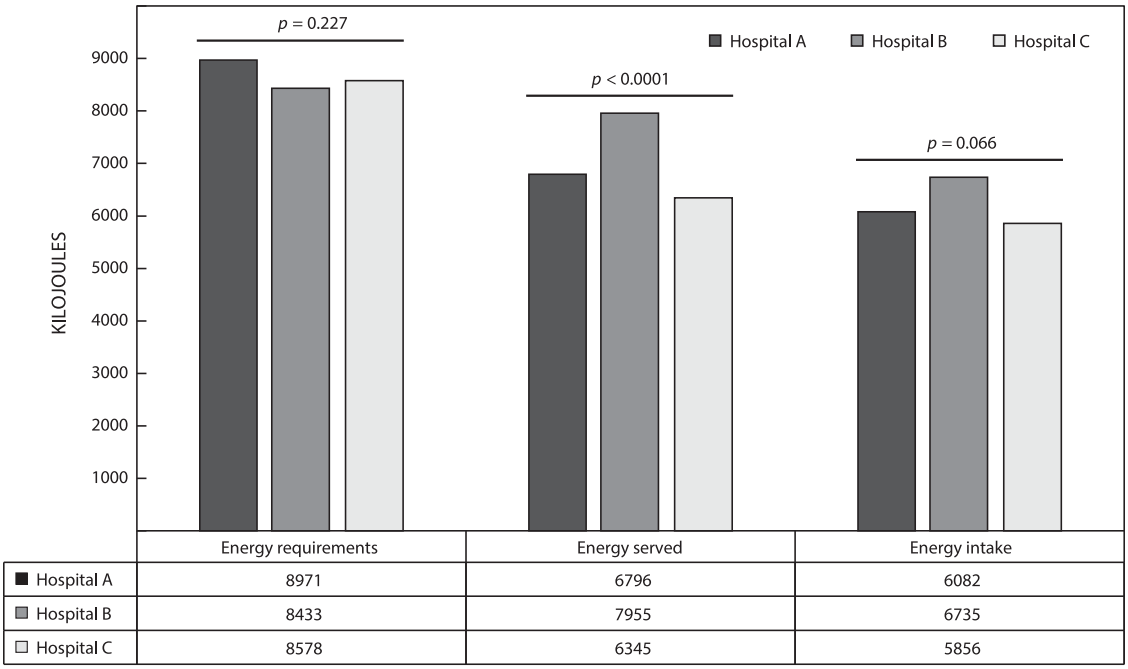
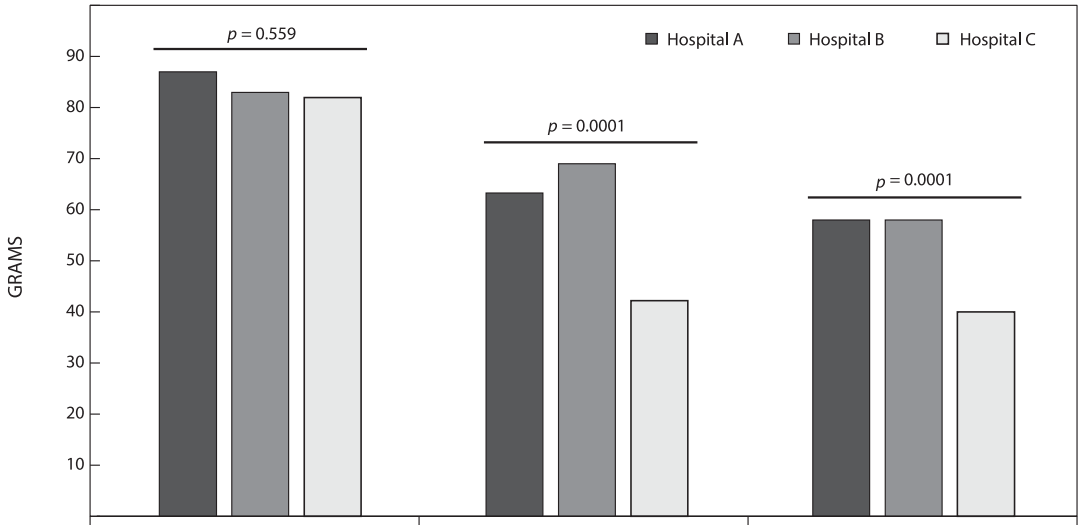


Figure 1: Comparison between hospitals of average energy requirements, amount served and intake for males.



	Protein requirements	Protein served	Protein intake
Hospital A	87	63.3	58
Hospital B	83	69.0	58
Hospital C	82	42.2	40

Figure 2: Comparison between hospitals of average protein requirements, amount served and intake for males.

may be due to poor staff training, where recommended portion sizes are not adhered to, or reflect insufficient funds available to public hospitals to meet catering costs.[17] Another reason may be hospital managements' expectation that all patients (including outpatients) are provided with meals, which means staff have to serve patients smaller portion sizes to stretch out the amount of food served.[17] Importantly, it may also be due to hospital food-service management not adhering to the South African Hospital Ration Scale.[17]

The ration scales are a set of hospital dietary guidelines that are mandated by the South African Department of Health and are based on the estimated nutrient needs of a healthy adult.[14] The ration scale states that the energy and protein content should achieve 12 073 kJ and 151 g protein per day. We found that the highest energy and protein amount served to patients was 7 955 kJ/d and 69 g/d respectively, which is 34% and 54% below the hospital ration scale recommendations, respectively.[14] Only hospital B, the large district hospital, supplied adequate energy 7 955 kJ to achieve female requirements of 7 104 kJ average (as determined by that sample group's sex, weight, height and age). However, all three hospitals supplied between 6 345 and 7 955 kJ for both males and females, while the requirements for males were significantly higher at 8 433–8 971 kJ.

Furthermore, patients in these hospitals consumed significantly less energy and protein than was served. A systematic review of hospital food service patient satisfaction studies has shown that improving patient satisfaction may improve nutrient intake.[29] Regarding patient satisfaction, two of the five constructs showed significant positive correlations with protein intake of patients, namely 'food quality' and 'staff/service issues'. 'Food quality' has been shown to be associated with concepts of freshness, taste/flavour, variety, aroma,[30] correct temperature of hot foods, tenderness of meat, appearance of meals and texture of food.[29] Based on our findings, we suggest that more attention should be given to the quality of food served by these hospitals. This could be achieved by implementing daily evaluations to gauge patient satisfaction, developing a broader range of recipes, enhancing menus, and ensuring that meals are provided at the correct temperature[29] and at the correct time.[31]

Research regarding 'staff/service issues' has shown that the attitude, neatness, knowledgeability and engagement of staff with patients are related to the patients' perception of the meal.[29] For instance, if staff were well trained, neat, helpful and aware of patients' nutrient requirements, food intake increased because patients' perception of the food environment was positive.[29] In addition, patients were often not able to feed themselves whilst in hospital and therefore required assistance with eating,[12] which relates to the concept of staff being helpful.

One possible strategy to address patients' low energy and protein intake may be to provide smaller protein-containing meals throughout the day. One study by Dijxhoorn *et al.*[12] found that by serving six smaller protein-containing meals such as yogurt, smoothies, cheese or sausages, patient energy and protein intakes improved significantly. The authors reported that 37% of the patients' energy needs were met using the six smaller meals, compared with the traditional way of serving three meals and two snacks, which met only 14% of the patients' energy needs.[12] Analysis of the data reported in the Western Cape Metropole public hospitals revealed that energy needs were met for 11% of patients in hospital A, 26% in hospital B and 4% in hospital C (Supplementary Material Appendix 5), which may lead to hospital-acquired malnutrition if patients were to stay in the hospital for extended periods of time.[3]

Given that our findings have shown that patients are consuming energy or protein intakes below recommendations, we suggest that a similar practice be undertaken to serve regular snacks in between meals, consisting of yogurt, milk, *amasi* (a sour-milk drink popular in South Africa), milkshakes, fruit smoothies, eggs, fruit salads with custard, sandwiches with protein fillings, biscuits, custard and jelly. An estimated 2–5 additional portions of protein-containing snacks would

Table 3: Public hospital meal plan, typical meals served, average of each serving and average percentage consumed per hospital

Meal plan	Hospital A[1]	Average serving[2] (g)	Percentage consumed[3]	Hospital B	Average serving[2] (g)	Percentage consumed[3]	Hospital C	Average serving[2] (g)	Percentage consumed[3]
Breakfast:									
Fruit	Apple	136	97	Apple	127	62	Orange	40	91
Porridge	Oats	173	78	Oats	122	84	Maize meal	214	90
Sugar	Sugar	25	79	Sugar	20	82	Sugar	11	88
Milk	Milk	100	79	Milk	100	82	Milk	69	92
Brown bread	Brown bread	60	80	Brown bread	60	70	Brown bread	70	79
Fat	Margarine	5	54	Margarine	7	70	Margarine	6	83
Spread/ protein	Jam	15	85	Jam	15	68	Syrup	10	79
Drink[4]	Coffee	250	93	Tea	250	96	Tea/coffee	250	97
Lunch:									
Starch	Samp[5]	104	78	Mashed potato	102	73	Rice	107	91
Protein	Brown beef stew	143	87	Fish fingers	155	73	Chicken chop suey	132	94
Vegetable	Green beans	58	64	Mixed veg	73	70	Sweetcorn	77	88
Supper:									
Starch	Rice	116	72	Rice, white	98	77	Spaghetti	131	91
Protein	Minced meat	100	73	Fish cakes	120	52	Bolognaise	101	93
Vegetable	Sweet carrots	76	73	Pumpkin	94	64	Green salad	65	91
Late-night snack[6]									

[1]Example of one of the day's items on the menu.
[2]Average serving amount taken from three plates over three days.
[3]Percentage consumed takes the average of all the patients' actual food intake per food, divided by the food served, to show percentage intake over three days.
[4]A drink consisted of coffee/tea with sugar and milk.
[5]Samp is made of dried corn kernels and is popular in Africa.
[6]Due to time constraints for field workers, the assumption was made that patients consumed their late-night snack and drink, which consisted of two slices of brown bread, margarine, jam/peanut butter/syrup and tea/coffee with sugar and milk.

Table 4: Findings for the main constructs of the patient satisfaction questionnaire in Hospitals A, B and C

Constructs	Hospital A ($n = 37$) % median (IQR)	Hospital B ($n = 42$) % median (IQR)	Hospital C ($n = 49$) % median (IQR)	p-value*
Food quality	70 (47–80)[a]	83 (60–88)[b]	67 (53–87)[a]	0.018*
Meal service quality	90 (80–100)	90 (60–100)	80 (60–100)	0.176
Staff/service issues	100 (87–100)[a]	100 (87–100)[a]	87 (80–100)[b]	0.001*
Physical environment	100 (73–100)	87 (73–100)	80 (73–100)	0.089
Meal size/sufficiency	80 (676–93)	87 (60–100)	67 (40–100)	0.125
Overall impression	80 (60–100)	80 (60–100)	80 (60–80)	0.457
Total constructs (all questions combined)	83 (74–88)	82 (74–90)	74 (60–87)	0.065

Interquartile range (IQR).
*Kruskal-Wallis ANOVA, medians with the same letter (a or b) do not differ significantly using multiple comparisons test (p-value < 0.05 is significant).

provide sufficient protein and energy for the shortfall of 18–45 g of protein and 1 000 kJ of energy, as highlighted in our findings. The addition of high-protein snacks may increase the overall hospital food service expenses. However, this may be offset by longer-term economic savings. According to Schuetz *et al*.,[32] improving patient nutritional status may save an estimated 3 582 Rand, equivalent to 200 US$ per person per day[32] due to a decreased LOS, reduced complications and improved recovery rates.

Patients expect that all meals should be provided whilst in hospital and therefore they do not have to rely on their family and friends to bring food to supplement their hospital meals. Hospital C, the smallest hospital, had the highest prevalence of underweight patients and the lowest amount of protein served, with 53% of patients reporting they had not received any food from family or friends. Additionally, 47% of patients in Hospital C had their usual appetite, suggesting that if sufficient protein-rich foods were served their nutritional status could have improved.

Our research also found that LOS and appetite were significantly negatively correlated with both energy and protein intake, indicating that a longer LOS and a lack of appetite may reduce a patient's food intake. Appetite is difficult to regulate as it is often influenced by the illness itself or related to side effects of medication. However, LOS may be reduced by improving nutritional status.[8] Evidence has shown that timely identification of undernourished patients plus adequate nutritional interventions can significantly reduce LOS by 12%[8] and reduce the mortality rate.[7] Therefore, by improving hospital food service and addressing the constructs that were found to be significant in this research, such as food quality, food quantity and staff training, South African public hospitals could improve the nutritional status of patients and reduce LOS.

Strengths

Three days of accurate food intake was measured across three different types of provincial public hospitals, namely a central, a large district and a medium district hospital. This is the first study conducted in South African public hospitals where the amount of food served and consumed was accurately determined by weight and analysed in conjunction with patient food satisfaction as well as using anthropometric measures to calculate energy and protein requirements on an individual basis.

Limitations

The sample size of this study was small and cannot be generalised to the South African population. The amounts of snacks/meals received from family and friends were not measured. We may therefore have underestimated patients' total energy and nutrient intake. The researchers assumed that the late-night snack consisting of two slices of bread, margarine and jam was consumed by all patients, which could have resulted in a higher estimated energy intake for all patients. A patient malnutrition risk-screening tool was not applied as the research focus was on hospital food intake and satisfaction.

Conclusion

This research highlights the inadequate energy- and protein-containing foods provided by public hospitals in the Cape Town Metropole, and insufficient energy and protein foods consumed by patients compared with their requirements. None of the hospitals served the amount of energy and protein as specified by the Department of Health ration scale. Nearly 40% of patients reported that their appetite was as usual and did not receive food from family or friends, suggesting that the food served by the hospital was their only source of nourishment. This research has revealed that patients who spend extended periods of time in one of these hospitals will likely become malnourished, leading to hospital-acquired malnutrition if additional quality food is not provided at the appropriate times.

Understanding the nutrient quality of the hospital food served to patients has revealed important knowledge that could be useful for the Department of Health when planning mealtimes, ration scales and menus. The information gained from the patient food satisfaction revealed in this study could also be used to improve staff training, which in turn may increase patient protein intake. It is recommended that the Department of Health restructure mealtimes, and investigate meal items and recipes to ensure optimal food intake by patients.

Acknowledgements – Special thanks are offered to the student dietitian fieldworkers: Alicia Coetzer, Thlolohelo Makae, Nicole Haird, Jay Hamman and Courtney Heathcote (Hospital A); Natasha Driescher, Melissa Colborne, Yenziwe Ndlovo, Megan Ropertz and Michaela Schultz (Hospital B); and Andricia Govender, Samantha de Kock, Cheyenne Oosthuizen (Hospital C).

Disclosure statement – No potential conflict of interest was reported by the authors.

Funding sources – No external funding was obtained for this research. Student dietitians completed all field work as part of their honours degree in dietetics research training; printing fees were paid from the internal University of Cape Town research fund.

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Supplementary material – Supplemental data for this article can be accessed at https://doi.org/10.1080/16070658.2021.1997267.

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Received: 1-12-2020 Accepted: 14-10-2021