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Helping understand nutritional gaps in the elderly (HUNGER) : A prospective study of patient factors associated with inadequate nutritional intake in older medical inpatients

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Short title: Helping understand nutritional gaps in the elderly (HUNGER)

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Abstract

BACKGROUND: Malnutrition, and poor intake during hospitalisation, are common in older medical patients. Better understanding of patient-specific factors associated with poor intake may inform nutritional interventions.

AIMS: To measure the proportion of older medical patients with inadequate nutritional intake, and identify patient-related factors associated with this outcome.

METHODS: Prospective cohort study enrolling consecutive consenting medical inpatients aged 65 years or older. Primary outcome was energy intake less than resting energy expenditure estimated using weight-based equations. Energy intake was calculated for a single day using direct observation of plate waste. Explanatory variables included age, gender, number of co-morbidities, number of medications, diagnosis, usual residence, nutritional status, functional and cognitive impairment, depressive symptoms, poor appetite, poor dentition, and dysphagia.

RESULTS: Of 134 participants (mean age 80 years, 51% female), only 41% met estimated resting energy requirements. Mean energy intake was 1220 kcal/day (SD 440), or 18.1 kcal/kg/day. Factors associated with inadequate energy intake in multivariate analysis were poor appetite, higher BMI, diagnosis of infection or cancer, delirium and need for assistance with feeding.

CONCLUSIONS: Inadequate nutritional intake is common, and patient factors contributing to poor intake need to be considered in nutritional interventions.

***Keywords**: malnutrition, aged, hospitalization, energy intake*

Introduction

Protein-energy malnutrition is common in older acute medical patients, where prevalence may be as high as 60% [1, 2]. Malnutrition is associated with poor clinical outcomes [3]. However, there is limited evidence that improved nutritional care improves outcomes in this group [4, 5]. There are several possible explanations. Enhanced nutritional care may not translate into increased nutritional intake because of implementation barriers at service or patient level; inpatient interventions may be of insufficient duration to influence clinical outcomes; or malnutrition may be a marker of disease severity rather than a modifiable risk factor.

Previous studies show that nutritional intake in hospital inpatients is often inadequate [1], which may lead to worsening nutritional status in hospital [6]. Some studies have highlighted deficiencies in systems of screening, prescribing and delivering nutritional care [1, 7]. However, even when effective systems are established to deliver adequate nutrition, food waste studies and clinical experience suggest that patients often do not consume their meals, snacks and supplements [5, 8]. Better understanding of the prevalence and impact of patient factors which limit nutritional intake might help explain the disappointing results of nutritional interventions in older medical patients and inform novel approaches to improve nutritional intake and nutritional status in hospital.

Several previous studies have considered patient-level factors which might reduce nutritional intake, such as poor appetite and difficulties with chewing or swallowing [6, 7, 9, 10]. However, these studies have several weaknesses, including inconsistencies in calculations of energy requirements and definitions of adequate intake, poor justification of explanatory variables, and inadequate adjustment for confounders. Recent studies using rigorous methodology have provided useful working definitions for resting energy requirements and total estimated energy and protein requirements in older medical inpatients [11, 12].

The aims of this study were to describe the prevalence of inadequate energy and protein intake in older medical inpatients in the first week of hospital admission, and to identify patient-level factors associated with reduced energy intake.

Subjects and methods

Design and setting: The study was a prospective cohort study conducted in the general medical wards of the Royal Brisbane and Women's Hospital, a large metropolitan public teaching hospital in Brisbane, Australia. The study was part of a larger multi-methods study which also examined cultural and environmental barriers to poor energy intake, in order to design an effective nutritional intervention.

Participants for this study were selected from four acute general medical wards, where they received care from one of five multidisciplinary medical units. Each unit cares for 20-30 inpatients and consists of 2-3 physicians, two medical registrars (post-graduate year 3-5), three interns (post-graduate year 1), and a consistent allied health team, including 0.4 fulltime equivalent accredited practising dietitian. The multidisciplinary team meets daily to ensure holistic assessment and prompt referral. This model, and the characteristics of the patient population, have been described in detail previously [13]. Nutrition screening is routinely conducted by dietetic assistants and/or ward nursing staff to identify patients at nutrition risk, who are referred to the unit dietitian and provided with high protein high energy diets and/or additional mid-meal snacks or supplements.

Participants: Consecutive patients admitted between November 2007 and March 2008 were screened by the study dietitian for eligibility. Patients were eligible if they were aged 65 years or older, had a hospital stay of more than 2 days, and were admitted from the emergency department to the study wards. Patients who were critically or terminally ill or were receiving parenteral or enteral nutrition at the time of admission were excluded. Informed consent was obtained from all participants or a suitable proxy (close family member or recognised carer). The study was approved by the hospital human research ethics committee.

Outcomes and measurement:

Dietary intake was measured on a single day between day 3 and day 7 of the hospital admission. Measurement was performed by the study dietitian supervising two trained dietetic assistants using visual estimation of plate waste, which has been shown to correlate closely with measured plate waste[14]. Each meal was inspected on delivery and on completion, and consumption was estimated (none, 1/8, ¼, ½, ¾, all) for each component of the meal (eg soup, meat, potato, green vegetables, bread). Mid-meal intake was estimated by observation and/or patient recall. Each dietary intake observation was converted to energy and protein intake based on food composition for each specific meal, using FoodWorks Professional nutrient analysis software (version 3.02, Xyris, Brisbane Australia 2004.) In 5 participants, intake data was missing for lunch or dinner; in view of the high measured correlation between breakfast intake and overall intake in the whole cohort, daily intake for these participants was imputed by multiplying breakfast intake by 3.56.

The primary outcome of inadequate energy intake was defined as measured energy intake less than estimated resting energy expenditure (REE), as this would inevitably lead to weight loss [7]. Based on published data from hospitalised elderly patients, we estimated REE as 18.4 kcal/kg bodyweight/day for patients with body mass index (BMI)>21kg/m^2 and 21.4 kcal/kg/day for those with BMI≤21 kg/m^2 [11].

Secondary outcomes were measured energy intake less than estimated total energy expenditure, and protein intake less than minimal estimated protein requirement. We multiplied REE by a physical activity factor of 1.42 to estimate total energy expenditure [11]. Minimal protein requirement was estimated as 1g dietary protein/kg bodyweight/day, which is a conservative estimate of the amount required to maintain positive protein balance [12].

Confounding and explanatory variables:

Potential explanatory and confounding variables were identified through literature review, multidisciplinary consultation, and focus groups with nursing and allied health staff. Confounders included age, sex, usual place of residence, diagnosis, number of co-morbidities, number of medications and hospital ward. Candidate explanatory variables were appetite, nutritional status, functional status, cognition, delirium, depression, dentition, dysphagia, and dietary modification [9, 10].

Detailed assessment was undertaken by the study dietitian, an experienced accredited practicing dietitian who did not provide clinical care to the participants. Demographic and disease variables were obtained from the medical record. Length of hospital stay, discharge destination and final diagnosis were obtained from the medical summary at the time of discharge.

Weight was measured using a single Tanita HD351 scale, precise to 0.1 kg; on occasions where seated scales were required, ward scales were used and calibrated by the study dietitian to the reference scale. In 12 cases, it was not possible to weigh the patient, and the study dietitian estimated weight to the nearest kg. Height was estimated from heel-knee length according to standard formulae [15], and used to derive the body mass index. Nutritional status was assessed using the Mini Nutritional Assessment (MNA), with scores of <17 indicating malnutrition, 17-23.5 at risk of malnutrition, and 24-30 indicating good nutritional status [16, 17].

Cognition was measured using Folstein's Mini-Mental State Examination [18] with cognitive impairment defined as ≤23, and the Confusion Assessment Method [19] was used to identify delirium. Depressive symptoms were assessed using the Geriatric Depression Scale [20], with possible depression defined as scores of 5 or greater. Functional dependency was obtained from patient self-report, using a 6 point ordinal scale based on the number of basic activities of daily living (ADL, including dressing, bathing, toileting, transfers, mobility and feeding) for which assistance from another person was required [21]. Feeding dependency was also considered as a separate variable using items from the modified Barthel index, and included need for help with set-up or supervision with meals[22]. Appetite was evaluated using the Simplified Nutritional Appetite Questionnaire, with scores of 14 or less indicating impaired appetite [23]. The study dietitian recorded the presence and state of current dentition, defining poor dentition as missing teeth, or ill-fitting or absent dentures. Risk of dysphagia was recorded using a validated screening tool [24].

Statistical Analyses:

Participant characteristics were summarised using mean and standard deviation for continuous variables, or categorised according to validated cut-offs and clinical meaning. Adequacy of nutritional intake was calculated for each participant by comparing daily energy intake with estimated REE, total energy expenditure and protein requirements.

The relationship of each explanatory variable to the primary outcome of inadequate nutritional intake (energy intake <REE) was examined using one-way analysis of variance for continuous variables and chi-squared test of association for categorical variables. If bivariate analysis suggested a possible association ($p<0.2$), the variable was included in a multiple logistic regression model, which included the confounding variables of age, usual residence and increased co-morbidities. Relative risk was estimated from the odds ratios generated from the logistic regression, using previously reported methods [25]. Associations were considered significant in multivariable analysis if $p<0.05$.

We recognised the potential to over-estimate requirements of obese participants (BMI≥30 kg/m^2) using a weight-based formula for REE. In clinical practice, estimates are often adjusted in obese patients based on ideal body weight plus 25% of additional body weight, on the assumption that only a proportion of the additional body mass is metabolically active. We undertook a sensitivity analysis redefining REE based on this adjusted body weight for obese participants, and report the logistic regression results.

We estimated a minimum sample size of approximately 120 participants was required to identify 8-10 significant variables with a moderate effect size in the regression analysis, with 80% power, All analyses were conducted using SPSS version 17.0.

Results

Participants

Over the 16 week study period, 351 patients aged 65 years or older who met eligibility criteria were admitted to general medical units from the Emergency Department, and 134 (38%) consented to participate. Of the remainder, 104 declined, and in 113 cases consent was not able to be obtained from the patient or an appropriate proxy within the timeframe. Non-participants had the same mean age (81 years) as participants and a similar length of stay (11 days vs 12 days) but were more likely to be discharged to residential aged care (24% versus 13%).

Participant characteristics are shown in **table 1**. A range of diagnoses were seen, as expected in a general medical service. In addition to their primary diagnosis, 104 participants (78%) had two or more co-morbidities, and participants had an average of 7 prescribed medications. The mean score on the Mini Nutritional Assessment was 20.1 (SD 6.0), with 41 (31%) classified as malnourished, 51 (37%) at risk of malnutrition and 41 (31%) well nourished. The mean BMI was 26.1 kg/m^2 (SD 6.0), and 27 (20%) had BMI <21 kg/m^2.

Eighty four (63%) participants needed assistance in at least one ADL at the time of assessment, including 43 (32%) who required help with set-up, supervision or actual feeding of meals. Of 125 participants for whom formal cognitive testing was possible, 41 (33%) demonstrated cognitive impairment, 12 (10%) had evidence of delirium, and 31 (27%) had symptoms suggesting depression. Impaired appetite was recorded in 68 (52%), poor dentition observed in 44 (33%), and potential risk of dysphagia or aspiration in 54 (41%).

Nutritional intake and estimated requirements

Mean energy provided in meals and snacks on the study day was 1836 kcal (SD 376). **Figure 1** shows the distribution of energy intake. The mean measured daily energy intake was 1220 kcal/day (SD 440), or 18.1 kcal/kg/day. This represented 66% of energy provided in meals and snacks; 27% of participants ate less than 50% of the energy provided, and 62% ate less than 75%. Most energy intake was from main meals (28% breakfast, 30% lunch, 33% dinner), with 9% from mid meals and snacks. The mean daily protein intake was 47.6 g per day (SD19.2) or 0.7 g / kg/day. Energy intake was sufficient for REE in 55/134 (41%) participants, and met estimated total energy expenditure in only 11/134 (8%). Only 14% had a protein intake ≥ 1g/kg bodyweight/day.

In a subgroup of 38 participants, energy intake measurement was repeated on day 3 and day 7. This showed no significant change in mean energy intake (1144 kcal/day on day 3 compared to 1113 kcal/day on day 7, p=0.63).

Predictors of inadequate energy intake

Participants with inadequate energy intake tended to be older (mean age 81 versus 78 years, p=0.06) have more co-morbidities (mean 2.9 versus 2.5, p=0.18) and more prescribed medications (mean 7.4 versus 6.4, p=0.13). Poor appetite, ADL dependency and obesity were all strongly associated with energy intake less than REE (**table 1**). There were weaker associations with dysphagia, delirium, and admission from residential aged care in bivariate analysis. Poor intake was somewhat more likely in those with diagnoses of infection or cancer. No association was seen with cognitive impairment, depression, poor dentition, or with nutritional status as assessed by the MNA.

Table 2 shows the results of the multiple logistic regression model. There was significant collinearity between feeding and ADL dependency (chi-square 37.7, $p<0.001$), so feeding dependency was selected for multivariate analysis. Factors which retained a significant association with inadequate nutritional intake were poor appetite, higher BMI, delirium and a diagnosis of infection or cancer. There was a trend to poorer intake in those requiring feeding assistance.

The distribution of daily energy intake for different BMI subgroups is shown in **figure 2,** which demonstrates similar intake in the obese group compared to normal weight despite increased weight. When we repeated REE estimates using adjusted body weight in the obese subgroup, 49% of participants still did not meet REE. However obesity was no longer a significant predictor of poor intake (**table 3**). Poor appetite and an infectious diagnosis remained significantly associated with poor intake, and the need for feeding assistance reached statistical significance. Risk estimates for the other variables remained similar.

Discussion

This study confirms that inadequate nutritional intake is common in older medical patients, despite established systems of malnutrition screening and nutrition support. Only 41% of participants consumed sufficient dietary intake to meet estimated resting energy requirements, 8% of participants had sufficient energy intake for estimated total energy expenditure, and 14% had sufficient protein intake to avoid protein catabolism [12].

The measured mean energy intake of 1220 kcal/day is consistent with previous reports in older medical patients [8, 9, 26-29], and was significantly lower than the energy delivered in meals and snacks. This was predominantly due to high levels of food waste, similar to previous investigators. Dupertuis reported that 45% of acute care patients did not meet resting energy requirements [28], while Rammohan [26] found that half of patients aged over 65 consumed less than 65% of their estimated energy requirement. Patel [10] and Incalzi [6] found that 67-70% ate less than 75% of their delivered hospital meals and Barton[8] reported that almost 40% of delivered food was not consumed.

We documented a high prevalence of many risk factors previously suggested to contribute to poor intake, such as poor dentition, cognitive impairment, depressed mood, poor appetite and the need for feeding assistance. However, not all these factors were associated with poor nutritional intake.

Poor appetite was strongly associated with poor nutritional intake. Poor appetite and difficulties with chewing or swallowing have been identified as risk factors for poor intake in several previous studies, although these did not use reliable measurement or account for potential confounders [6, 7, 10]. We did not find a significant association with poor dentition or dysphagia. A diagnosis of infection or cancer tended to be associated with poorer intake, even though we did not include a stress factor for these conditions in estimates of energy requirement, as is often done in clinical practice.

Despite the high prevalence of functional disability in the hospitalised elderly, few previous studies have evaluated functional status as a risk factor for poor intake [9]. Our study suggests that the need for assistance or supervision with feeding was associated with poor intake, although the strength of this association was dependent on other model parameters. Our study also suggests that poor nutritional intake may be a consequence of delirium. Delirium is a common complication of acute medical admissions [25], and was probably under-represented in our sample because of consent considerations.

Poor intake associated with poor appetite, delirium and feeding dependency are unlikely to be mitigated by simple provision of oral supplements, the commonest nutritional support strategy reported in the literature. Multidisciplinary approaches which recognise and specifically address these barriers may offer more promise.

It is reassuring that patients with a low BMI were much less likely to receive inadequate intake, despite using a formula which recognised a higher REE in this subgroup, suggesting that most of these patients are being recognised and their nutritional needs identified early in the hospital admission. The strong association of inadequate energy intake with obesity has been reported previously [9, 28]. This finding may depend on the method for estimating REE. The best method for estimating individual REE in acutely ill older patients remains controversial, and several studies have shown poor performance of a range of estimating equations at individual level compared to calorimetry [30, 31]. We based our estimates on the recommendations of a recent study in older medical patients with characteristics similar to our own study[11], which used actual body weight, adjusting only for those with BMI <21 kg/m^2. There is conflicting data regarding whether weight-based formulae overestimate energy requirements in the older obese subgroup [30, 31,32]. As a sensitivity analysis, we recalculated REE estimates in the obese subgroup in keeping with common clinical practice. This attenuated the influence of BMI (table 3), and increased the significance of feeding dependency as a risk factor.

Our study has several strengths which contribute to its internal validity. Nutritional intake was measured by detailed direct observation of meal components. Inadequate intake was explicitly defined in a physiologically meaningful way, based on calorimetric studies in a similar population[11]. Explanatory variables and confounders were informed by a multidisciplinary perspective, and validated measures were chosen [17]. Few other studies have used multivariate methods to allow for potential confounding. Although this study only considered patient factors contributing to poor intake, the influence of staff and environmental factors were also investigated and will be reported separately.

We recognise several weaknesses in the study. In particular, the relatively small sample size means that we may have missed or under-recognised associations. Consent rates were lower than anticipated, partly because of high clinical acuity and partly because of the high prevalence of cognitive impairment in this group, with proxy consent not always feasible within the time frame. These reasons for non-consent suggest that our estimates of adequate nutritional intake may in fact be optimistic. Energy requirements are ideally estimated by calorimetry, but our use of estimating equations is consistent with the reality of clinical practice. The study was conducted at a single site, although patient characteristics suggest a “typical” older general medical population. Intake was only measured on a single day for most participants; however, the subgroup with repeated measurements suggests that intake remains relatively consistent, at least in the first week of hospitalisation. The study sampled medical patients with a relatively long length of stay, which may limit generalisability, but we deliberately selected this group because of their vulnerability to further nutritional decline in hospital.

Conclusions

In summary, our study confirms that energy and protein intake are inadequate to meet requirements in most older acute medical inpatients, which may lead to worsening malnutrition during hospitalisation, and contribute to poor outcomes. It supports recent recommendations for monitoring of intake and repeated nutritional risk screening during the hospital stay, as well as at admission [2]. Poor nutritional intake in hospital may be especially common in the obese elderly, but further research is required in this group to clarify energy requirements during acute illness.

Poor intake was associated with several common patient characteristics, particularly poor appetite, need for feeding assistance and delirium associated with acute illness. These factors may not be assessed in routine nutritional screening, and deserve greater recognition as factors impeding adequate intake in hospital. Interventions which deliver additional nutrition to the bedside, without considering these common patient-level barriers, are unlikely to succeed in improving nutritional status or clinical outcomes in this patient group. Multi-faceted interventions which prioritise nutritional care, directly address these barriers, and support nutritional screening with ongoing intake monitoring may offer more promise [5].

The authors declare no conflict of interest

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AM conceived the study and designed the study, undertook data analysis and initial data interpretation, and drafted the manuscript.

LR, MB and EI contributed to study design, data interpretation and critical review of the manuscript.

AY contributed to methods, undertook data collection and entry, and contributed to data interpretation and critical review of the manuscript.

All authors approved the final manuscript.

References

1. Corish CA, Kennedy NP. Protein-energy undernutrition in hospital in-patients. Br J Nutr. 2000;83:575-591.

2. Watterson C, Fraser A, Banks M, et al. Evidence based guidelines for nutritional management of malnutrition in adult patients across the continuum of care. Nutr Diet. 2009;66(Suppl 3):S1-34.

3. Covinsky KE, Martin GE, Beyth RJ, Justice AC, Sehgal AR, Landefeld CS. The relationship between clinical assessments of nutritional status and adverse outcomes in older hospitalized medical patients. J Am Geriatr Soc 1999;47(5):532-538.

4. Vanderkroft D, Collins CE, FitzGerald M, Neve M. Minimising undernutrition in the older inpatient. Int J Evid Based Health. 2007;5:110-181.

5. Weekes CE, Sprio A, Baldwin C, et al. A review of the evidence for the impact of improving nutritional care on nutritional and clinical outcomes and cost. J Hum Nutr Diet 2009;22:324-335.

6. Incalzi RA, Gemma A, Capparella O, Cipriani L, Landi F, Carbonin P. Energy intake and in-hospital starvation: a clinically relevant relationship. Arch Intern Med 1996;156(4):425-429.

7. Kondrup J, Johansen N, Plum LM, et al. Incidence of nutritional risk and causes of inadequate nutritional care in hospitals. Clin Nutr 2002;21(6):461-468.

8. Barton A, Beigg C, Macdonald I, Allison S. High food wastage and low nutritional intakes in hospital patients. Clin Nutr 2000;19(6):445-449.

9. Sullivan DH, Walls RC. Protein-energy undernutrition among elderly hospitalized patients: a prospective study. JAMA. 1999;281(21):2013-2019.

10. Patel MD, Martin FC. Why don't elderly hospital inpatients eat adequately? J Nutr Health Aging. 2008;12(4):227-231.

11. Alix E, Berrut G, Bore M, et al. Energy requirements in hospitalized elderly people. . J Am Geriatr Soc 2007;55:1085-1089.

12. Gaillard C, Alix E, Boirie Y, Berrut G, Ritz P. Are elderly hospitalized patients getting enough protein? . J Am Geriatr Soc 2008;56:1045-1049.

13. Mudge A, Laracy S, Richter K, Denaro C. Controlled trial of multidisciplinary care teams for acutely ill medical inpatients: enhanced multidisciplinary care. Intern Med J. 2006;36(9):558-563.

14. Odlund Olin A, Osterberg P, Hadell K, Armyr I, Jerstrom S, Ljungqvist O. Energy-enriched hospital food to improve energy intake in elderly patients. JPEN J Parenter Enteral Nutr 1996;20(2):93-97.

15. Chumlea WC, Guo SS. Equations for predicting stature in white and black elderly individuals. J Gerontology A Biol Sci Med Sci. 1992;47A:M197-M203.

16. Guigoz Y, Vellas B, Garry P. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996;54(S59-65).

17. Salva A, Corman B, Andrieu S, Salas J, Vellas B. Minimum data set for nutritional intervention studies in elderly people. J Gerontology A Biol Sci Med Sci. 2004;59A(7):724-729.

18. Folstein MF, E FS, McHugh PR. The Folstein Mini-Mental State Examination: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-198.

19. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI. Clarifying confusion: the Confusion Assessment Method. Ann Intern Med 1990;113:941-948.

20. Sheikh J, Yesavage J. Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. Clin Gerontol. 1986;5:165-172.

21. Sager MA, Franke T, Inouye SK, et al. Functional outcomes of acute medical illness and hospitalization in older persons. Arch Int Med. 1996;156(6):645-652.

22. Shah S, Vancaly F, Cooper B. Improving the sensitivity of the Barthel index for stroke rehabilitation. J Clin Epidemiol. 1989;42(8):703-709.

23. Wilson MG, Thomas DR, Rubenstein LZ, et al. Appetite assessment: simple appetite questionnaire predicts weight loss in community-dwelling adults and nursing home residents. Am J Clin Nutr 2005;82(5):1074-1081.

24. Cichero JA, Heaton S, Bassett L. Triaging dysphagia: nurse screening for dysphagia in an acute hospital. J Clin Nurs 2009;18(11):1649-1659.

25. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. JAMA. 1998;280(19):1690-1691.

26. Rammohan M, Juan D, Jung D. Hypophagia among hospitalized elderly. J Am Diet Assoc 1989;89(12):1774-1780.

27. Klipstien-Grobusch K, Reilly JJ, Potter J, Edwards CA, Roberts MA. Energy intake and expenditure in elderly patients admitted to hospital with acute illness. Br J Nutr 1995;73:323-334.

28. Dupertuis YM, Kossovsky MP, Kyle UG, Raguso CA, Genton L, Pichard C. Food intake in 1707 hospitalised patients: a prospective comprehensive hospital survey. Clin Nutr 2003;22(2):115-123.

29. Perier C, Triouleyre P, Terrat C, Chomette MC, Beauchet O, Gonthier R. Energy and nutrient intake of elderly hospitalized patients in a steady metabolic state versus catabolic states. J Nutr Health Aging 2004;8(6):518-520.

30. Frankenfeld DC, Coleman A, Alam S, Cooney RN. Analysis of estimation methods for resting metabolic rate in critically ill adults. JPEN J Parenter Enteral Nutr 2009;33:27-36.

31. Boullata J, Williams J, Cottrell F, Hudson L, Compher C. Accurate determination of energy needs in hospitalized patients. J Am Diet Assoc 2007;107:393-401.

32. Weekes, C E. Controversies in the determination of energy requirements. Proc Nutr Soc 2007; 66: 367-377

Figure 1: Energy intake (kcal per day) based on observation of individual meal delivery and waste on the study day (between day 3 and 7 of hospital admission) in 134 consecutive older medical patients

Figure 2: Energy intake (kcal per day) on the study day in 134 consecutive older medical patients, grouped by body mass index subgroup.

2(A) underweight (BMI<21 kg/m^2, n=27).

2(B) normal weight (BMI 21-29.9 kg/m^2, n=76).

2(C) obese (BMI 30 kg/m^2 or greater, n=31).

Table 1: Participant characteristics, and bivariate associations with inadequate energy intake, defined as an energy intake less than estimated resting energy expenditure (REE) on the study day. Row percentages are shown. Denominators are provided (in brackets) for variables with missing data. ADL activities of daily living.

Characteristic	**Number of participants**	**Number (%) with inadequate intake**	**p**
Age (years)			0.49
65-84	93	53 (57)	
85 and older	41	26 (63)	
Sex			0.31
Male	66	36 (55)	
Female	68	43 (63)	
Diagnosis			0.16
Chronic cardiorespiratory disease	37	21 (57)	
Acute infection	27	21 (78)	
Gastrointestinal disease	13	7 (54)	
Cancer	10	7 (70)	
Other	47	23 (49)	
Living situation			0.16
Community living	115	65 (56)	
Residential care	19	14 (74)	
Body mass index (kg/m^2)			0.004
<21	27	12 (44)	

21-30	76	41 (54)	
≥30	31	26 (84)	
Mini Nutritional Assessment			0.70
<17	41	23 (56)	
17-23.5	51	32 (63)	
>23.5	42	23 (55)	
Dependent in any ADL	84	57 (68)	0.007
Needs help with feeding	43	31 (72)	0.03
Impaired appetite (n=131)	68	47 (69)	0.006
Cognitive impairment (n=125)	41	23 (56)	0.72
Delirium (n=130)	12	10 (83)	0.07
Depression (n=115)	31	18 (58)	0.98
Poor dentition (n=132)	44	25 (57)	0.71
Medical dietary restrictions	46	28 (61)	0.75
Positive dysphagia screen (n=133)	54	37 (69)	0.06
TOTAL	**134**	**79 (59)**	**134**

Table 2: Multivariate analysis (n=126) of potential predictors of inadequate intake (energy intake less than estimated resting energy expenditure), adjusted for age and comorbidity count. Reference category for multi-level variables is included in brackets.

	Adjusted odds ratio (95% CI)	**p**
Poor appetite	1.85 (1.42-2.06)	0.001
BMI (21-30 kg/m^2)		<0.001
<21 kg/m^2	0.28 (0.08-0.77)	
≥30 kg/m^2	1.70 (1.40-1.81)	
Requires assistance with feeding	1.45 (0.95-1.72)	0.08
Delirium	1.62 (1.01-1.74)	0.04
Positive dysphagia screen	1.16 (0.70-1.54)	0.50
Diagnosis (other)		0.06
Cardio-respiratory	1.44 (0.85-1.81)	
Infectious	1.70 (1.14-1.94)	
Cancer	1.79 (1.06-2.00)	
Gastrointestinal	0.91 (0.29-1.63)	
Age 85 years or older	1.02 (0.50-1.45)	0.94
2 or more co-morbidities	0.65 (0.27-1.14)	0.43
From residential aged care	1.28 (0.65-1.62)	0.37

Table 3: Multivariate analysis (n=126) of potential predictors of inadequate intake (energy intake less than estimated resting energy expenditure, adjusted in the obese subgroup), adjusted for age and comorbidity count. Reference category for multi-level variables is included in brackets. Adjusted weight was based on ideal body weight plus 25% of excess body weight in participants with BMI ≥30 kg/m^2

	Adjusted odds ratio (95% CI)	**p**
Poor appetite	2.22 (1.47-2.73)	0.001
BMI (21-30 kg/m^2)		0.08
<21 kg/m^2	0.39 (0.12-0.91)	
≥30 kg/m^2	0.79 (0.38-1.26)	
Requires assistance with feeding	1.84 (1.19-2.23)	0.01
Delirium	1.54(0.64-2.01)	0.24
Positive dysphagia screen	1.37 (0.84-1.86)	0.18
Diagnosis (other)		0.06
Cardio-respiratory	0.93 (0.43-1.55)	
Infectious	1.80 (1.13-2.15)	
Cancer	1.83 (0.87-2.23)	
Gastrointestinal	0.87 (0.25-1.73)	
Age 85 years or older	0.66 (0.27-1.22)	0.22
2 or more co-morbidities	0.59 (0.22-1.20)	0.17
From residential aged care	1.27 (0.53-1.87)	0.51

Figure 1

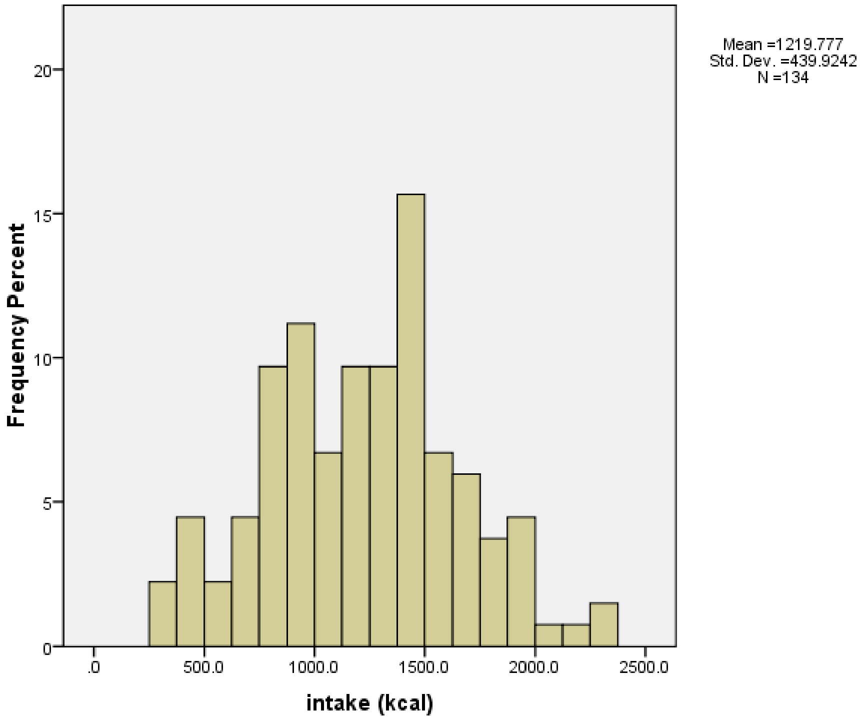

Mean =1219.777
Std. Dev. =439.9242
N =134
Frequency Percent
20
15
10
5
0
.0
500.0
1000.0
1500.0
2000.0
2500.0
intake (kcal)

Figure 2A

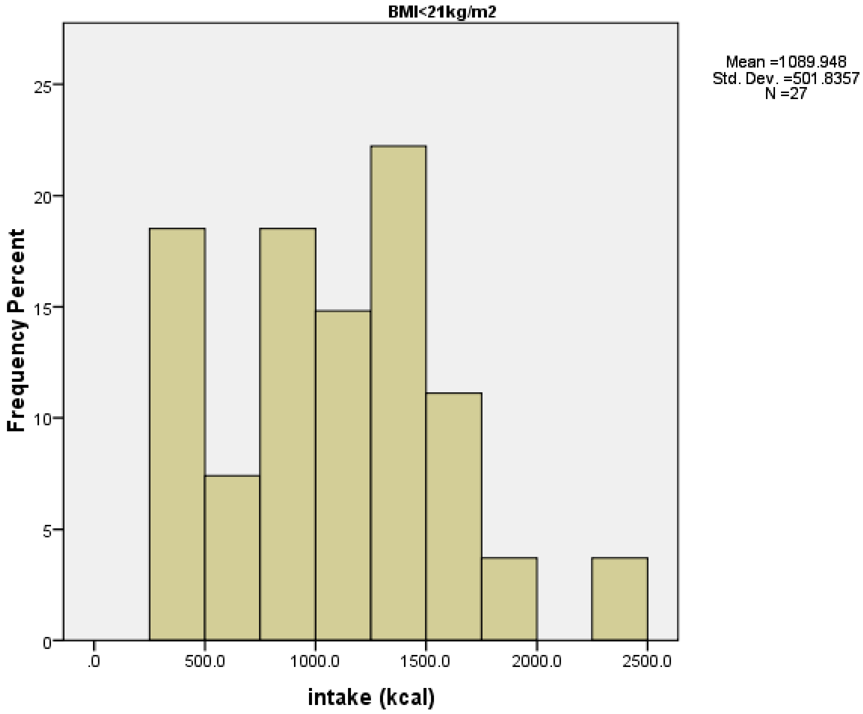


Figure 2B

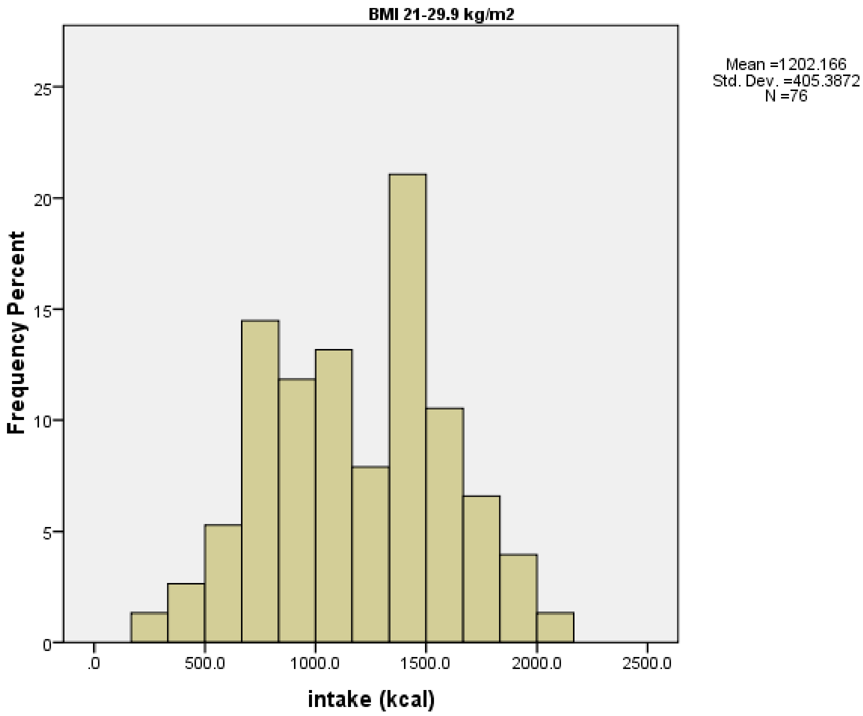
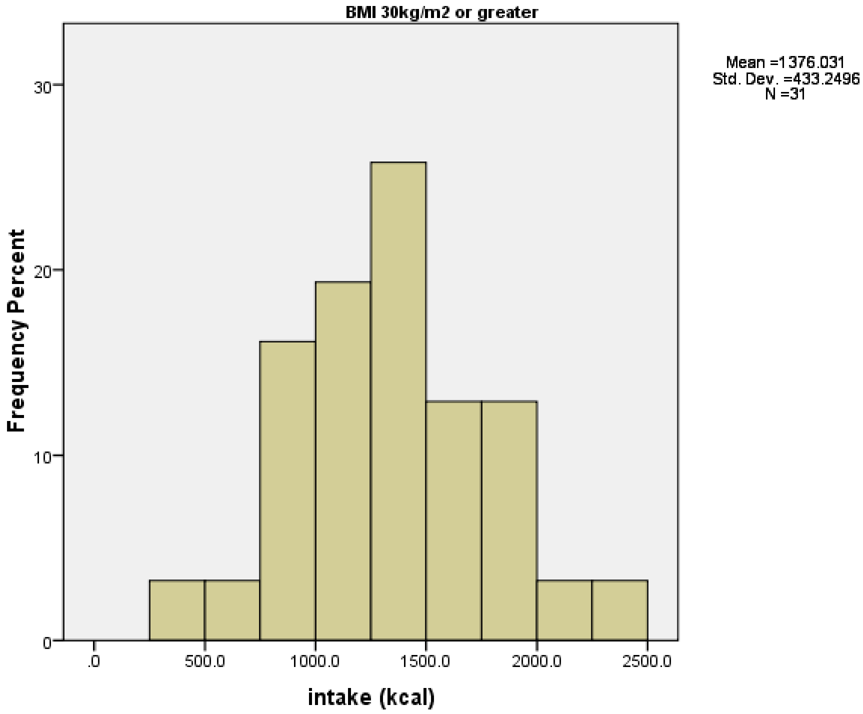


Figure 2C


BMI 30kg/m2 or greater
Mean =1376.031
Std. Dev. =433.2496
N =31
Frequency Percent
0
10
20
30
.0
500.0
1000.0
1500.0
2000.0
2500.0
intake (kcal)