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1	Helping understand nutritional gaps in the elderly (HUNGER) :
2	A prospective study of patient factors associated with inadequate
3	nutritional intake in older medical inpatients
4	
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11	Short title: Helping understand nutritional gaps in the elderly (HUNGER)
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24	

25 Abstract

26 BACKGROUND: Malnutrition, and poor intake during hospitalisation, are common

27 in older medical patients. Better understanding of patient-specific factors associated

28 with poor intake may inform nutritional interventions.

29 AIMS: To measure the proportion of older medical patients with inadequate

30 nutritional intake, and identify patient-related factors associated with this outcome.

31 METHODS: Prospective cohort study enrolling consecutive consenting medical

32 inpatients aged 65 years or older. Primary outcome was energy intake less than resting

33 energy expenditure estimated using weight-based equations. Energy intake was

34 calculated for a single day using direct observation of plate waste. Explanatory

35 variables included age, gender, number of co-morbidities, number of medications,

36 diagnosis, usual residence, nutritional status, functional and cognitive impairment,

37 depressive symptoms, poor appetite, poor dentition, and dysphagia.

38 RESULTS: Of 134 participants (mean age 80 years, 51% female), only 41% met

39 estimated resting energy requirements. Mean energy intake was 1220 kcal/day (SD

40 440), or 18.1 kcal/kg/day. Factors associated with inadequate energy intake in

41 multivariate analysis were poor appetite, higher BMI, diagnosis of infection or cancer,

42 delirium and need for assistance with feeding.

43 CONCLUSIONS: Inadequate nutritional intake is common, and patient factors

- 44 contributing to poor intake need to be considered in nutritional interventions.
- 45

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

48 Introduction

49 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 50 outcomes³. However, there is limited evidence that improved nutritional care 51 improves outcomes in this group^{4,5}. There are several possible explanations. 52 53 Enhanced nutritional care may not translate into increased nutritional intake because 54 of implementation barriers at service or patient level; inpatient interventions may be 55 of insufficient duration to influence clinical outcomes; or malnutrition may be a 56 marker of disease severity rather than a modifiable risk factor. 57 58 Previous studies show that nutritional intake in hospital inpatients is often inadequate 59 ¹, which may lead to worsening nutritional status in hospital ⁶. Some studies have highlighted deficiencies in systems of screening, prescribing and delivering nutritional 60 care^{1,7}. However, even when effective systems are established to deliver adequate 61 62 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 63 64 prevalence and impact of patient factors which limit nutritional intake might help 65 explain the disappointing results of nutritional interventions in older medical patients 66 and inform novel approaches to improve nutritional intake and nutritional status in 67 hospital. 68 Several previous studies have considered patient-level factors which might reduce 69 nutritional intake, such as poor appetite and difficulties with chewing or swallowing 6, 70 ^{7, 9, 10}. However, these studies have several weaknesses, including inconsistencies in 71

72 calculations of energy requirements and definitions of adequate intake, poor

- 73 justification of explanatory variables, and inadequate adjustment for confounders.
- 74 Recent studies using rigorous methodology have provided useful working definitions
- 75 for resting energy requirements and total estimated energy and protein requirements in
- 76 older medical inpatients ^{11, 12}.
- 77
- 78 The aims of this study were to describe the prevalence of inadequate energy and
- 79 protein intake in older medical inpatients in the first week of hospital admission, and
- 80 to identify patient-level factors associated with reduced energy intake.

82 Subjects and methods

83 Design and setting: The study was a prospective cohort study conducted in the 84 general medical wards of the Royal Brisbane and Women's Hospital, a large 85 metropolitan public teaching hospital in Brisbane, Australia. The study was part of a 86 larger multi-methods study which also examined cultural and environmental barriers 87 to poor energy intake, in order to design an effective nutritional intervention. 88 89 Participants for this study were selected from four acute general medical wards, where 90 they received care from one of five multidisciplinary medical units. Each unit cares 91 for 20-30 inpatients and consists of 2-3 physicians, two medical registrars (post-92 graduate year 3-5), three interns (post-graduate year 1), and a consistent allied health 93 team, including 0.4 fulltime equivalent accredited practising dietitian. The 94 multidisciplinary team meets daily to ensure holistic assessment and prompt referral. 95 This model, and the characteristics of the patient population, have been described in detail previously ¹³. Nutrition screening is routinely conducted by dietetic assistants 96 97 and/or ward nursing staff to identify patients at nutrition risk, who are referred to the 98 unit dietitian and provided with high protein high energy diets and/or additional mid-99 meal snacks or supplements.

100

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 bythe hospital human research ethics committee.

109

110 Outcomes and measurement:

111 Dietary intake was measured on a single day between day 3 and day 7 of the hospital 112 admission. Measurement was performed by the study dietitian supervising two trained 113 dietetic assistants using visual estimation of plate waste, which has been shown to correlate closely with measured plate waste¹⁴. Each meal was inspected on delivery 114 and on completion, and consumption was estimated (none, 1/8, 1/4, 1/2, 3/4, all) for each 115 116 component of the meal (eg soup, meat, potato, green vegetables, bread). Mid-meal 117 intake was estimated by observation and/or patient recall. Each dietary intake 118 observation was converted to energy and protein intake based on food composition for 119 each specific meal, using FoodWorks Professional nutrient analysis software (version 120 3.02, Xyris, Brisbane Australia 2004.) In 5 participants, intake data was missing for 121 lunch or dinner; in view of the high measured correlation between breakfast intake 122 and overall intake in the whole cohort, daily intake for these participants was imputed 123 by multiplying breakfast intake by 3.56.

124

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/m² 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.

137

138 Confounding and explanatory variables:

139 Potential explanatory and confounding variables were identified through literature

140 review, multidisciplinary consultation, and focus groups with nursing and allied

141 health staff. Confounders included age, sex, usual place of residence, diagnosis,

142 number of co-morbidities, number of medications and hospital ward. Candidate

143 explanatory variables were appetite, nutritional status, functional status, cognition,

144 delirium, depression, dentition, dysphagia, and dietary modification ^{9, 10}.

145

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.

151

152 Weight was measured using a single Tanita HD351 scale, precise to 0.1 kg; on

153 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

155 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

158 Assessment (MNA), with scores of <17 indicating malnutrition, 17-23.5 at risk of

159 malnutrition, and 24-30 indicating good nutritional status ^{16, 17}.

160

Cognition was measured using Folstein's Mini-Mental State Examination¹⁸ with 161 cognitive impairment defined as 23, and the Confusion Assessment Method ¹⁹ was 162 used to identify delirium. Depressive symptoms were assessed using the Geriatric 163 164 Depression Scale²⁰, with possible depression defined as scores of 5 or greater. 165 Functional dependency was obtained from patient self-report, using a 6 point ordinal 166 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 167 person was required ²¹. Feeding dependency was also considered as a separate 168 169 variable using items from the modified Barthel index, and included need for help with set-up or supervision with meals²². Appetite was evaluated using the Simplified 170 171 Nutritional Appetite Questionnaire, with scores of 14 or less indicating impaired appetite²³. The study digitian recorded the presence and state of current dentition. 172 defining poor dentition as missing teeth, or ill-fitting or absent dentures. Risk of 173 dysphagia was recorded using a validated screening tool²⁴. 174 175

176 Statistical Analyses:

177 Participant characteristics were summarised using mean and standard deviation for

178 continuous variables, or categorised according to validated cut-offs and clinical

179 meaning. A dequacy of nutritional intake was calculated for each participant by

180 comparing daily energy intake with estimated REE, total energy expenditure and181 protein requirements.

182

183	The relationship of each explanatory variable to the primary outcome of inadequate
184	nutritional intake (energy intake < REE) was examined using one-way analysis of
185	variance for continuous variables and chi-squared test of association for categorical
186	variables. If bivariate analysis suggested a possible association (p<0.2), the variable
187	was included in a multiple logistic regression model, which included the confounding
188	variables of age, usual residence and increased co-morbidities. Relative risk was
189	estimated from the odds ratios generated from the logistic regression, using previously
190	reported methods ²⁵ . Associations were considered significant in multivariable
191	analysis if p<0.05.
192	

193 We recognised the potential to over-estimate requirements of obese participants (BMI≥30 kg/m²) using a weight-based formula for REE. In clinical practic fro3 -2r(eni69p4)pn6s 206 **Results**

207 **Participants**

208 Over the 16 week study period, 351 patients aged 65 years or older who met

209 eligibility criteria were admitted to general medical units from the Emergency

210 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

213 years) as participants and a similar length of stay (11 days vs 12 days) but were more

214 likely to be discharged to residential aged care (24% versus 13%).

215

216 Participant characteristics are shown in table 1. A range of diagnoses were seen, as

217 expected in a general medical service. In addition to their primary diagnosis, 104

218 participants (78%) had two or more co-morbidities, and participants had an average of

219 7 prescribed medications. The mean score on the Mini Nutritional Assessment was

220 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/m² (SD 6.0),

222 and 27 (20%) had BMI <21 kg/m².

223

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%).

232 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
- 240 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 \geq 1g/kg

242 bodyweight/day.

243

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).

247

248 Predictors of inadequate energy intake

249 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

251 prescribed medications (mean 7.4 versus 6.4, p=0.13). Poor appetite, ADL

252 dependency and obesity were all strongly associated with energy intake less than REE

- 253 (table 1). There were weaker associations with dysphagia, delirium, and admission
- from residential aged care in bivariate analysis. Poor intake was somewhat more
- 255 likely in those with diagnoses of infection or cancer. No association was seen with

256 cognitive impairment, depression, poor dentition, or with nutritional status as assessed257 by the MNA.

258

259 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

262 which retained a significant association with inadequate nutritional intake were poor

263 appetite, higher BMI, delirium and a diagnosis of infection or cancer. There was a

trend to poorer intake in those requiring feeding assistance.

265

266 The distribution of daily energy intake for different BMI subgroups is shown in figure 267 2, which demonstrates similar intake in the obese group compared to normal weight despite increased weight. When we repeated REE estimates using adjusted body 268 269 weight in the obese subgroup, 49% of participants still did not meet REE. However 270 obesity was no longer a significant predictor of poor intake (table 3). Poor appetite 271 and an infectious diagnosis remained significantly associated with poor intake, and 272 the need for feeding assistance reached statistical significance. Risk estimates for the 273 other variables remained similar.

275 Discussion

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

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.

305

Despite the high prevalence of functional disability in the hospitalised elderly, few 306 previous studies have evaluated functional status as a risk factor for poor intake⁹. Our 307 308 study suggests that the need for assistance or supervision with feeding was associated 309 with poor intake, although the strength of this association was dependent on other 310 model parameters. Our study also suggests that poor nutritional intake may be a 311 consequence of delirium. Delirium is a common complication of acute medical admissions²⁵, and was probably under-represented in our sample because of consent 312 313 considerations.

314

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.

320 It is reassuring that patients with a low BMI were much less likely to receive 321 inadequate intake, despite using a formula which recognised a higher REE in this 322 subgroup, suggesting that most of these patients are being recognised and their 323 nutritional needs identified early in the hospital admission. The strong association of 324 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 325 326 individual REE in acutely ill older patients remains controversial, and several studies 327 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 328 recent study in older medical patients with characteristics similar to our own study¹¹, 329 which used actual body weight, adjusting only for those with BMI <21 kg/m². There 330 331 is conflicting data regarding whether weight-based formulae overestimate energy requirements in the older obese subgroup ^{30, 31,32}. As a sensitivity analysis, we 332 333 recalculated REE estimates in the obese subgroup in keeping with common clinical 334 practice. This attenuated the influence of BMI (table 3), and increased the significance 335 of feeding dependency as a risk factor.

336

Our study has several strengths which contribute to its internal validity. Nutritional 337 338 intake was measured by detailed direct observation of meal components. Inadequate 339 intake was explicitly defined in a physiologically meaningful way, based on calorimetric studies in a similar population¹¹. Explanatory variables and confounders 340 341 were informed by a multidisciplinary perspective, and validated measures were chosen¹⁷. Few other studies have used multivariate methods to allow for potential 342 343 confounding. Although this study only considered patient factors contributing to poor 344 intake, the influence of staff and environmental factors were also investigated and will 345 be reported separately.

346

347 We recognise several weaknesses in the study. In particular, the relatively small

348 sample size means that we may have missed or under-recognised associations.

349 Consent rates were lower than anticipated, partly because of high clinical acuity and

350 partly because of the high prevalence of cognitive impairment in this group, with 351 proxy consent not always feasible within the time frame. These reasons for non-352 consent suggest that our estimates of adequate nutritional intake may in fact be 353 optimistic. Energy requirements are ideally estimated by calorimetry, but our use of 354 estimating equations is consistent with the reality of clinical practice. The study was 355 conducted at a single site, although patient characteristics suggest a "typical" older 356 general medical population. Intake was only measured on a single day for most 357 participants; however, the subgroup with repeated measurements suggests that intake 358 remains relatively consistent, at least in the first week of hospitalisation. The study 359 sampled medical patients with a relatively long length of stay, which may limit 360 generalisability, but we deliberately selected this group because of their vulnerability 361 to further nutritional decline in hospital. 362

364 Conclusions

365	In summary, our study confirms that energy and protein intake are inadequate to meet
366	requirements in most older acute medical inpatients, which may lead to worsening
367	malnutrition during hospitalisation, and contribute to poor outcomes. It supports
368	recent recommendations for monitoring of intake and repeated nutritional risk
369	screening during the hospital stay, as well as at admission ² . Poor nutritional intake in
370	hospital may be especially common in the obese elderly, but further research is
371	required in this group to clarify energy requirements during acute illness.
372	
373	Poor intake was associated with several common patient characteristics, particularly
374	poor appetite, need for feeding assistance and delirium associated with acute illness.
375	These factors may not be assessed in routine nutritional screening, and deserve greater
376	recognition as factors impeding adequate intake in hospital. Interventions which
377	deliver additional nutrition to the bedside, without considering these common patient-
378	level barriers, are unlikely to succeed in improving nutritional status or clinical
379	outcomes in this patient group. Multi-faceted interventions which prioritise nutritional
380	care, directly address these barriers, and support nutritional screening with ongoing
381	intake monitoring may offer more promise ⁵ .
382 383	
384	The authors declare no conflict of interest

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- 393 AM conceived the study and designed the study, undertook data analysis and initial
- 394 data interpretation, and drafted the manuscript.
- 395 LR, MB and EI contributed to study design, data interpretation and critical review of
- 396 the manuscript.
- 397 AY contributed to methods, undertook data collection and entry, and contributed to
- 398 data interpretation and critical review of the manuscript.
- 399 All authors approved the final manuscript.
- 400

401 **References**

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

404 2. Watterson C, Fraser A, Banks M, et al. Evidence based guidelines for

405 nutritional management of malnutrition in adult patients across the continuum of care.

406 Nutr Diet. 2009;66(Suppl 3):S1-34.

407 3. Covinsky KE, Martin GE, Beyth RJ, Justice AC, Sehgal AR, Landefeld CS.

408 The relationship between clinical assessments of nutritional status and adverse

409 outcomes in older hospitalized medical patients. J Am Geriatr Soc 1999;47(5):532-

410 538.

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

413 5. Weekes CE, Sprio A, Baldwin C, et al. A review of the evidence for the

414 impact of improving nutritional care on nutritional and clinical outcomes and cost. J

415 Hum Nutr Diet 2009;22:324-335.

416 6. Incalzi RA, Gemma A, Capparella O, Cipriani L, Landi F, Carbonin P. Energy

417 intake and in-hospital starvation: a clinically relevant relationship. Arch Intern Med
418 1996;156(4):425-429.

419 7. Kondrup J, Johansen N, Plum LM, et al. Incidence of nutritional risk and

420 causes of inadequate nutritional care in hospitals. Clin Nutr 2002;21(6):461-468.

421 8. Barton A, Beigg C, Macdonald I, Allison S. High food wastage and low

422 nutritional intakes in hospital patients. Clin Nutr 2000;19(6):445-449.

423 9. Sullivan DH, Walls RC. Protein-energy undernutrition among elderly

424 hospitalized patients: a prospective study. JAMA. 1999;281(21):2013-2019.

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

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

429 12. Gaillard C, Alix E, Boirie Y, Berrut G, Ritz P. Are elderly hospitalized

430 patients getting enough protein? . J Am Geriatr Soc 2008;56:1045-1049.

431 13. Mudge A, Laracy S, Richter K, Denaro C. Controlled trial of multidisciplinary

432 care teams for acutely ill medical inpatients: enhanced multidisciplinary care. Intern

433 Med J. 2006;36(9):558-563.

434 14. Odlund Olin A, Osterberg P, Hadell K, Armyr I, Jerstrom S, Ljungqvist O.

435 Energy-enriched hospital food to improve energy intake in elderly patients. JPEN J

436 Parenter Enteral Nutr 1996;20(2):93-97.

437 15. Chumlea WC, Guo SS. Equations for predicting stature in white and black

438 elderly individuals. J Gerontology A Biol Sci Med Sci. 1992;47A:M197-M203.

439 16. Guigoz Y, Vellas B, Garry P. Assessing the nutritional status of the elderly:

440 the Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev

441 1996;54(S59-65).

442 17. Salva A, Corman B, Andrieu S, Salas J, Vellas B. Minimum data set for

443 nutritional intervention studies in elderly people. J Gerontology A Biol Sci Med Sci.

444 2004;59A(7):724-729.

445 18. Folstein MF, E FS, McHugh PR. The Folstein Mini-Mental State

446 Examination: a practical method for grading the cognitive state of patients for the

447 clinician. J Psychiatr Res 1975;12:189-198.

448 19. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI.

449 Clarifying confusion: the Confusion Assessment Method. Ann Intern Med

450 1990;113:941-948.

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

453 21. Sager MA, Franke T, Inouye SK, et al. Functional outcomes of acute medical

454 illness and hospitalization in older persons. Arch Int Med. 1996;156(6):645-652.

455 22. Shah S, Vancaly F, Cooper B. Improving the sensitivity of the Barthel index

456 for stroke rehabilitation. J Clin Epidemiol. 1989;42(8):703-709.

457 23. Wilson MG, Thomas DR, Rubenstein LZ, et al. Appetite assessment: simple

458 appetite questionnaire predicts weight loss in community-dwelling adults and nursing

459 home residents. Am J Clin Nutr 2005;82(5):1074-1081.

460 24. Cichero JA, Heaton S, Bassett L. Triaging dysphagia: nurse screening for

461 dysphagia in an acute hospital. J Clin Nurs 2009;18(11):1649-1659.

462 25. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds

463 ratio in cohort studies of common outcomes. JAMA. 1998;280(19):1690-1691.

464 26. Rammohan M, Juan D, Jung D. Hypophagia among hospitalized elderly. J Am

465 Diet Assoc 1989;89(12):1774-1780.

466 27. Klipstien-Grobusch K, Reilly JJ, Potter J, Edwards CA, Roberts MA. Energy

467 intake and expenditure in elderly patients admitted to hospital with acute illness. Br J

468 Nutr 1995;73:323-334.

469 28. Dupertuis YM, Kossovsky MP, Kyle UG, Raguso CA, Genton L, Pichard C.

470 Food intake in 1707 hospitalised patients: a prospective comprehensive hospital

471 survey. Clin Nutr 2003;22(2):115-123.

- 472 29. Perier C, Triouleyre P, Terrat C, Chomette MC, Beauchet O, Gonthier R.
- 473 Energy and nutrient intake of elderly hospitalized patients in a steady metabolic state
- 474 versus catabolic states. J Nutr Health Aging 2004;8(6):518-520.
- 475 30. Frankenfeld DC, Coleman A, Alam S, Cooney RN. Analysis of estimation
- 476 methods for resting metabolic rate in critically ill adults. JPEN J Parenter Enteral Nutr
- 477 2009;33:27-36.
- 478 31. Boullata J, Williams J, Cottrell F, Hudson L, Compher C. Accurate
- 479 determination of energy needs in hospitalized patients. J Am Diet Assoc
- 480 2007;107:393-401.
- 481 32. Weekes, C E. Controversies in the determination of energy requirements. Proc
- 482 Nutr Soc 2007; 66: 367-377

- 484 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
- 486 134 consecutive older medical patients

- 491 Figure 2: Energy intake (kcal per day) on the study day in 134 consecutive older
- 492 medical patients, grouped by body mass index subgroup.
- 493 2(A) underweight (BMI<21 kg/m², n=27).
- 494 2(B) normal weight (BMI 21-29.9 kg/m², n=76).
- 495 2(C) obese (BMI 30 kg/m² or greater, n=31).

498 Table 1: Participant characteristics, and bivariate associations with inadequate energy

499 intake, defined as an energy intake less than estimated resting energy expenditure

500 (REE) on the study day. Row percentages are shown. Denominators are provided (in

501	brackets) for variables with missing data. ADL activities of	daily living.
-----	--	---------------

Characteristic	Number of	Number (%)	р
	participants	with	
		inadequate	
		intake	
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)	
Acuteinfection	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/m²)			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

507 Table 2: Multivariate analysis (n=126) of potential predictors of inadequate intake

508 (energy intake less than estimated resting energy expenditure), adjusted for age and

509 comorbidity count. Reference category for multi-level variables is included in

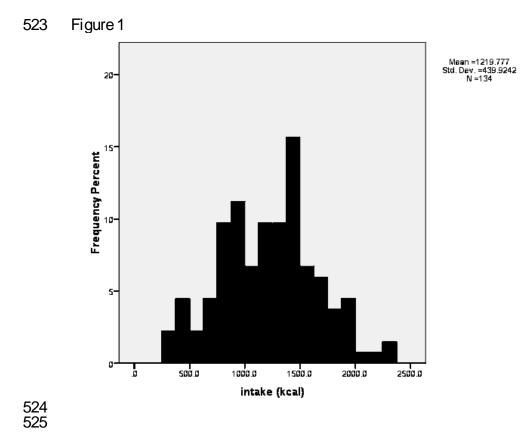
510 brackets.

511

	Adjusted odds ratio (95% CI)	р
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)	
\geq 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

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

	Adjusted odds ratio (95%	р
	CI)	
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)	
\geq 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



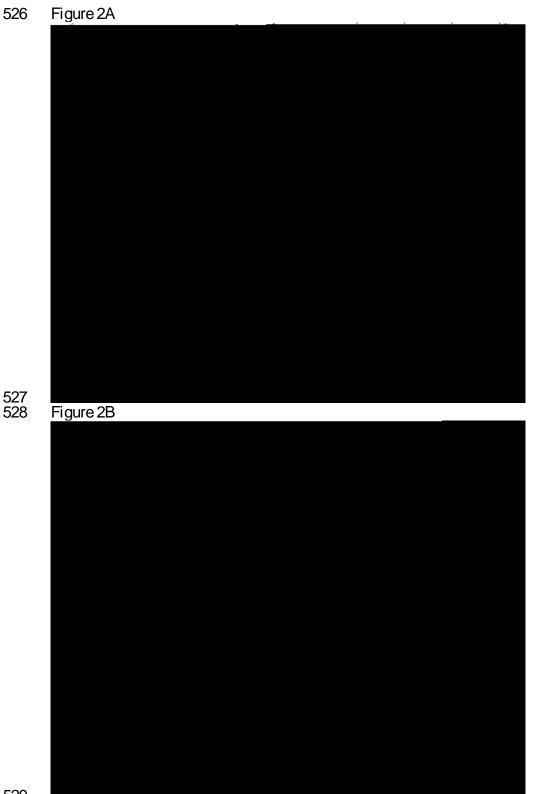
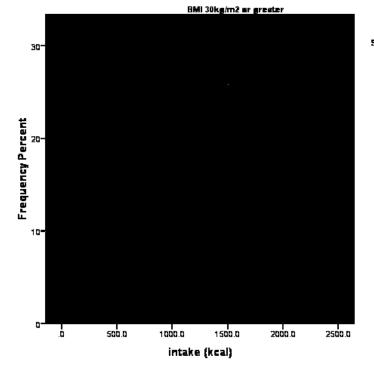


Figure 2C



Meen =1376.031 Std. Dev. =433.2496 N =31