

## 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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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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10

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

12

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21

22 This study was presented at the Royal Australian College of Physicians national  
23 meeting (Physician's Week) April 2009

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*

47

## 48 **Introduction**

49 Protein-energy malnutrition is common in older acute medical patients, where  
50 prevalence may be as high as 60%<sup>1,2</sup>. Malnutrition is associated with poor clinical  
51 outcomes<sup>3</sup>. However, there is limited evidence that improved nutritional care  
52 improves outcomes in this group<sup>4,5</sup>. There are several possible explanations.  
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<sup>1</sup>, which may lead to worsening nutritional status in hospital<sup>6</sup>. Some studies have  
60 highlighted deficiencies in systems of screening, prescribing and delivering nutritional  
61 care<sup>1,7</sup>. However, even when effective systems are established to deliver adequate  
62 nutrition, food waste studies and clinical experience suggest that patients often do not  
63 consume their meals, snacks and supplements<sup>5,8</sup>. Better understanding of the  
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

69 Several previous studies have considered patient-level factors which might reduce  
70 nutritional intake, such as poor appetite and difficulties with chewing or swallowing<sup>6</sup>,  
71<sup>7,9,10</sup>. However, these studies have several weaknesses, including inconsistencies in  
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 <sup>11, 12</sup>.

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.

81

## 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  
96 detail previously<sup>13</sup>. Nutrition screening is routinely conducted by dietetic assistants  
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

101 **Participants:** Consecutive patients admitted between November 2007 and March  
102 2008 were screened by the study dietitian for eligibility. Patients were eligible if they  
103 were aged 65 years or older, had a hospital stay of more than 2 days, and were  
104 admitted from the emergency department to the study wards. Patients who were  
105 critically or terminally ill or were receiving parenteral or enteral nutrition at the time  
106 of admission were excluded. Informed consent was obtained from all participants or a

107 suitable proxy (close family member or recognised carer). The study was approved by  
108 the 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  
114 correlate closely with measured plate waste<sup>14</sup>. Each meal was inspected on delivery  
115 and on completion, and consumption was estimated (none, 1/8, 1/4, 1/2, 3/4, all) for each  
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

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

130

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

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<sup>9, 10</sup>.

145

146 Detailed assessment was undertaken by the study dietitian, an experienced accredited  
147 practicing dietitian who did not provide clinical care to the participants. Demographic  
148 and disease variables were obtained from the medical record. Length of hospital stay,  
149 discharge destination and final diagnosis were obtained from the medical summary at  
150 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  
154 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



156 estimated from heel-knee length according to standard formulae <sup>15</sup>, and used to derive  
157 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 <sup>16, 17</sup>.

160

161 Cognition was measured using Folstein's Mini-Mental State Examination <sup>18</sup> with  
162 cognitive impairment defined as  $\leq 23$ , and the Confusion Assessment Method <sup>19</sup> was  
163 used to identify delirium. Depressive symptoms were assessed using the Geriatric  
164 Depression Scale <sup>20</sup>, 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,  
167 bathing, toileting, transfers, mobility and feeding) for which assistance from another  
168 person was required <sup>21</sup>. Feeding dependency was also considered as a separate  
169 variable using items from the modified Barthel index, and included need for help with  
170 set-up or supervision with meals <sup>22</sup>. Appetite was evaluated using the Simplified  
171 Nutritional Appetite Questionnaire, with scores of 14 or less indicating impaired  
172 appetite <sup>23</sup>. The study dietitian recorded the presence and state of current dentition,  
173 defining poor dentition as missing teeth, or ill-fitting or absent dentures. Risk of  
174 dysphagia was recorded using a validated screening tool <sup>24</sup>.

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. Adequacy of nutritional intake was calculated for each participant by

180 comparing daily energy intake with estimated REE, total energy expenditure and  
181 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<sup>25</sup>. 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  
194 ( $BMI \geq 30 \text{ kg/m}^2$ ) using a weight-based formula for REE. In clinical practice, estimates  
195 are often adjusted in obese patients based on ideal body weight plus 25% of additional  
196 body weight, on the assumption that only a proportion of the additional body mass is  
197 metabolically active. We undertook a sensitivity analysis redefining REE based on  
198 this adjusted body weight for obese participants, and report the logistic regression  
199 results.

200

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

204

205

## 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,  
211 and in 113 cases consent was not able to be obtained from the patient or an  
212 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  
221 malnutrition and 41 (31%) well nourished. The mean BMI was 26.1 kg/m<sup>2</sup> (SD 6.0),  
222 and 27 (20%) had BMI <21 kg/m<sup>2</sup>.

223

224 Eighty four (63%) participants needed assistance in at least one ADL at the time of  
225 assessment, including 43 (32%) who required help with set-up, supervision or actual  
226 feeding of meals. Of 125 participants for whom formal cognitive testing was possible,  
227 41 (33%) demonstrated cognitive impairment, 12 (10%) had evidence of delirium, and  
228 31 (27%) had symptoms suggesting depression. Impaired appetite was recorded in 68  
229 (52%), poor dentition observed in 44 (33%), and potential risk of dysphagia or  
230 aspiration in 54 (41%).

231

**232 Nutritional intake and estimated requirements**

233 Mean energy provided in meals and snacks on the study day was 1836 kcal (SD 376).

234 **Figure 1** shows the distribution of energy intake. The mean measured daily energy

235 intake was 1220 kcal/day (SD 440), or 18.1 kcal/kg/day. This represented 66% of

236 energy provided in meals and snacks; 27% of participants ate less than 50% of the

237 energy provided, and 62% ate less than 75%. Most energy intake was from main

238 meals (28% breakfast, 30% lunch, 33% dinner), with 9% from mid meals and snacks.

239 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

241 energy expenditure in only 11/134 (8%). Only 14% had a protein intake  $\geq$  1g/kg

242 bodyweight/day.

243

244 In a subgroup of 38 participants, energy intake measurement was repeated on day 3

245 and day 7. This showed no significant change in mean energy intake (1144 kcal/day

246 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

250 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

254 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 assessed  
257 by the MNA.

258

259 **Table 2** shows the results of the multiple logistic regression model. There was  
260 significant collinearity between feeding and ADL dependency (chi-square 37.7,  
261  $p < 0.001$ ), 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  
264 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  
268 despite increased weight. When we repeated REE estimates using adjusted body  
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.

274

## 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  
280 total energy expenditure, and 14% had sufficient protein intake to avoid protein  
281 catabolism <sup>12</sup>.

282

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

292

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

297

298 Poor appetite was strongly associated with poor nutritional intake. Poor appetite and  
299 difficulties with chewing or swallowing have been identified as risk factors for poor

300 intake in several previous studies, although these did not use reliable measurement or  
301 account for potential confounders<sup>6,7,10</sup>. We did not find a significant association with  
302 poor dentition or dysphagia. A diagnosis of infection or cancer tended to be associated  
303 with poorer intake, even though we did not include a stress factor for these conditions  
304 in estimates of energy requirement, as is often done in clinical practice.

305

306 Despite the high prevalence of functional disability in the hospitalised elderly, few  
307 previous studies have evaluated functional status as a risk factor for poor intake<sup>9</sup>. Our  
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  
312 admissions<sup>25</sup>, and was probably under-represented in our sample because of consent  
313 considerations.

314

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

319

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<sup>9,28</sup>. This finding

325 may depend on the method for estimating REE. The best method for estimating  
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  
328 compared to calorimetry<sup>30,31</sup>. We based our estimates on the recommendations of a  
329 recent study in older medical patients with characteristics similar to our own study<sup>11</sup>,  
330 which used actual body weight, adjusting only for those with BMI <21 kg/m<sup>2</sup>. There  
331 is conflicting data regarding whether weight-based formulae overestimate energy  
332 requirements in the older obese subgroup<sup>30,31,32</sup>. As a sensitivity analysis, we  
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

337 Our study has several strengths which contribute to its internal validity. Nutritional  
338 intake was measured by detailed direct observation of meal components. Inadequate  
339 intake was explicitly defined in a physiologically meaningful way, based on  
340 calorimetric studies in a similar population<sup>11</sup>. Explanatory variables and confounders  
341 were informed by a multidisciplinary perspective, and validated measures were  
342 chosen<sup>17</sup>. Few other studies have used multivariate methods to allow for potential  
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

363

## 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 <sup>2</sup>. 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 <sup>5</sup>.

382

383

384 *The authors declare no conflict of interest*

385

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389

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392

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

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484 Figure 1: Energy intake (kcal per day) based on observation of individual meal  
485 delivery and waste on the study day (between day 3 and 7 of hospital admission) in  
486 134 consecutive older medical patients

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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/m<sup>2</sup>, n=27).

494 2(B) normal weight (BMI 21-29.9 kg/m<sup>2</sup>, n=76).

495 2(C) obese (BMI 30 kg/m<sup>2</sup> or greater, n=31).

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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.

<b>Characteristic</b>	<b>Number of participants</b>	<b>Number (%) with inadequate intake</b>	<b>p</b>
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 <sup>2</sup> )			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
<b><i>TOTAL</i></b>	<b>134</b>	<b>79 (59)</b>	<b>134</b>

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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

	<b>Adjusted odds ratio (95% CI)</b>	<b>p</b>
Poor appetite	1.85 (1.42-2.06)	0.001
BMI (21-30 kg/m <sup>2</sup> )		<0.001
<21 kg/m <sup>2</sup>	0.28 (0.08-0.77)	
≥30 kg/m <sup>2</sup>	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

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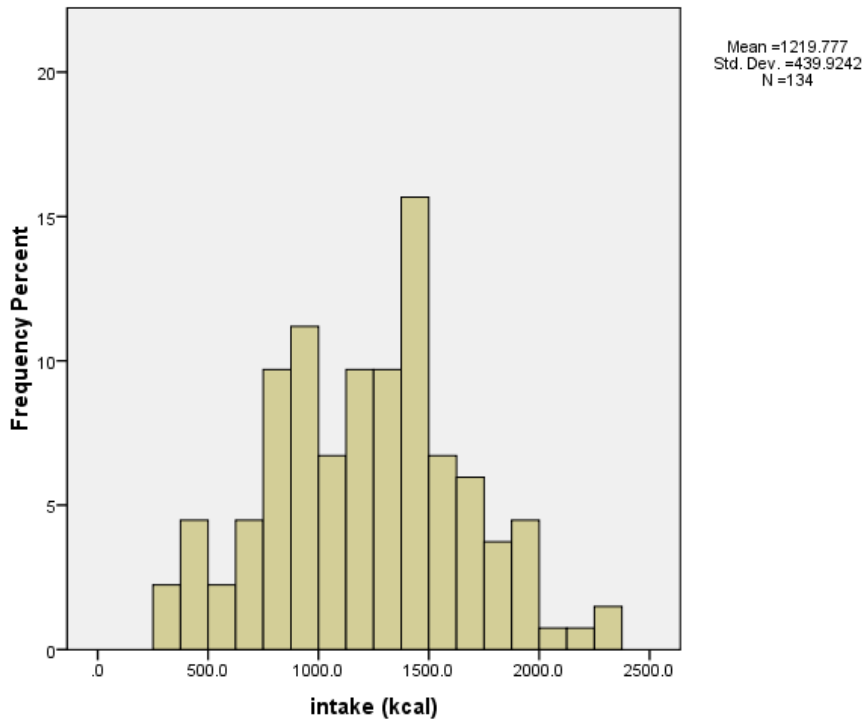
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514 Table 3: Multivariate analysis (n=126) of potential predictors of inadequate intake  
 515 (energy intake less than estimated resting energy expenditure, adjusted in the obese  
 516 subgroup), adjusted for age and comorbidity count. Reference 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<sup>2</sup>  
 519

	<b>Adjusted odds ratio (95% CI)</b>	<b>p</b>
Poor appetite	2.22 (1.47-2.73)	0.001
BMI (21-30 kg/m <sup>2</sup> )		0.08
<21 kg/m <sup>2</sup>	0.39 (0.12-0.91)	
$\geq 30$ kg/m <sup>2</sup>	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

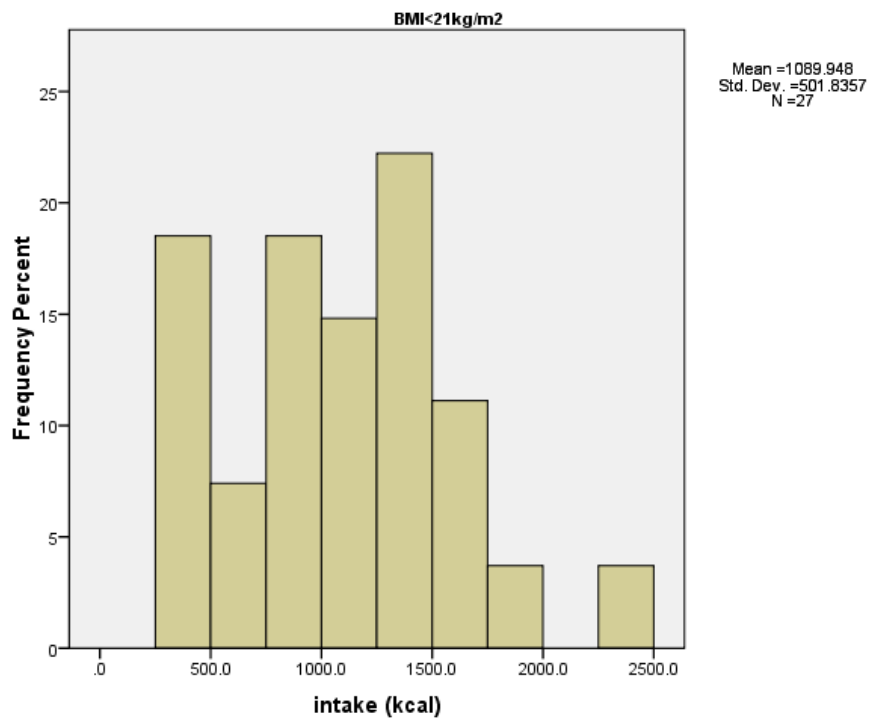
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523 Figure 1

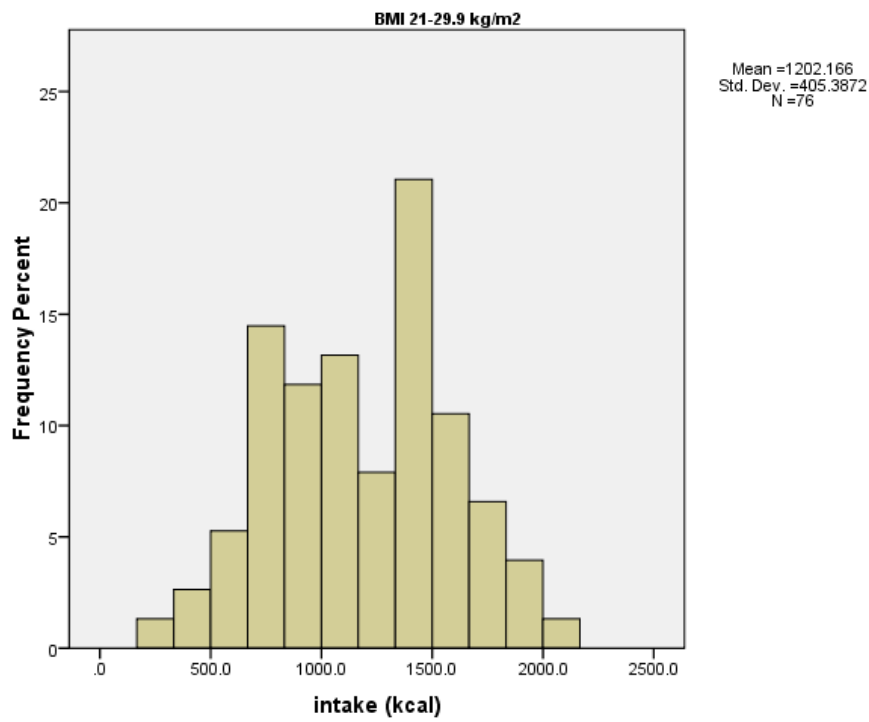


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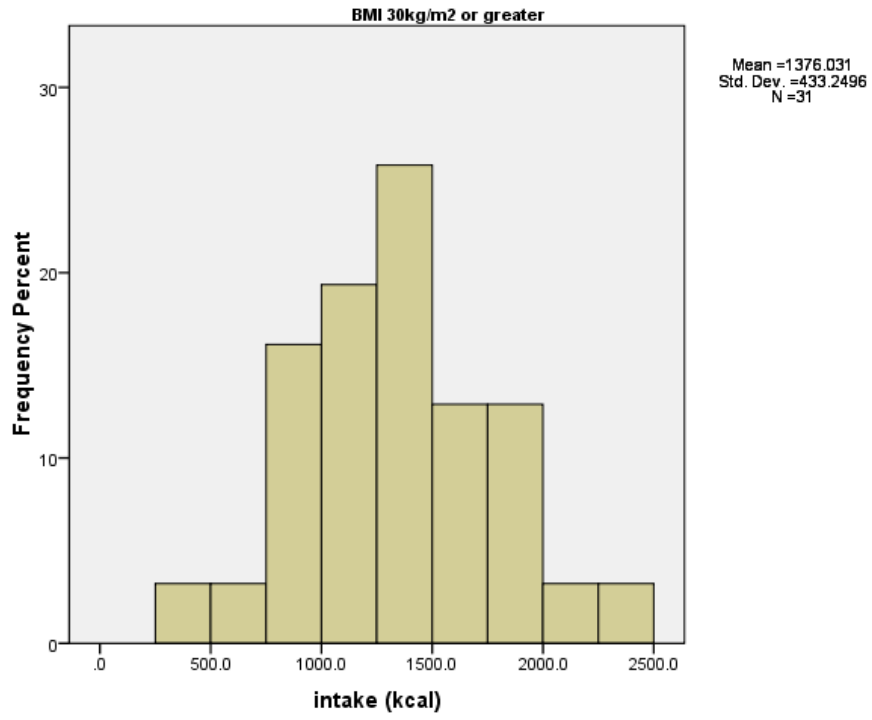
526 Figure 2A



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528 Figure 2B



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530 Figure 2C



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