

**Malnutrition and poor food intake are associated with prolonged hospital stay, frequent readmissions, and greater in-hospital mortality  
results from the Nutrition Care Day Survey 2010**

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1 **Title: Malnutrition and poor food intake are associated with prolonged hospital**  
2 **stay, frequent readmissions, and greater in-hospital mortality: Results from**  
3 **the Nutrition Care Day Survey 2010**

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14

15 **Short title:** Malnutrition, poor food intake, poor outcomes. (50 characters)

16

17 **List of Abbreviations:**

18 ANCDS- Australasian Nutrition Care Day Survey

19 ARDRG- Australian Refined Diagnosis Related Group

20 BMI- Body Mass Index

21 CI- Confidence Interval

22 DRG- Diagnosis Related Group

23 EQ-5Dvas- EQ-5D visual analogue scale

24 LOS- Length of stay

25 MDC- Major Diagnostic Category

26 MST- Malnutrition Screening Tool

27 PCCL- Patient Clinical Complexity Level

28 SGA- Subjective Global Assessment

29

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38

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40 on Clinical Nutrition and Metabolism in Barcelona, Spain (8 – 11 September 2012).

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51 **ABSTRACT**

52 **Background and Aims:** The Australasian Nutrition Care Day Survey (ANCDS)  
53 ascertained if malnutrition and poor food intake are independent risk factors for  
54 health-related outcomes in Australian and New Zealand hospital patients.

55 **Methods:** Phase 1 recorded nutritional status (Subjective Global Assessment) and  
56 24-hour food intake (0, 25, 50, 75, 100% intake). Outcomes data (Phase 2) were  
57 collected 90-days post-Phase 1 and included length of hospital stay (LOS),  
58 readmissions and in-hospital mortality.

59 **Results:** Of 3122 participants (47% females,  $65 \pm 18$  years) from 56 hospitals, 32%  
60 were malnourished and 23% consumed  $\leq 25\%$  of the offered food. Malnourished  
61 patients had greater median LOS (15 days vs. 10 days,  $p < 0.0001$ ) and readmissions  
62 rates (36% vs. 30%,  $p = 0.001$ ). Median LOS for patients consuming  $\leq 25\%$  of the food  
63 was higher than those consuming  $\geq 50\%$  (13 vs. 11 days,  $p < 0.0001$ ). The odds of 90-  
64 day in-hospital mortality were twice greater for malnourished patients (CI: 1.09-3.34,  
65  $p = 0.023$ ) and those consuming  $\leq 25\%$  of the offered food (CI: 1.13-3.51,  $p = 0.017$ )  
66 respectively.

67 **Conclusion:** The ANCDS establishes that malnutrition and poor food intake are  
68 independently associated with in-hospital mortality in the Australian and New  
69 Zealand acute care setting.

70 **(196 words)**

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72

73 **Keywords:** malnutrition, poor food intake; disease type and severity; length of stay;  
74 readmissions; in-hospital mortality

75

## 76 **INTRODUCTION**

77 The Australasian Nutrition Care Day Survey (ANCDS) is the largest multicentre study  
78 in the Australasian region, reporting the prevalence of malnutrition and poor food  
79 intake in 3122 patients across 56 Australian and New Zealand hospitals [1]. With  
80 one-in-three patients malnourished; and two-in-three patients not consuming all of  
81 the offered hospital food, it was evident that malnutrition and poor food intake are a  
82 common occurrence in Australian and New Zealand hospitals [1].

83 Numerous studies have suggested that in comparison to well-nourished patients,  
84 malnourished patients experience worse outcomes such as prolonged length of  
85 hospital stay (LOS), increased readmissions, and mortality [2-6]. There is  
86 documented evidence to suggest that malnourished patients incur greater  
87 hospitalisation costs [7], related to longer LOS, readmissions, and greater utilisation  
88 of hospital resources [2, 5].

89 The ANCDS found that one-in-three malnourished patients (n= 305, 30%), and one-  
90 in-five well-nourished patients (n= 371, 18%) consumed nothing or up to 25% of the  
91 food offered during the 24-hour data collection period [1]. Since continued sub-  
92 optimal food intake can eventually lead to deterioration of nutritional status, it is  
93 important to evaluate the effect of poor food intake on health-related outcomes. Two  
94 studies have reported the link between poor food intake during hospitalisation and  
95 mortality [6, 8], however there is no published evidence regarding the association  
96 between poor food intake and readmissions and/or LOS.

97

98 Although previous studies have investigated associations between malnutrition and  
99 patient outcomes, issues such as heterogeneity in patient populations; study design;  
100 methods of evaluating nutritional status, food intake and/or outcomes; prevent the

101 results from these studies being generalised throughout the acute care population.  
102 Factors such as type and severity of disease are major causes of malnutrition [9],  
103 poor food intake [10], and patient outcomes, and yet they have rarely been controlled  
104 for. Without accounting for the confounding effect of disease type and severity most  
105 studies fail to distinguish the association between the effect of disease, nutritional  
106 issues, and other factors (such as age, gender), and patient outcomes. Therefore,  
107 there is a risk of underestimating the independent effects of disease, and  
108 overestimating the independent effects of nutritional issues. The aim of this study  
109 was to take into account disease type and severity and explore associations  
110 between: (1) nutritional status; (2) food intake; and health-related outcomes (LOS,  
111 mortality, and readmissions) in participants from the ANCDS.

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## 126 **METHODS**

127 The ANCDs was conducted in two phases. Participants were recruited in Phase 1 of  
128 the study and the episode of admission was referred to as “index hospitalisation”.

129 In Phase 1 data were collected by dietitians from participating hospitals [1]. Data  
130 included demographic, nutritional status, and 24-hour food intake information for  
131 each participant [1]. Participants’ body mass index (BMI) were calculated based on  
132 their recorded weight and height [1]. To evaluate nutritional status, each participant  
133 was screened using the Malnutrition Screening Tool (MST) [11] and those deemed at  
134 risk of malnutrition underwent comprehensive nutritional assessment using  
135 Subjective Global Assessment (SGA) [12]. Based on the International Classification  
136 of Disease and Related Health Problems (ICD-10-AM) [13], malnutrition was defined  
137 as BMI <18.5 kg/m<sup>2</sup> and an SGA rating of moderately malnourished (SGA-B) or  
138 severely malnourished (SGA-C). Over a 24-hour period, each participants’  
139 percentage food intake was observed and recorded by meal and snack on a five-  
140 point scale (0%, 25%, 50%, 75%, and 100%) [1]. Information on the prescribed diet  
141 on the day of the survey was also recorded [11].

142 The present study (Phase 2) is a prospective cohort study and includes participants  
143 from Phase 1. Data were collected 90 days post Phase 1 and includes:

- 144 • Admission-related data: Nature of admission, type and severity of disease,  
145 discharge status (Appendix 1);
- 146 • Outcomes-related data: Length of stay, readmissions, date of death (Appendix  
147 1).
- 148 • Quality of life data: Participants’ self-perceived quality of life was assessed  
149 using EQ-5D [14], a non-disease specific two part questionnaire (Appendix 1).

150 Ethical approval for the present study was provided by the Medical and Research  
151 Ethics Committee of The University of Queensland and local Human Research Ethics  
152 Committees of participating hospitals. Data were collected in accordance with the  
153 ethical standards of the ethics committees.

154

### 155 **Statistical Analysis**

156 Data were analysed using PASW Statistics 18. The following variables were  
157 dichotomised:

- 158 • Age- < 65 years, ≥ 65 years;
- 159 • PCCL scores- not severe/catastrophic PCCL (i.e. PCCL score of 0, 1 or 2),  
160 severe/catastrophic PCCL (i.e. PCCL score of 3 or 4);
- 161 • EQ-5Dprofile (i.e. each of the five dimensions (mobility, self-care, activity,  
162 pain/discomfort, anxiety/depression)- no problem, some problem (included  
163 moderate/severe problem)[14];
- 164 • Nutritional status: Malnourished (included SGA-B[12], SGA-C[12], and patients  
165 with BMI <18.5 kg/m<sup>2</sup> [13]), well-nourished (included MST < 2 [11]and SGA-A[12]);
- 166 • Food Intake- Since food intake of ≤25% (i.e. nil-by-mouth (NBM), 0%, 25% food  
167 consumption during Phase 1 of the survey) was significantly associated with the  
168 outcomes at the bivariate level, food intake was dichotomised as ≤25% and ≥50%  
169 (i.e. 50%, 75%, and 100% food consumption during Phase 1 of the survey).

170 Appendix 2 describes the steps undertaken to clean the dataset for outcomes  
171 variables.

172 All categorical variables were reported as frequency and percentage. The distribution  
173 of LOS, as a continuous variable, was analysed. Length of stay remained skewed  
174 after trimming, and is therefore reported using median (range). LOS was transformed



175 by using the square root for analysis. Bivariate analyses were undertaken using chi-  
176 square tests for categorical variables and independent sample t-tests or equivalent  
177 non-parametric t-tests for continuous variables, to identify significance between  
178 confounders and outcome variables. Variables considered as risk factors from the  
179 literature (confounding variables) and those demonstrating a significant association  
180 with each outcome variable at a bivariate level (evaluative confounding variables)  
181 were entered into regression models (Appendix 3). Preliminary assumption testing  
182 were conducted to ensure no violation of the assumptions, including multicollinearity.  
183 High intercorrelations were observed between diet type and nutritional status, and  
184 therefore diet type was excluded from the regression models. A  $p$ -value  $< 0.05$  was  
185 considered statistically significant.

186

187

## 188 **RESULTS**

189 Outcomes data were available for 3017 of the total 3122 participants (97%). After  
190 data cleaning (as previously outlined), data analyses for LOS and mortality included  
191 2982 participants (95%), and readmissions data were analysed for 2942 participants  
192 (94%).

193

194 Table 1 depicts admission-related characteristics of the participants. Malnutrition was  
195 significantly associated with age  $\geq 65$  years, emergency admissions, admissions  
196 other than surgical or medical, certain MDCs, severe/catastrophic PCCL scores,  
197 discharge status (excluding those who left against medical advice), EQ-5D<sub>profile</sub> and  
198 EQ-5D<sub>vas</sub> scores, and pre-survey LOS (Table 1). Consumption of  $\leq 25\%$  of the  
199 offered hospital food was significantly associated with age  $\geq 65$  years, certain MDCs,

200 surgical and medical admissions, severe/catastrophic PCCL scores, EQ-5D<sub>profile</sub> and  
201 EQ-5D<sub>vas</sub> scores (Table 1). Participants who consumed  $\geq 50\%$  of the offered food  
202 were more likely to be discharged to their home/place of usual residence (Table 1).  
203 Percentage food intake was not associated with pre-survey LOS (Table 1).

204

205 **LOS:** The median LOS for all patients was 11 days (Table 2) with 67 patients (2%)  
206 having a LOS of  $\geq 90$  days. Malnourished participants had longer median LOS (15  
207 days, range: 2 – 119 days) compared to well-nourished participants (median LOS: 10  
208 days, range: 2 – 158 days) ( $p < 0.0001$ ) (Table 2). Severely malnourished  
209 participants (SGA-C) had a significantly longer median LOS (21 days, range: 2 – 259  
210 days) versus well-nourished participants (12 days, range: 2 – 291 days) and  
211 moderately malnourished (SGA-B) participants (15 days, range: 2 – 467 days) ( $p <$   
212  $0.0001$ ). The median LOS of participants who consumed  $\leq 25\%$  of the offered food  
213 was longer (13 days, range: 2 – 158 days) than those who consumed  $\geq 50\%$  of the  
214 food (11 days, range: 2 – 119 days) ( $p < 0.0001$ ) (Table 2).

215 The multiple regression analysis model explained 32% of the variance in LOS ( $R^2 =$   
216  $0.329$ , adjusted  $R^2 = 0.319$ ,  $F(34, 2290) = 32.95$ ,  $p < 0.0001$ ). PCCL scores were the  
217 largest unique contribution (beta: 0.353, CI: 0.417 – 0.513,  $p$ -value  $< 0.0001$ ).  
218 Nutritional status made a statistically significant contribution (beta: 0.084, CI: 0.167 –  
219  $0.414$ ,  $p$ -value  $< 0.0001$ ). Percentage food intake was not significant.

220

221 **Readmissions:** The overall readmission rate was 30% ( $n = 882$ ) (Table 2) within 90-  
222 days from post-index hospitalisation. While malnourished patients had a significantly  
223 higher readmission rate (35%) in comparison to well-nourished patients (27%), no  
224 association was found between percentage food intake and readmissions (Table 2).

225 An ordinal regression model did not find malnutrition to be a significant risk factor for  
226 readmissions. Neoplastic disease and discharge to other healthcare facilities were  
227 the highest risk factors for significantly increasing the odds of readmissions within 90  
228 days of index hospitalisation (Table 3).

229

230 **Mortality:** The 30-day and 90-day in-hospital mortality rate were 1.5% (n= 46) and  
231 2.4% (n= 72) respectively (Table 2). Malnourished patients and those who ate  $\leq 25\%$   
232 of the offered food had significantly higher mortality rates than others (Table 2). Risk  
233 factors for in-hospital mortality have been included in Tables 4a and 4b. Logistic  
234 regression analysis revealed:

- 235 • Although malnutrition was not an independent risk factor for 30-day in-hospital  
236 mortality (Table 4a) it increased the odds of 90-day in-hospital mortality by  
237 almost two times (OR: 1.91, CI: 1.09-3.34,  $p= 0.023$ ) (Table 4b).
- 238 • Eating  $\leq 25\%$  of the offered food increased the risk of 30- and 90-day in-  
239 hospital mortality by  $> 2.5$  times (OR: 2.69, CI: 1.31 – 5.52,  $p= 0.007$ ) (Table  
240 4a) and 2 times (CI: 1.13 – 3.51,  $p = 0.017$ ) respectively (Table 4b).
- 241 • Severe/catastrophic PCCL score and age  $\geq 65$  years were independent risk  
242 factors common for both, 30- and 90-day in-hospital mortality (Tables 4a, 4b).

243 The hazard ratio of 90-day in-hospital mortality for malnourished patients who  
244 consumed  $\leq 25\%$  of the offered food was 2.3 times greater (CI: 1.39-3.76,  $p= 0.001$ )  
245 than well-nourished patients (Table 5; Figure 1).

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## 250 **DISCUSSION**

251 The ANCDs is the first multicentre study in acute care hospitals across Australia and  
252 New Zealand to report the association between patients' nutritional status, food  
253 intake and health-related outcomes. The study found that patients who were  
254 malnourished or consumed  $\leq 25\%$  of the hospital offered food had significantly longer  
255 LOS and higher in-hospital mortality rates. Malnourished patients also had  
256 significantly higher readmissions rates than well-nourished patients.

257 Considering there are several non-nutritional factors that can influence LOS [15],  
258 readmissions [16], and in-hospital mortality, it is important to account for these  
259 factors. Although three studies have previously used multivariate regression analyses  
260 to control for the effect of confounders in a general, adult acute care population [2, 5,  
261 6], they have limited comparability as they did not control for disease severity. They  
262 also did not evaluate readmissions as an outcome [2, 6], participants' food intake [2,  
263 5] or participants' nutritional status using validated and reliable methods [6]. To the  
264 best of our knowledge, the ANCDs is the only study to control for disease severity  
265 (using PCCL scores) and other non-nutritional factors (age, gender, disease type,  
266 QoL indicators) in multivariate regression models to report the independent  
267 association between malnutrition and poor food intake and LOS, readmissions, and  
268 mortality in a general, adult acute care population. Multivariate regression analyses  
269 confirmed that non-nutritional factors associated with all three outcomes were  
270 severe/catastrophic disease severity and age  $\geq 65$  years. Respiratory disease was a  
271 common risk factor for readmissions and 90-day in-hospital mortality.

272 **LOS:** Three other studies have used regression analyses to report associations  
273 between malnutrition and LOS [2, 5, 17]. Pirlich et al used number of prescriptions  
274 per day as a surrogate marker for disease severity, although they acknowledged the

275 limitation of this method [17]. Lim et al did not control for disease severity per se,  
276 however, they used the DRG-matching technique and controlled for diagnosis,  
277 investigations, and treatment costs. Their study demonstrated that malnutrition was  
278 an independent risk factor for longer LOS [5]. Other nutrition studies have not  
279 controlled for disease severity [2] while establishing associations between  
280 malnutrition and LOS. Results from the ANCDs establish that malnutrition is a  
281 contributor to prolonged LOS, independent of the disease status.

282 Studies evaluating the association between food intake and LOS in hospitals are  
283 extremely limited and conflicting. Kandiah et al reported a positive association  
284 between extended LOS and greater plate waste [18]. Conversely, Dupertuis et al  
285 found that patients with a hospital LOS of more than eight days were less likely to “be  
286 underfed” and speculated that the extended duration of hospital stay helped with  
287 adapting to the taste of hospital food, and mealtimes [19]. The present study could  
288 not find a significant difference in the median pre-survey LOS of patients consuming  
289  $\leq 25\%$  of the hospital offered food versus those consuming  $\geq 50\%$  of the food. Given  
290 that the present study demonstrated a significant association between malnutrition  
291 and LOS, and poor food intake during hospitalisation is a risk factor for malnutrition, it  
292 is important to recognise and provide timely nutrition support to patients with poor  
293 food intake during hospital admission.

294 **Readmissions:** The ANCDs reported that one-in-three patients (30%) are  
295 readmitted within three months of index hospitalisation. The readmission rate at three  
296 months in this study is substantially higher than the 19 – 24% rate previously  
297 reported [20].

298 Although analyses found that the readmission rate of malnourished patients was 1.3  
299 times higher than that of well-nourished patients, this effect was lost during ordinal

300 regression analysis. Five previous studies have reported a positive association  
301 between malnutrition and readmissions [3-5, 21, 22]. The findings from three of these  
302 studies cannot be compared to the present study as they were conducted in small  
303 cohorts of participants  $\geq 50$  years of age, and used anthropometric and/or  
304 biochemical measures to define malnutrition [3, 21, 22]. The findings by Planas et al  
305 have limited application as despite having a larger cohort and using a validated  
306 method to define malnutrition (i.e. SGA), they did not control for the effect of  
307 confounding variables [4]. The study by Lim et al is comparable as they included a  
308 large cohort (n: >800 participants, age: >18 years), used the validated SGA to define  
309 malnutrition, and controlled for various confounders (age, gender, ethnicity, DRG) [5].  
310 Similar to the ANCDs, their study could not find an association between malnutrition  
311 and readmissions within 90-days of index hospitalisation [5]. However, they found  
312 that malnourished patients had a 60% higher readmission risk within 15-days post-  
313 hospital discharge [5]. It was beyond the scope of this study to record the nutritional  
314 status of the participants at each episode of readmission. Further research evaluating  
315 the effectiveness of hospital- and/or community-based nutrition interventions in  
316 preventing readmissions will be valuable in filling this gap in the literature.

317 The ANCDs found that neoplastic disease, discharge destinations,  
318 severe/catastrophic disease severity, and age  $\geq 65$  years were associated with  
319 increased readmissions. Several studies, as summarised in one meta-analysis [16]  
320 and two systematic reviews [23, 24], have previously reported these associations.

321 **Mortality:** The ANCDs also found that malnourished patients consuming  $\leq 25\%$  of  
322 the offered food had more than a two-fold risk of 90-day in-hospital death compared  
323 to well-nourished patients who consumed at least half the offered food. This effect  
324 was not significant for 30-day in-hospital mortality. Our results contrast with the

325 nutritionDay Survey by Hiesmayr et al, which was also a one-day multicentre study  
326 (involving >16000 patients from >250 hospitals in 25 European countries), reported  
327 an adjusted hazard ratio of 2.10 (CI: 1.53 – 2.89) for 30-day in-hospital mortality in  
328 patients who consumed a quarter of the offered meal [6]. More detailed analysis of  
329 disease severity and nutritional status characteristics of the sub-group of patients in  
330 the ANCDs who experienced 30-day in-hospital mortality indicated that there was no  
331 significant difference in the number of well-nourished (n= 20, 45%) and malnourished  
332 patients (n= 24, 55%) ( $p > 0.05$ ) and that a majority of these patients (n= 44, 96%)  
333 had a severe/catastrophic PCCL score during index hospitalisation. Since disease  
334 severity is associated with increased mortality, and highly correlated with  
335 malnutrition, this could explain why malnutrition was not a significant independent  
336 risk factor for 30-day in-hospital mortality.

337

338 **LIMITATIONS:** The ANCDs could record readmissions only within participating  
339 hospitals. Even though the readmission rate was higher than that reported by other  
340 studies, considering that readmissions to other hospitals can account for  
341 approximately 25% of all readmissions [25], this study may have underreported  
342 readmission rates.

343 The ANCDs has provided in-hospital mortality data only. Mortality data for those that  
344 may have occurred post-discharge in a different setting were not recorded making it  
345 likely that mortality rates may have also been underreported in this study.

346 Participating hospitals represent at least 20% of acute care hospitals in Australia [26]  
347 and 40% of acute care hospitals in New Zealand [27] (that have more than 60 beds)  
348 limiting the generalisability of the results across the acute care population in Australia  
349 and New Zealand. Nevertheless, the ANCDs is the first and largest multicentre study

350 to provide a snapshot of the association between malnutrition, poor food intake and  
351 patient outcomes in this region.

352 The ANCDs reported point prevalence malnutrition for a majority of the patients and  
353 food intake was recorded for a 24-hour period only. In addition, being a cross-  
354 sectional observational study it cannot determine if poor food intake caused in-  
355 hospital mortality within 30-days of hospital admission. It is noteworthy that  
356 regardless of the type and severity of disease, age, nutritional status, and other  
357 potential confounders, consuming  $\leq 25\%$  the offered food (during Phase I)  
358 independently increased the odds for 30- and 90-day in-hospital mortality. It was  
359 beyond the scope of this study to calculate the nutritional intake for participants who  
360 consumed  $\leq 25\%$  the offered food; however, it can be speculated that consumption of  
361  $\leq 25\%$  of the offered food would be unlikely to meet participants' nutritional  
362 requirements.

363

364 **STRENGTHS:** The ANCDs is the first study to highlight the independent association  
365 of malnutrition and poor food intake during hospitalisation on health-related outcomes  
366 in Australian and New Zealand acute care patients, after controlling for various  
367 confounders including disease type and severity. Evidence regarding the association  
368 between poor food intake and negative outcomes is scarce. Even though previous  
369 studies have reported the association between nutritional status and negative  
370 outcomes, they have seldom controlled for disease severity and other confounding  
371 factors, thus providing an incomplete analysis of association. It is possible that  
372 controlling for disease severity was a challenge for previous studies, particularly  
373 when there is no universally accepted measure for disease severity [6]. There are a  
374 variety of generally accepted comorbidity indices [28] that can reduce all the



375 coexisting diseases and their severities to a single score to allow comparisons with  
376 other patients with the same score [28]. However, they measure comorbidity at a  
377 given time and are either designed for a specific patient group or consist of a limited  
378 number of disease categories [28]. The ANCDs cohort was anticipated to include  
379 patients with a vast variety of acute care condition/s, limiting the application of any  
380 particular comorbidity index. In addition, comorbidity indices require data abstraction  
381 by reviewing patients' medical charts [28]. Given the large cohort, it would not only be  
382 time-consuming and impractical to review individual hand-written medical charts to  
383 record each participants' comorbidities, missing data would also be a risk [28].  
384 Therefore, the ANCDs used a novel approach to overcome the challenge of  
385 controlling for disease type and severity- by using diagnostic codes (AR-DRG) and  
386 PCCL scores respectively. Moreover, PCCL scores are reflective of the cumulative  
387 effect of patients' complications and comorbidities for the entire episode of  
388 admission, and thus a more accurate measure of patients' disease severity.

389

390 **PRACTICAL IMPLICATIONS:** The ANCDs is the first study that we know of which  
391 demonstrates that poor food intake, independent of disease type and severity, and  
392 malnutrition is associated with in-hospital mortality in acute care patients. While one-  
393 in-three malnourished patients consumed  $\leq 25\%$  of the offered food, one-in-five well-  
394 nourished patients also consumed  $\leq 25\%$  of the offered food [1]. These results call  
395 for more consistent monitoring of hospitalised patients' food intake levels. Perhaps  
396 protocols for recording patients' food intake after each meal need to be implemented  
397 akin to those for authorising medication charts soon after medications are  
398 administered. In light of our results, and those from the European NutritionDay

399 Survey, perhaps consumption of  $\leq 25\%$  of the offered food should be used as a  
400 screening (and rescreening) tool to commence appropriate medical nutrition therapy.

401

402 **CONCLUSION:** The ANCDS is the first multicentre study in acute care patients  
403 across Australia and New Zealand to examine the association between nutritional  
404 status and food intake, and health-related outcomes (LOS, readmissions, and in-  
405 hospital mortality), after controlling for a range of confounding factors (including  
406 disease type and severity). The ANCDS confirms that malnutrition and poor food  
407 intake have independent associations with health-related outcomes in acute care  
408 patients. Both these risk factors are modifiable, in contrast to other risk factors such  
409 as age and disease. Findings from the ANCDS accentuate the importance of  
410 implementing every step of the nutrition care process (nutrition screening and  
411 assessment, nutrition support, nutrition monitoring and evaluation of nutrition  
412 support) as standardised practice across acute care hospitals.

413

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422

423

424 **Authors' contributions to manuscript:**

425 EA designed and coordinated the study; acquired, analysed and interpreted the data;  
426 and wrote the manuscript. MF, MB and EI provided significant advice on the study  
427 design. MBatterham provided statistical advice. All authors participated in editing and  
428 final revisions of the manuscript. All authors have read and approved the final  
429 manuscript.

430

431 **Conflict of Interest:** EA, MBatterham, JB, and SC have no conflict of interest to  
432 declare. MF, MB and EI are employed by Queensland Health, Australia.

433

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Table 1: Admission-related characteristics of the participants:

Characteristics	Overall Results	Results as per Nutritional Status			Results as per % Food Consumption		
		Well-nourished <sup>a</sup>	Malnourished <sup>b</sup>	p-value	≥50% intake <sup>c</sup>	≤ 25% intake <sup>d</sup>	p-value
<b>Age group<sup>e</sup></b>							
< 65 years	1314 (44%)	911 (46%)	382 (40%)	} 0.003	981 (43%)	316 (48%)	} 0.028
≥ 65 years	1650 (56%)	1064 (54%)	564 (60%)		1294 (57%)	343 (52%)	
<b>Admission Status (n (%))<sup>e</sup></b>							
Emergency	2173 (73%)	1426 (72%)	719 (76%)	0.027	1669 (73%) <sup>g</sup>	483 (73%) <sup>g</sup>	0.935
Elective	623 (21%)	433 (22%) <sup>g</sup>	180 (19%) <sup>g</sup>	0.075	468 (21%) <sup>g</sup>	148 (22%) <sup>g</sup>	0.302
Other <sup>h</sup>	183 (6%)	127 (6%) <sup>g</sup>	51 (5%) <sup>g</sup>	0.321	149 (7%) <sup>g</sup>	32 (5%) <sup>g</sup>	0.110
<b>Main Diagnostic Categories (MDC) (n (%))<sup>e</sup></b>							
Digestive, Hepatobiliary	562 (19%)	335 (17%)	222 (23%)	0.000	351 (15%)	206 (31%)	0.000
Musculoskeletal	445 (15%)	326 (16%)	108 (11%)	0.000	348 (15%) <sup>g</sup>	86 (13%) <sup>g</sup>	0.150
Circulatory	388 (13%)	295 (15%)	87 (9%)	0.000	329 (14%)	55 (8%)	0.000
Respiratory	372 (13%)	231 (12%)	135 (14%)	0.045	296 (13%) <sup>g</sup>	76 (12%) <sup>g</sup>	0.311
Nervous	277 (9%)	192 (10%) <sup>g</sup>	80 (8%) <sup>g</sup>	0.285	220 (10%) <sup>g</sup>	56 (9%) <sup>g</sup>	0.360
Skin, Subcutaneous Tissue, Burns, Breast	124 (4%)	100 (5%)	24 (2%)	0.002	113 (5%)	10 (2%)	0.000
Kidney, Urinary Tract	109 (4%)	64 (3%) <sup>g</sup>	43 (5%) <sup>g</sup>	0.075	90 (4%) <sup>g</sup>	17 (3%) <sup>g</sup>	0.096
Others	110 (4%)	64 (3%)	45 (5%)	0.041	96 (4%) <sup>g</sup>	14 (2%) <sup>g</sup>	0.013
Pre-MDC	100 (3%)	54 (3%)	46 (5%)	0.003	58 (3%)	40 (6%)	0.000
Infectious & Parasitic	99 (3%)	56 (3%)	42 (4%)	0.023	77 (3%) <sup>g</sup>	22 (3%) <sup>g</sup>	0.950
Neoplastic	82 (3%)	46 (2%)	36 (4%)	0.023	67 (3%) <sup>g</sup>	15 (2%) <sup>g</sup>	0.357
Endocrine, Metabolic and Nutritional	82 (3%)	56 (3%) <sup>g</sup>	25 (3%) <sup>g</sup>	0.779	64 (3%) <sup>g</sup>	16 (2%) <sup>g</sup>	0.590
Injuries, Poisoning, Drug and Alcohol abuse	80 (3%)	56 (3%) <sup>g</sup>	20 (2%) <sup>g</sup>	0.258	62 (3%) <sup>g</sup>	17 (3%) <sup>g</sup>	0.836
Male & Female Reproductive System	72 (2%)	56 (3%) <sup>g</sup>	16 (2%) <sup>g</sup>	0.064	55 (2%) <sup>g</sup>	17 (3%) <sup>g</sup>	0.816
Eye, Ear-Nose-Throat, Mouth	42 (1%)	35 (2%)	6 (1%)	0.015	32 (1%) <sup>g</sup>	10 (2%) <sup>g</sup>	0.835
Blood & Blood-forming Organs	31 (1%)	19 (1%) <sup>g</sup>	12 (1%) <sup>g</sup>	0.443	25 (1%) <sup>g</sup>	5 (1%) <sup>g</sup>	0.443
<b>Partition (Admission type) (n (%))<sup>e</sup></b>							
Surgical	1270 (43%)	847 (43%) <sup>g</sup>	403 (43%) <sup>g</sup>	0.953	886 (39%)	369 (56%)	0.000
Medical	1547 (52%)	1044 (53%) <sup>g</sup>	482 (51%) <sup>g</sup>	0.390	1279 (56%)	255 (39%)	0.000
Other	158 (5%)	94 (5%)	62 (7%)	0.041	118 (5%) <sup>g</sup>	38 (6%) <sup>g</sup>	0.563

<b>Patient Clinical Complexity Level Scores (PCCL) (n (%))<sup>e</sup></b>								
	Not severe	1145 (39%)	887 (45%)	244 (26%)	} 0.000	933 (41%)	200 (30%)	} 0.000
	Severe/Catastrophic	1821 (61%)	1096 (55%)	696 (74%)		1344 (59%)	459 (70%)	
<b>Discharge Status (n (%))<sup>e</sup></b>								
	Usual Residence	2129 (74%)	1521 (79%)	576 (65%)	0.000	1667 (75%)	440 (71%)	0.024
	Other Hospital	303 (11%)	177 (9%)	123 (14%)	0.000	224 (10%) <sup>g</sup>	74 (11%) <sup>g</sup>	0.198
	Other Facility <sup>i</sup>	423 (14.5%)	231 (12%)	185 (21%)	0.000	317 (14%) <sup>g</sup>	103 (17%) <sup>g</sup>	0.161
	Left Against Medical Advice	9 (0.5%)	5 (0.3%) <sup>g</sup>	4 (0.4%) <sup>g</sup>	0.401	5 (0.2%) <sup>g</sup>	4 (0.6%) <sup>g</sup>	0.102
<b>EQ-5D<sub>profile</sub> (n (%))<sup>e</sup>: Some/Major Problem with:</b>								
	Mobility	1870 (64%)	1181 (60%)	667 (72%)	0.000	1422 (63%)	432 (68%)	0.014
	Pain	1846 (63%)	1189 (61%)	634 (68%)	0.000	1376 (61%)	451 (71%)	0.000
	Self-Care	1296 (45%)	772 (40%)	510 (55%)	0.000	934 (42%)	349 (55%)	0.000
	Anxiety/Depression	1246 (43%)	727 (38%)	507 (55%)	0.000	919 (41%)	316 (51%)	0.000
	Activity	1893 (65%)	1171 (60%)	699 (75%)	0.000	1412 (63%)	460 (73%)	0.000
<b>EQ-5D<sub>vas</sub> (median (range))<sup>f</sup></b>								
		51 (0 – 100)	60 (0 – 100)	50 (0 – 100)	0.000	58 (0 – 100)	50 (0–100)	0.000
<b>Pre-survey Length of Stay (median (range))<sup>f</sup></b>								
		6 (0 – 449)	5 (0 – 364)	9 (0 – 449)	0.000	6 (0 – 449)	6 (0 – 364)	0.459

<sup>a</sup> Well-nourished participants [1]: included those not at risk of malnutrition (MST[28]) and SGA-A[26]

<sup>b</sup> Malnourished participants [1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m<sup>2</sup> [27]

<sup>c</sup> ≥ 50% intake includes 50%, 75% and 100% food intake

<sup>d</sup> ≤ 25% intake includes nil-by-mouth, 0%, and 25% intake

<sup>e</sup> Categorical variables represented as n (%)

<sup>f</sup> Continuous Variable presented as Median (Range) for data that is not normally distributed

<sup>g</sup> non-significant ( $p$ -value  $>0.05$ )

<sup>h</sup> includes waitlists and non-assigned

<sup>i</sup> includes residential aged care facility, rehabilitation, episode change within same hospital, other health facility

NOTE: Admission status data were missing for 3 participants; MDC data were missing for 9 participants; Partition data were missing for 7 participants; PCCL data were missing for 16 participants; Discharge Status data were missing for 78 participants; EQ-5Dprofile: Mobility data were missing for 62 participants, Pain data were missing for 64 participants, Self-care data were missing for 69 participants, Anxiety/Depression data were missing for 83 participants, Activity data were missing for 82 participants, EQ-5D<sub>vas</sub> data were missing for 249 participants, Pre-survey Length of Stay data were missing for 17 participants.



**Table 2: Comparison of outcomes by participants' nutritional status and 24-hour % food intake bivariate level**

Variables	Overall Results	As per Nutritional Status			As per % food intake		
		Well-nourished <sup>a</sup>	Malnourished <sup>b</sup>	p-value	≥50% intake <sup>c</sup>	≤ 25% intake <sup>d</sup>	p-value
<b>Length of Stay (LOS) (days)<sup>e</sup></b>	11 (2 – 158)	10 (2 – 158)	15 (2 – 119)	0.000	11 (2 – 119)	13 (2 – 158)	0.000
<b>Readmissions<sup>f</sup> (n (%)):</b>							
1 readmission (n (%))	564 (19%)	349 (18%)	206 (23%)	}0.000	435	122	}0.378 <sup>g</sup>
2 readmissions (n (%))	198 (7%)	127 (6%)	66 (7%)		161	35	
≥ 3 readmissions (n (%))	120 (4%)	68 (3%)	49 (5%)		88	31	
<b>Mortality<sup>f</sup>:</b>							
90 day in-hospital mortality (n (%)) <sup>h</sup>	72 (2.4%)	28 (1%)	43 (5%)	0.000	40 (2%)	32 (5%)	0.000
30-day in-hospital mortality (n (%))	46 (1.5%)	22 (1%)	23 (2.5%)	0.010	25 (1%)	21 (3%)	0.001

<sup>a</sup> Well-nourished participants [1]: included those not at risk of malnutrition (MST[28]) and SGA-A[26]

<sup>b</sup> Malnourished participants [1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m<sup>2</sup> [27]

<sup>c</sup> ≥ 50% intake includes 50%, 75% and 100% food intake

<sup>d</sup> ≤ 25% intake includes nil-by-mouth, 0%, and 25% intake

<sup>e</sup> Continuous Variable presented as Median (Range) for data that is not normally distributed

<sup>f</sup> Categorical variables represented as n (%)

<sup>g</sup> non-significant (p-value >0.05)

<sup>h</sup> Includes 30-day in-hospital mortality results

**Table 3: Bivariate and Ordinal Regression results for readmissions within 90-days of index hospitalisation (N= 3017)**

Risk Factors	Bivariate Analyses			Ordinal Regression Analyses	
	Readmissions n (%)	No readmissions n (%)	<i>p</i> - value	Odds Ratio	CI ( <i>p</i> - value)
<b>MDC: Neoplastic</b>	35 (43%)	47 (57%)	0.032	1.55	1.20 – 1.99 (0.001)
<b>Discharge to Other Facility<sup>a</sup></b>	210 (50%)	209 (50%)	<0.001	1.43	1.16 – 1.51 (0.000)
<b>Discharge to Usual Residence</b>	633 (30%)	1465 (70%)	<0.001	1.33	1.16 – 1.51 (0.000)
<b>Severe/Catastrophic PCCL score</b>	650 (36%)	1171 (64%)	<0.001	1.30	1.18 – 1.43 (0.000)
<b>Medical Partition</b>	571 (37%)	976 (63%)	<0.001	1.22	1.00 – 1.48 (0.049)
<b>MDC: Respiratory</b>	145 (39%)	227 (61%)	0.005	1.15	1.00 – 1.31 (0.048)
<b>Age ≥ 65 years</b>	587 (36%)	1063 (64%)	<0.001	1.11	1.02 – 1.22 (0.021)
<b>EQ<sub>vas</sub> score<sup>b</sup></b>	50 (0 – 100)	55 (0 – 100)	<0.001	1.00	1.00 – 1.004 (0.044)
<b>Malnutrition<sup>c</sup></b>	346 (36%)	605 (64%)	0.001	1.06 <sup>d</sup>	1.04 – 1.17 (0.235) <sup>d</sup>

CI: Confidence Intervals; MDC: Major Diagnostic Category; PCCL: Patient Clinical Complexity Level

<sup>a</sup> includes residential aged care facility, rehabilitation, episode change within same hospital, other health facility

<sup>b</sup> Represented as median (range)

<sup>c</sup>Malnutrition[1]: included moderately (SGA-B)[26] and severely (SGA-C)[26] malnourished participants, and patients with BMI < 18.5 kg/m<sup>2</sup> [27]

<sup>d</sup> non-significant (*p*-value >0.05)

Table 4a: Bivariate and Logistic Regression results for 30-day in-hospital mortality (N=3017)

Risk Factors	Bivariate Analyses			Logistic Regression Analyses	
	In-hospital mortality n (%)	No in-hospital mortality n (%)	p- value	Odds Ratio	CI (p- value)
<b>Severe/Catastrophic PCCL score</b>	44 (3%)	1745 (97%)	<0.001	8.18	1.93 – 34.73 (0.004)
<b>MDC: Respiratory</b>	13 (4%)	348 (96%)	0.03	1.78	0.81 – 3.93 (0.151) <sup>a</sup>
<b>≤ 25% Food Intake</b>	21 (3%)	629 (97%)	0.001	2.69	1.31 – 5.52 (0.007)
<b>Malnutrition<sup>b</sup></b>	23 (3%)	906 (97%)	0.01	1.27	0.63 – 2.59 (0.504) <sup>a</sup>
<b>Age ≥ 65 years</b>	40 (3%)	1573 (97%)	<0.001	2.74	1.11 – 6.79 (0.03)
<b>EQ<sub>vas</sub> score<sup>c</sup></b>	50 (0 – 85)	51 (0 – 100)	0.03	0.99	0.98 – 1.01 (0.215) <sup>a</sup>

CI: Confidence Intervals; PCCL: Patient Clinical Complexity Level; MDC: Major Diagnostic Category

<sup>a</sup> non-significant (p-value >0.05)

<sup>b</sup> Malnutrition [1]: included moderately (SGA-B) [26] and severely (SGA-C) [26] malnourished participants, and participants with BMI < 18.5 kg/m<sup>2</sup>[27].

<sup>c</sup> Represented as median (range)

**Table 4b: Bivariate and Logistic Regression results for 90-day in-hospital mortality (N=3017)**

Risk Factors	Bivariate Analyses			Logistic Regression Analyses	
	In-hospital mortality n (%)	No in-hospital mortality n (%)	p- value	Odds Ratio	CI (p- value)
<b>Severe/Catastrophic PCCL score</b>	68 (4%)	1721 (96%)	<0.001	6.01	2.14 – 16.89 (0.001)
<b>MDC: Respiratory</b>	19 (5%)	342 (95%)	0.001	1.91	1.01 – 3.61 (0.047)
<b>≤ 25% Food Intake</b>	32 (5%)	618 (95%)	<0.001	1.99	1.13 – 3.51 (0.017)
<b>Malnutrition<sup>b</sup></b>	43 (5%)	886 (95%)	<0.001	1.91	1.09 – 3.34 (0.023)
<b>Age ≥ 65 years</b>	58 (4%)	1555 (96%)	<0.001	2.23	1.15 – 4.34 (0.018)
<b>EQ<sub>vas</sub> score<sup>c</sup></b>	43 (0 – 99)	51 (0 – 100)	<0.001	0.98	0.97 – 0.99 (0.015)

CI: Confidence Intervals; PCCL: Patient Clinical Complexity Level; MDC: Major Diagnostic Category

<sup>a</sup> non-significant (p-value >0.05)

<sup>b</sup> Malnutrition [1]: included moderately (SGA-B) [26] and severely (SGA-C) [26] malnourished participants, and participants with BMI < 18.5 kg/m<sup>2</sup>[27].

<sup>c</sup> Represented as median (range)

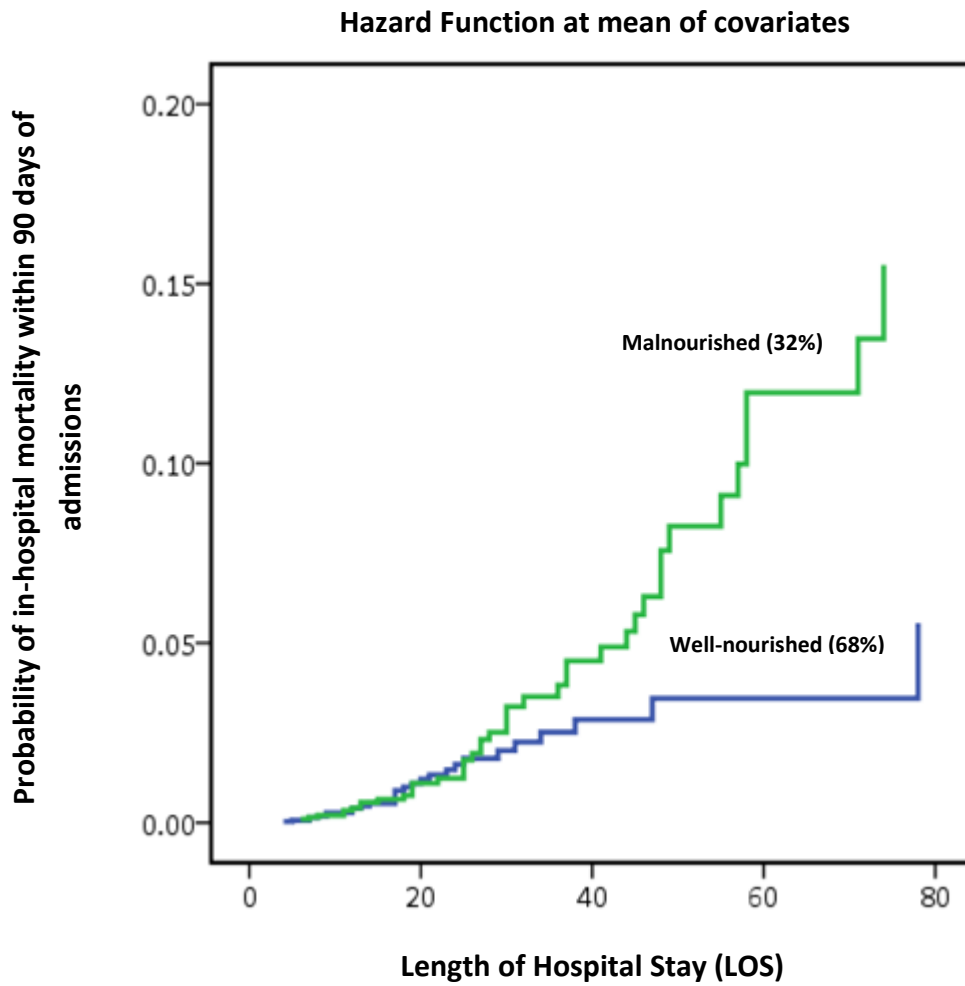
**Table 5: Hazard Analysis of risk factors and 90-day in-hospital mortality (N= 3017)**

<b>Risk Factor</b>	<b>Hazard Ratio</b>	<b>CI (<i>p</i>- Value)</b>
<b>Surgical Partition</b>	3.03	1.06 – 8.69 (0.039)
<b>Medical Partition</b>	3.71	2.01 – 6.85 (0.000)
<b>Age ≥ 65 years</b>	2.84	1.53 – 5.29 (0.001)
<b>Severe/Catastrophic PCCL</b>	3.55	1.27 – 9.92 (0.016)
<b>≤ 25% Food Intake</b>	2.29	1.39 – 3.76 (0.001)

CI: Confidence Interval; PCCL: Patient Clinical Complexity Level

Note: Other risk factors such as Main Diagnostic Categories, Admission Status, and gender were not significant

**Figure 1: Cumulative incidence of 90-day in-hospital mortality in well-nourished and malnourished patients (N= 3017)**



## Appendix 1: Data collected for each participant:

<b>Admission-related:</b>	Admission Status	Whether it was an emergency, elective or other admission
	Australian Refined Diagnosis Related Group (AR-DRG)	<p>Refers to Australia's national diagnosis related care (DRG) classification scheme that provides a clinically meaningful way for relating the number and types of patients treated in hospitals to the resources required by the hospitals [29]. AR-DRGs are assigned based on Principal Diagnosis [29]. While New Zealand used version 5.0 of the AR-DRGs, hospitals in Australia used a range of versions (4.2, 5, 5.1, 5.2, and 6). Since the study cohort represented a large number of AR-DRGs (n= 685) it was necessary to simplify the categorisation of participants by disease type.</p> <p><b>Major Diagnostic Categories (MDCs)</b>, which are based on a single body system or aetiology that is associated with a medical speciality and therefore include AR-DRGs and principal diagnoses [29], were used for this purpose. Since MDCs are uniform across various AR-DRG versions, categorising the type of disease into MDCs maintained consistency across the AR-DRG versions.</p>
	Partition	<p>MDCs are sub-divided into a maximum of three separate partitions or type of admissions: surgical, medical, and other. The presence or absence of operating room and non-operating room procedures is generally responsible for the assignment of the episode of admission to one or other of these partitions [29].</p>
	Patient Clinical Complexity Level (PCCL) scores	<p>refers to the cumulative effect of a patient's complications and comorbidities [29]. The calculation of these scores is a complex process and is designed to prevent similar conditions from being counted more than once [29]. PCCL scores are calculated for each episode of admission and range from 0 – 4 (for surgical episodes) and from 0 – 3 (for medical episodes) and are defined as follows [29]:</p> <ul style="list-style-type: none"> <li>0 = not a complication or comorbidity</li> <li>1 = a minor complication or comorbidity</li> <li>2 = a moderate complication or comorbidity</li> <li>3 = a severe complication or comorbidity</li> <li>4 = a catastrophic complication or comorbidity.</li> </ul>
	Discharge Status	<p>refers to the discharge destinations of the participants after index hospitalisation. The following categories were used:</p> <ul style="list-style-type: none"> <li>▪ Home/Usual residence</li> <li>▪ Other hospital</li> </ul>

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		<ul style="list-style-type: none"> <li>▪ Other healthcare facility- included residential aged care facility, rehabilitation, episode change within same hospital, other health facility</li> <li>▪ Left against medical advice</li> <li>▪ Death</li> </ul>
<b>Outcomes-related</b>	Pre-survey LOS	Was computed as the difference between the date of the survey and date of admission. This was done to evaluate if length of hospital stay impacts food intake.
	Index LOS	Refers to the LOS for the index hospital admission (i.e. hospital admission during which participants were enrolled in Phase 1 of the study). It was computed as the difference between date of discharge and date of index hospital admission.
	Date of Death	Was used to compute the number of days between date of admission and date of in-hospital death.
	Readmissions	Were recorded, along with the frequency of readmissions, for up to 90 days from the date of index hospitalisation.
<b>Quality of life</b>	<p>In Phase I of the survey, participants' self-perceived quality of life was assessed using EQ-5D, a non-disease specific two part questionnaire [14]. The first part of the questionnaire, EQ-5D<sub>profile</sub>, comprises five dimensions: mobility, self-care, usual activities, pain, and anxiety or depression [14]. Each dimension is divided into three categories of severity (no, moderate, or extreme problem) [14]. The second part of the questionnaire includes a visual analogue scale, EQ-5D<sub>vas</sub>, ranging from 0 (worst possible health) to 100 (perfect health) [14]. Although the EQ-5D was primarily designed for self-completion, it does allow for proxies to rate how they would rate the subject's health [14]. In the ANCDs, when appropriate, an authorised carer or next of kin was permitted to complete the questionnaire [14].</p>	

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## Appendix 2: Steps undertaken to clean the dataset for outcomes variables:

Outcome	Steps undertaken to clean the dataset
Length of Stay (LOS)	<p>Since LOS was positively skewed and varied across the Major Diagnostic Categories (MDC); trimming (deleting) LOS methodology was used to prevent outliers from having a significant and unrepresentative impact on the average LOS. The following steps were followed to trim the LOS data [30]:</p> <p><b>Step 1:</b> Patients were excluded based on the following criteria [30]:</p> <ul style="list-style-type: none"> <li>• Death during index hospitalisation;</li> <li>• Missing data values for: LOS, age, discharge status, MDC, admission source, admission status, PCCL;</li> <li>• Discharge against medical advice.</li> </ul> <p><b>Step 2:</b> Upper and lower trim points were calculated for each MDC as per the following equations [30]:  Lower Trim Point= <math>Q1 - (3 \cdot IQR)</math>; Upper Trim Point= <math>Q3 + (3 \cdot IQR)</math> where:</p> <ul style="list-style-type: none"> <li>• Q1: the first quartile of all patients records from the LOS dataset</li> <li>• Q3: the third quartile of all patients records from the LOS dataset</li> <li>• IQR: <math>Q3 - Q1</math></li> </ul> <p><b>Step 3:</b> Since the lower trim points for MDCs were in negative values, participants with LOS &gt; upper trim points for each MDC were excluded [30]. Participants with LOS= 1 day were also excluded as their admissions were more likely to be associated with clinical investigations or tests.</p>
Readmissions	Participants who died during index hospitalisation were excluded from the analyses related to readmissions data.
In-hospital mortality	Participants who were not discharged within 90 days of index hospital admission were included in the analyses.

### Appendix 3: Regression Models used for evaluating the association between confounding and outcome variables

Outcome variables	Regression Model used	Confounding variables <sup>a</sup>	Evaluative confounding variables <sup>b</sup>
<b>LOS (square root)</b>	Linear regression model	Partition, MDCs[31], age group[31], admission status, disease severity[31] (dichotomised PCCL score), nutritional status[31]	Dichotomised EQ-5D <sub>profile</sub> , EQ-5D <sub>vas</sub> score, dichotomised percentage food intake (i.e. ≤25% and ≥50%)
<b>Readmission</b>	Ordinal regression model	LOS [21], surgical admission, medical admission, MDCs (respiratory, neoplastic), age group[31], disease severity [31](dichotomised PCCL score), discharge status (home/usual residence, other healthcare facility)	Nutritional status, dichotomised EQ-5D <sub>profile</sub> (excluding pain), EQ-5D <sub>vas</sub> score
<b>Mortality</b>	Logistic regression model	Emergency admissions, surgical admissions, respiratory disease, disease severity[31] (dichotomised PCCL score), age group[31]	Nutritional status, dichotomised % food intake, dichotomised EQ-5D <sub>profile</sub> (mobility, self-care), EQ-5D <sub>vas</sub> scores.
<b>Hazard Analysis</b>	Cox Regression model	Surgical and medical admission, MDCs, age group[31], gender[31], admission status, disease severity [31] (dichotomised PCCL score)	Nutritional status, dichotomised % food intake

EQ-5D<sub>vas</sub>: EQ-5D visual analogue scale; LOS: length of hospital stay, MDC: major diagnostic category; PCCL: Patient Clinical Complexity Level

<sup>a</sup> Confounding variables: Variables that are considered risk factors as per the literature.

<sup>b</sup> Evaluative Confounding variables: Variables that demonstrated a significant association with the outcomes variable at a bivariate level requiring an evaluation of their significance at a multivariate level.