

**The consequences of malnutrition following discharge from rehabilitation to the community
A systematic review of current evidence in older adults**

Marshall, Skye; Bauer, J; Isenring, E

Published in:
Journal of Human Nutrition and Dietetics

DOI:
[10.1111/jhn.12167](https://doi.org/10.1111/jhn.12167)

Published: 01/04/2014

Document Version:
Peer reviewed version

[Link to publication in Bond University research repository.](#)

Recommended citation(APA):
Marshall, S., Bauer, J., & Isenring, E. (2014). The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults. *Journal of Human Nutrition and Dietetics*, 27(2), 133-41. <https://doi.org/10.1111/jhn.12167>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

For more information, or if you believe that this document breaches copyright, please contact the Bond University research repository coordinator.

1 **The consequences of malnutrition -following discharge from rehabilitation to the**
2 **community: A systematic review of current evidence in older adults**

3 Skye Marshall^{a,b,c}, Judith Bauer^{a,d}, Elizabeth Isenring^{a,e,f,g}

4 ^a Centre for Dietetics Research, School of Human Movement Studies, University of
5 Queensland, Brisbane, Queensland, 4072, Australia

6 ^b Corresponding author. School of Human Movement Studies, Room 407B, Building 26, the
7 University of Queensland, Brisbane, Queensland, 4072, Australia. Phone: 61+ 07336 56982,
8 Fax: 61+ 07 3365 6877, skye.marshall@uq.net.au

9 ^c BNutr&Diet(Hons), PhD Candidate

10 ^d Associate Professor Nutrition and Dietetics

11 ^e Alternate corresponding author. School of Human Movement Studies, Room 407B,
12 Building 26, the University of Queensland, Brisbane, Queensland, 4072, Australia. Phone:
13 61+ 07 3365 6982, Fax: 61+ 07 3365 6877, e.isenring@uq.edu.au

14 ^f Princess Alexandra Hospital, Woolloongabba, Queensland

15 ^g BHSc(Nutr&Diet)(Hons), PhD

16

17 **Text words: 3 281 (excluding tables/figures)**

18

19 **Keywords:** malnutrition, nutritional status, rehabilitation, aged, community

20

21 **Contributions:** SM carried out the literature review, data extraction and analysis,
22 interpretation of data, drafting and revising manuscript; SM and EI reviewed study quality
23 and strength; and JB and EI provided supervision, guidance and revision of the manuscript.

24

25 **Acknowledgement**

26 The authors declare that they have no financial, personal or potential competing interests. The
27 current research received no funding. SM is supported by an Australian Postgraduate Award
28 as part of her PhD Candidature.

29

30

31

Abstract

32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59

Background: The prevalence of malnutrition in the rehabilitation setting is estimated to be 30 -50%, with older adults at higher nutritional risk. Malnutrition also exists in the community setting, where 10 – 30% of adults are malnourished, however the relationship between the two settings has been little explored. **The aim was to** determine the association between malnutrition in older adults admitted for rehabilitation and nutrition status, functional status, quality of life, institutionalisation, acute care admissions and mortality once discharged to the community.

Methods: Six electronic databases were searched for relevant publications (1990 – 2013) using controlled vocabulary. Longitudinal papers were included in which older adults ($\geq 65y$) were admitted for rehabilitation if nutrition assessment was performed during admission with relevant outcomes measured following discharge to the community.

Results: Five observational studies were eligible for review which had similar populations. The five reviews comprised n=1020 participants in total and follow-up once discharged ranged from immediate to 26 months. Malnutrition during rehabilitation was negatively associated with physical function and quality of life, and positively associated with risk of institutionalisation, hospitalisation and mortality. Although these studies were of high quality and strength, the overall contribution to the evidence is limited due to the small number of heterogenic studies. No intervention studies were identified.

Conclusion: Malnutrition in older adults admitted for rehabilitation has a negative effect on functional recovery and quality of life following discharge to the community. This review highlights an evidence gap along the continuum of care for malnourished older adults, where further observational and intervention research is needed following discharge from rehabilitation to the community.

Abstract words: 248

Introduction

60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75

76
77
78
79
80
81
82
83

84
85
86
87
88
89
90
91
92

Malnutrition occurs when food and nutrient intake is unable to meet protein, energy and nutrient requirements over time leading to a disruption of homeostasis in lean tissues, body weight and physical function (Kunert, 2005; Skipper, 2012). Malnutrition may be both a consequence and a cause of disease (Watterson *et al.*, 2009). The physiological and psychosocial consequences of malnutrition are significant and diverse, and contribute to impaired recovery from injury and illness (NICE, 2006; Stratton *et al.*, 2003). This is significant in the rehabilitative setting, where malnutrition prevalence is estimated to be 30 – 50%, and is associated with extended length of stay (Charlton *et al.*, 2010; Finestone *et al.*, 1996; O'Leary *et al.*, 2011; Watterson *et al.*, 2009). The rehabilitation setting is defined as an in-patient service by a multidisciplinary team with the goal of reducing disability in improving task-orientated functional behaviour (Cameron *et al.*, 2008), such as a stroke or hip fracture rehabilitation centre or rehabilitation ward in a general hospital. A 2003 study by Olsson *et al.* (2003) found that 18 of 19 older women admitted for rehabilitation had inadequate oral protein and energy intake, however all participants believed they consumed sufficient food to meet their physiological need.

The chronic diseases and the physiological and psychosocial changes that occur in ageing place older adults (≥ 65 y (AIHW, 2010) at higher nutritional risk, both during health service admissions and in the community (Watterson *et al.*, 2009). It is estimated that 10 – 30% of adults in the community, that is free living populations with or without community services, are malnourished (Watterson *et al.*, 2009). There is level I evidence to indicate that malnutrition is under-recognised and under-diagnosed both in rehabilitation and community settings (Watterson *et al.*, 2009), however the relationship between the two has been little explored.

Due to the variable temporal and physiological nature of malnutrition, there is no single measure sufficiently accurate or reliable as a sole method of diagnosis for malnutrition (Skipper, 2012). In consequence, diagnostic criteria reported in the literature vary widely leading to confusion and the potential for misdiagnosis. It should be recognised that nutrition screening tools determine risk of malnutrition and diagnoses made from using these tools may not be accurate. Nutrition screening tools, such as the Malnutrition Screening Tool (MST) (Ferguson *et al.*, 1999), Malnutrition Universal Screening Tool (MUST) (Stratton *et al.*, 2004) and Simplified Nutritional Assessment Questionnaire (SNAQ) (Wilson *et al.*, 2005) may be used by any trained person as a simple and timely method to identify patients

93 which may be at risk of malnutrition and require further nutrition assessment by a dietitian
94 (Skipper, 2012; Watterson *et al.*, 2009). The development of global nutrition assessment tools
95 such as the Mini Nutritional Assessment (MNA) (Guigoz *et al.*, 1994; Neumann *et al.*, 2007)
96 and Subjective Global Assessment (SGA) (Detsky *et al.*, 1987) are accepted and valid
97 methods of nutrition assessment, and provide sufficient information for practitioners to use
98 clinical judgement to make a diagnosis of malnutrition. These nutrition assessment tools
99 overcome the limitations of nutrition screening tools or individual markers by encompassing
100 multiple criteria, such as measures of anthropometry and assessment of oral intake. The MNA
101 and SGA are the only nutrition assessment tools with sufficient evidence for appropriate use
102 in the rehabilitation and community settings according to best practice guidelines (Detsky *et*
103 *al.*, 1987; Neumann *et al.*, 2007; Watterson *et al.*, 2009).

104 This review aimed to determine the association between malnutrition in older adults admitted
105 for rehabilitation and nutrition status, functional status, quality of life, institutionalisation,
106 acute care admissions and mortality once discharged to the community. Secondary
107 objectives were to explore extent to which malnutrition-focused interventions may impact
108 upon these post-discharge outcomes in older adults and to describe the types of interventions
109 used.

110 **Materials and methods**

111 A systematic literature review of current evidence was conducted.

112 *Search strategy*

113 Published English-language studies were searched for in the electronic databases CENTRAL,
114 CINAHL (via Ebscohost), EMBASE, Health Source: Nursing/Academic Edition, PubMed
115 and Web of Science for publications from 1990 to the 31st January 2013. The search strategy
116 used each databases' controlled vocabulary. The search strategy was complemented by a
117 "snowball" search of cited papers.

118 PubMed and CENTRAL was searched using the MeSH Terms:

119 *(Protein energy malnutrition OR Malnutrition OR Nutritional status OR*
120 *Nutrition assessment) AND (Rehabilitation OR Rehabilitation centers)*

121 CENTRAL was also searched using the same MeSH terms as keywords in the title, abstract
122 and keywords. CINAHL (via Ebscohost) was searched using the following CINAHL
123 Headings:

124 (*Malnutrition OR Protein-energy malnutrition OR Nutrition* [as keyword -
125 subject]) AND (*Rehabilitation OR Rehabilitation centers OR Rehabilitation*
126 *patients*).

127 Health Source: Nursing/Academic Edition (via Ebscohost) was searched using the following
128 Health Source Subjects:

129 (*Malnutrition* [exp] OR *Nutrition disorders in old age* OR *Nutrition* [as
130 keyword – abstract/title]) AND (*Rehabilitation OR Rehabilitation centers*)

131 EMBASE was searched for citations from both EMBASE and MEDLINE using Emtree
132 terms:

133 (*Malnutrition/exp OR 'Protein calorie malnutriiton'/exp OR 'Nutritional*
134 *assessment'/exp OR 'Nutritional status'/exp*) AND (*'Cancer rehabilitation'*
135 *OR 'Functional assessment' OR 'Geriatric rehabilitation' OR 'Muscle*
136 *training' OR 'Pulmonary rehabilitation' OR 'Vocational rehabilitation' OR*
137 *'Rehabilitation care' OR 'Rehabilitation center' OR 'Rehabilitation patient'*
138 *OR Rehabilitation Research*) NOT (*Child* OR Paed* OR Pediatric OR*
139 *Dialysis* OR Acute OR 'Nursing home' OR Residential* [as keywords])

140 Web of Science was also searched for the following keywords in topic or title:

141 [(*Nutrition OR Malnutrition*) AND *Rehabilitation*] NOT *Parenteral* NOT *Tube*
142 NOT *Child** NOT *Pediatric* NOT *Infant* NOT *Nursing home* NOT *Acute* NOT
143 *Dialysis* NOT *Mice* NOT *Rat*

144 A list of outcome measures meaningful to the review's primary objective was developed in
145 order to identify the relevant research. These outcome measures include:

- 146 1) Mini Nutritional Assessment (MNA)
- 147 2) Mini Nutritional Assessment – Short Form (MNA-SF) (Charlton *et al.*, 2010;
148 Rubenstein *et al.*, 2001)
- 149 3) Subjective Global Assessment (SGA)

- 150 4) functional status (any validated tool)
- 151 5) quality of life (any validated tool)
- 152 6) institutionalisation (admission to long-term care, nursing home, residential home;
153 events, costs)
- 154 7) hospitalisation (general, emergency, intensive care unit, rehabilitation; events, costs)
- 155 8) mortality (up to three years post-discharge).

156 Inclusion criteria for types of participants were older adults (mean age of study sample ≥ 65 y)
157 (AIHW, 2010) admitted as an in-patient to a rehabilitation ward, centre or unit. Inclusion
158 criteria for types of studies were intervention studies of any kind which had more than one
159 point of data collection, and observational studies which were prospective or retrospective
160 cohorts, case series, all or none, and case-control studies. Studies were included only if
161 nutrition assessment was conducted during admission to rehabilitation (outcomes 1, 2 or 3
162 measured at baseline) *and* if any one outcome of interest was measured once discharged to
163 the community (outcomes 1, 2, 3, 4, 5, 6, 7 or 8 at post-discharge follow-up). Intervention
164 papers were included if any form of nutrition intervention was delivered to the population
165 group either during rehabilitation or post-discharge to the community.

166 Exclusion criteria for types of participants included populations which had cystic fibrosis,
167 were receiving drug and alcohol rehabilitation, ambulatory rehabilitation, enteral or parental
168 tube feeding, haemodialysis or peritoneal dialysis, or where interventions had no nutritional
169 component, or focused on improving control of diabetes or cardiovascular risk factors.

170 Exclusion criteria for types of studies included cross-sectional, as the design does not allow
171 for outcomes to be assessed during rehabilitation and post-discharged to the community,
172 protocol studies, abstracts, conference papers and review papers. Studies which reported
173 malnutrition by using a nutrition screening tool or single maker such as serum albumin or
174 weight loss were excluded, as were those which failed to assess nutrition status during
175 rehabilitation or any outcome of interest once discharged to the community.

176 *Selection of studies and data synthesis*

177 A two-step screening process was employed. In step 1, one author scanned the titles and
178 abstracts of studies identified by the search for their eligibility. At step 2, full-text articles
179 were screened by one author for eligibility. Data were extracted from the published papers
180 into standardised tables by one author. In the tables, results of studies were reported only for
181 the outcome measures interest. Results were reported as significant at the $P < 0.05$ level and no

182 exclusions were made for type of statistical approach. As well as study design, the study
183 population was described.

184 *Review of study strength and quality*

185 The strength of studies was determined using the NHMRC levels of evidence according to the
186 type of research question (Coleman *et al.*, 2005). The NHMRC levels of evidence provide a
187 guide to the strength of evidence addressing clinical questions based on a hierarchy of study
188 design, and are graded I (strongest) to IV (weakest). The quality of studies, including risk of
189 bias and appropriate statistical analysis, was assessed using the Academy of Nutrition and
190 Dietetics' Quality Criteria Checklists for primary research and designated with a positive (+,
191 strong quality), neutral (Ø, neither strong nor weak quality) or negative (-, weak quality)
192 assessment (AND, 2009). Review of strength and quality of studies was conducted by one
193 author and checked by a second author. Where the authors did not agree, the third author was
194 approached.

195

Results

196

197 *Search results*

198 The search identified 2236 citations, of which 115 were considered potentially relevant at
199 step 1 based on the information in the title and abstract (Figure 1). A further two potentially
200 eligible papers were identified during the “snowball” search. Using an inclusion/exclusion
201 form, five studies were identified as eligible for full review at step 2 (Table 1). The main
202 reason studies were excluded (n=43 studies) was due to ineligible study design, such as cross-
203 sectional studies or studies which did not measure outcomes following discharge to the
204 community. In the 12 ineligible studies that did not measure outcomes of interest, all 12
205 failed to use the MNA, MNA-SF or SGA to identify malnutrition. Instead, these studies used
206 various measures such as serum albumin, body mass index or body circumference alone or in
207 combination, thereby failing to provide a reliable diagnosis of protein-energy malnutrition.
208 Of consequence, no intervention studies were identified which included outcome measures
209 following discharge from rehabilitation to the community. Although not an intervention
210 study, Visvanathan et al. (2004) reported patients with moderate to severe malnutrition
211 received nutritional supplements as a matter of routine clinical care. The intervention was not
212 described in detail.

213 Three studies were conducted in Australia with data collected from 2003 – 2009 (Charlton *et*
214 *al.*, 2012; Neumann *et al.*, 2005; Visvanathan *et al.*, 2004), one from the United States of
215 America (1987) (Sullivan *et al.*, 1991), and one study conducted in Europe (2012) (Nicosia *et*
216 *al.*, 2012). All studies reported similar study populations with mean ages of 76 – 81 years,
217 and sample sizes ranged widely from n=65 – 469 with a total of 1020 participants from the
218 five studies (Table 1). Outcome measures post-discharge from rehabilitation to the
219 community ranged from immediately following discharge to 26 months.

220 *Review of study strength and quality*

221 The strength of the studies was high, with all four being prospective cohort studies. The
222 studies by Neumann et al. (2005), Nicosia et al. (2012) and Visvanathan et al. (2004) provide
223 level II prognosis evidence and the study by Sullivan et al. (1991) provides level II aetiology
224 evidence. The largest study (Charlton *et al.*, 2012) was a retrospective cohort study providing
225 level III-3 prognosis evidence. The quality of studies was good, with Charlton et al. (2012),
226 Sullivan et al. (1991) and Nicosia et al. (2012) being assessed as positive quality, and those
227 by Neumann et al. (2005) and Visvanathan et al. (2004) as neutral. Although the study by

228 Sullivan et al. (1991) was found to have positive quality, there was a high level of attrition
229 (31%). There were no conflicts in assessment of study strength and quality between the
230 reviewers.

231

232

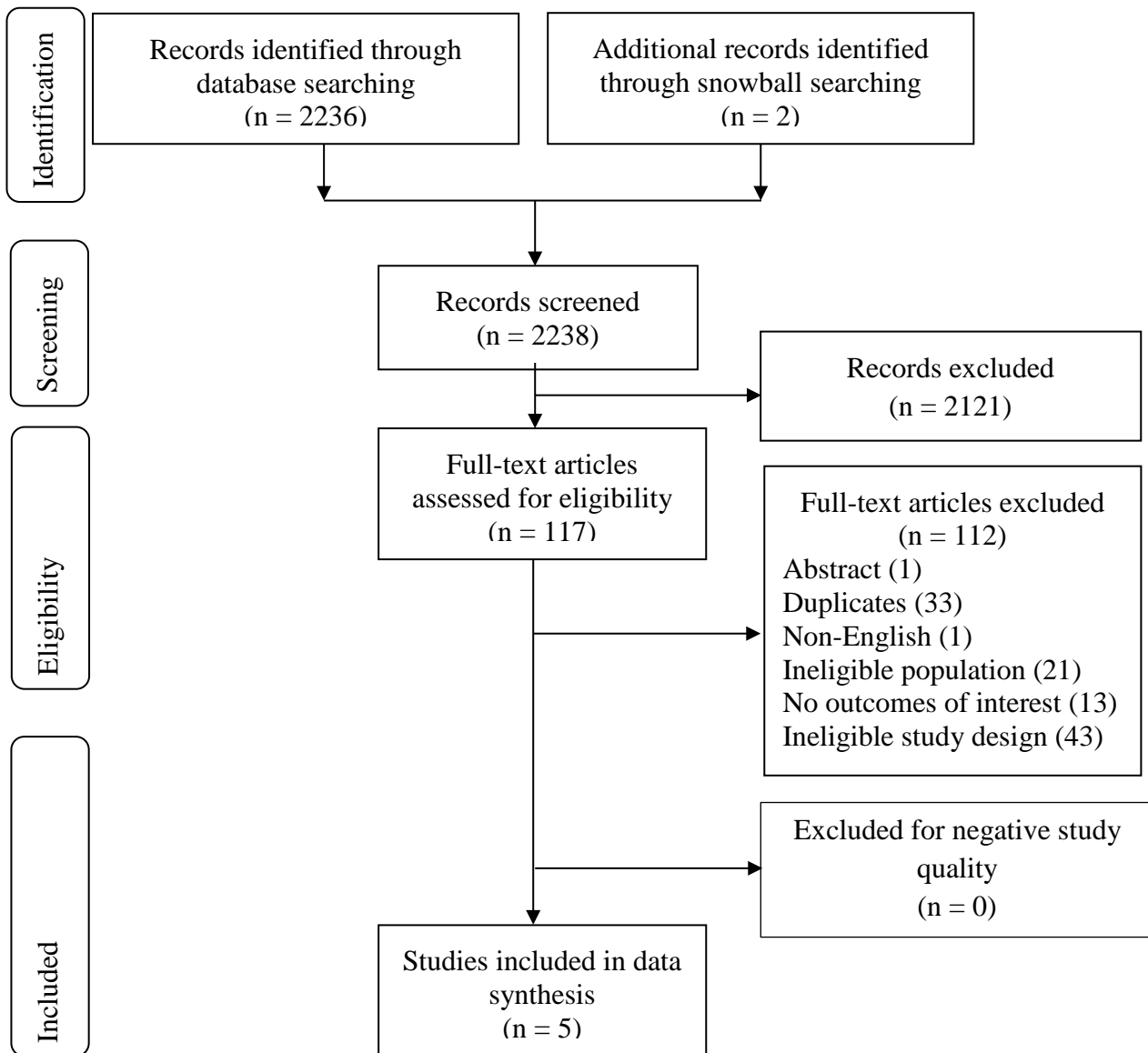


Figure 1: Study flow diagram

233 *The consequences of malnutrition following discharge from rehabilitation to the community*

234 Table 2 describes the outcomes of the included studies. The MNA-SF and MNA were used
235 by four studies to identify malnutrition, with the SGA used once. Visvanathan et al. (2004)
236 used two different techniques to calculate malnutrition using the MNA. Traditional scoring
237 (≤ 24 indicating risk of/malnutrition) was considered in this review. Nutrition assessment was
238 conducted within four days in all studies, except where Nicosia et al. (2012) did not report the
239 timing of nutrition assessment, indicating that older adults were malnourished prior to
240 admission, rather than developing malnutrition during the rehabilitation period.

241 Mortality was the sole dependent variable in two studies (n=353 participants in total, 1 and 2
242 year follow-up) and no association with malnutrition was identified (Nicosia *et al.*, 2012;
243 Sullivan *et al.*, 1991). In the larger study by Charlton et al. (2012), malnourished older adults
244 were 3.4 times more likely to die than well-nourished older adults (n=469 participants, 26
245 months follow-up), however the increased rate of death for risk of malnutrition in this
246 population was not significant.

247 Physical function, as measured by the Modified Barthel Index (MBI) at 90 days post-
248 discharge (Neumann *et al.*, 2005), was found to significantly decrease with risk
249 of/malnutrition as determined by both the MNA ($P=0.002$) and MNA-SF ($P=0.001$).
250 Similarly, risk of/malnutrition measured by both the MNA ($P=0.001$) and MNA-SF
251 ($P=0.009$) were associated with decreased quality of life, via the Assessment of Quality of
252 Life Instrument (IQoL), 90 days post-discharge (Neumann *et al.*, 2005).

253 Risk of admission to higher level care, such as residential facilities, was found to increase in
254 malnourished older adults admitted for rehabilitation (3 studies, n=667 participants in total)
255 (Charlton *et al.*, 2012; Neumann *et al.*, 2005; Visvanathan *et al.*, 2004). Visvanathan et al.
256 (2004) also found malnourished older adults admitted for rehabilitation were more likely to
257 be admitted to an acute care facility directly upon discharge from rehabilitation, however
258 Charlton et al. (2012) found no significant results regarding rehospitalisation. Neither
259 nutrition status, nor the cost of health and aged care were measured post-discharge to the
260 community in any study identified.

261 **Table 1: Characteristics of Identified Studies**

Citation	Setting	Study Design	Study Sample	Attrition	NHMRC Level (Coleman <i>et al.</i> , 2005)	AND Quality (AND, 2009)
Charlton et al. (2012)	Two rehabilitation hospitals. Unknown bed numbers NSW, Australia	Retrospective cohort study	≥65y, mean=80.2y (±7.1y) N=469 Data collected 2006 - 2009	0%	III-3 – Prognosis evidence	+
Neumann et al. (2005)	55 bed rehabilitation unit at a general hospital SA, Australia	Prospective cohort study	≥65y, mean =81y (±6y) N=133 Data collected: 2003	13%	II – Prognosis evidence	Ø
Nicosia et al. (2012)	70 bed rehabilitation unit Lombardy, Italy	Prospective cohort study	≥65y, mean =79-81y N=243 Data collected: 2007 - 2008	10%	II – Prognosis evidence	+
Sullivan et al. (1991)	20 bed rehabilitation unit in a Veterans Administration hospital Arkansas, USA	Prospective cohort study	mean =78y (±9y) N=110 Data collected: 1987 - 1988	31%	II- Aetiology evidence	+
Visvanathan et al. (2004)	Medical, orthopaedic and geriatric wards at a rehabilitation centre. Unknown bed numbers. SA, Australia	Prospective cohort study	≥65y, mean =76 - 79y N=65 Data collected: 2002 - 2003	0%	II – Prognosis evidence	Ø

262 AND, Academy of Nutrition and Dietetics; NHMRC, National Health and Medical Research Council; NSW, New South Wales; SA, South
 263 Australia; USA, United States of America; y, year.

264

Table 2: Outcomes of Identified Studies

Citation	Baseline outcomes and cross-sectional results	Time point of outcome measure	Post-discharge associations
Charlton et al. (2012)	Measured within 72h of admission MNA ^a : median 20 (16 – 22.5), 53.1% at risk or malnourished	Outcome measures up to 26m post-discharge, mean follow-up was 18.97m (±3.84m)	Mortality: increased change of death associated with malnutrition but not risk of malnutrition · Malnutrition via MNA hazard rate 3.41, 95% CI (1.07 – 10.87), times well-nourished Institutionalisation: admission nursing homes and hostels associated with risk of and malnutrition · Discharged to a higher level of care than prior to admission: risk of/malnutrition via MNA 50% vs well-nourished 4.9% · Risk of malnutrition via MNA 23.4% admitted vs well-nourished 7.8% · Malnutrition via MNA 44.3% admitted vs well-nourished 7.8% · Risk of/malnutrition via MNA 67.7% vs well-nourished 7.8% Hospitalisation: no association
Neumann et al. (2005)	Measured within 4d of admission MNA ^a : mean 23 (±4.0), 53% at risk or malnourished MNA-SF ^b : mean 10.4 (±2.7), 62% at risk of malnutrition.	Outcome measures 90d from baseline for physical function and quality of life; Immediate post-discharge outcome for institutionalisation	Physical function via MBF ^c : poorer physical function associated with risk of and malnutrition · Risk/malnutrition via MNA mean 85 (±19) vs well-nourished mean 96 (±7) · Risk of malnutrition via MNA-SF μ86 (±18) vs low risk μ97 (±7) Quality of life via AQoL ^d : poorer quality of life associated with risk of and malnutrition · Risk of malnutrition via MNA-SF mean 16 (±6) vs low risk mean 13 (±5) · Risk of/malnutrition via MNA mean 17 (±6) vs low risk mean 12 (±5) Institutionalisation: admission to higher level care associated with risk of and malnutrition · Risk of malnutrition via MNA-SF RRR 2.22, 95% CI (1.02 – 4.82) · Risk of/malnutrition via MNA RRR 2.29, 95% CI (1.09 – 4.80)
Nicosia et al. (2012)	Measured at an unknown point during admission MNA-SF: results not reported	Outcome measures 2y from baseline	Mortality: no association
Sullivan et al. (1991)	Measured within 2d of admission SGA ^e : results not reported	Outcome measures 1y post discharge	Mortality: no association
Visvanathan et al. (2004)	Measured within 2d of admission MNA: 43.1% at risk or malnourished.	Immediate post-discharge outcome	Institutionalisation: admission to higher level care associated with risk of and malnutrition · Risk of/malnutrition 17.9% admitted vs well-nourished 8.1% Hospitalisation: admission to an acute care facility directly upon discharge from rehabilitation · Risk of/malnutrition 32.1% admitted vs well-nourished 13.5%

266

267 ^a Range of the full MNA is 0 – 30 points, where <17 indicates malnutrition, 17 – 23.5 indicates risk of malnutrition and 24 – 30 indicates normal
268 nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

269 ^b Range of the MNA-SF is 0 – 14 points, where 0 – 7 indicates malnutrition, 8 – 11 indicates risk of malnutrition and 12 – 14 indicates normal
270 nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

271 ^c Range of the MBI is scored 0 – 99, where 0 – 24 indicates total dependency, 25 – 49 indicates severe dependency, 50 – 74 indicates moderate
272 dependency, 75 – 90 indicates mild dependency, and 91 – 99 indicates minimal dependency (Shah *et al.*, 1989).

273 ^d Range of the AQoL is 0 – 30, with lower scores indicating better quality of life (Neumann *et al.*, 2005).

274 ^e The SGA is scored categorically, where A indicates well nourished, B indicates mild-moderately malnourished, and C indicates severely
275 malnourished (Detsky *et al.*, 1987)

276 ADL, activities of daily living; AQoL, Assessment of Quality of Life Instrument; CI, confidence interval; d, day; IADL, Instrumental Activity of
277 Daily Living; m, month; MBI, Modified Barthel Index; MNA, Mini Nutritional Assessment; MNA-SF, Mini Nutritional Assessment Short
278 Form; N/A, not applicable; RRR, relative risk ratio; SF-36, Short Form Health Survey; SGA, Subjective Global Assessment; vs, versus; y, year.

279

Discussion

280 The results of this review suggest malnutrition in older adults admitted for rehabilitation will
281 have a negative effect on their functional recovery and quality of life following discharge to
282 the community. In addition, malnourished older adults are more likely to die to be admitted to
283 higher level care or acute care than be discharged to the community, which may have a
284 confounding effect on quality of life. It is unfortunate that no study repeated a measure of
285 nutrition status at the time of discharge or post-discharge to the community, and therefore it
286 remains unknown if older adults discharged from rehabilitation were malnourished at the
287 time of discharge or are at risk of continued malnutrition or are at higher risk of developing
288 malnutrition once in the community. However, the increased risk of poor physical function
289 and mortality suggests this is the case. Identifying and treating malnourished community-
290 dwelling older adults is challenging due to the limited access of affordable services, and
291 interventions addressing how to provide treatment in this setting, such as educating
292 caregivers, are needed (Marshall *et al.*, 2013). Indeed, a study of stroke rehabilitation patients
293 found that indicators of malnutrition, such as low body weight, were more prevalent
294 following discharge from rehabilitation in older adults that did not receive community care
295 services (Finestone *et al.*, 1995). In this regard, the lack of intervention studies is important,
296 as rehabilitation may be an ideal setting to prevent poor outcomes once discharged from
297 inpatient health services in older adults who are malnourished at admission and to prevent
298 malnutrition from developing subsequent to admission.

299 Several studies found an association between indicators of malnutrition, such as low muscle
300 mass and weight loss with outcomes post-discharge from rehabilitation to the community.
301 Brynningsen et al. (Brynningsen *et al.*, 2007) found that older adult stroke rehabilitation
302 patients had no significant change in body mass index or weight from admission to six
303 months post-discharge to the community. However, low subscapular skinfold thickness was
304 predictive of non-elective hospital readmission within three months of discharge from a
305 geriatric rehabilitation unit (Sullivan, 1992). In this review, these single measures of
306 “nutrition status” were not considered as a diagnosis of malnutrition. Though they may be
307 indicators of malnutrition in some circumstances, and though they may correlate with poor
308 outcomes, there is no assurance the measure is a result of true protein-energy malnutrition
309 (Watterson *et al.*, 2009).

310 In the two studies which failed to find a significant association between malnutrition during
311 rehabilitation and post-discharge mortality, perhaps the studies were under-powered to detect
312 a change in this dependent variable, as the study by Charlton et al. (2012) did identify a
313 strong association, possibly due to a large sample size. Interestingly, the study by Sullivan et
314 al. (1991) found that percent body weight lost one year prior to rehabilitation was highly
315 associated with mortality one year post-discharge to the community, suggesting that prior
316 community and/or acute care malnutrition may also be predictive of mortality in the
317 rehabilitation setting. To support this hypothesis, Donini et al. (2004) and Charlton et al.
318 (2012) found older adults were more likely to die during rehabilitation if they were
319 malnourished at admission.

320 The focus of intervention research in populations discharged from inpatient health services to
321 the community to date appears to be in acute care arena, where malnutrition is highly
322 prevalent and nutrition support delivered post-discharge has been found to improve physical
323 function in community-dwelling older adults (Agarwal *et al.*, 2012; Jensen *et al.*, 2000).
324 Additionally, treatment offered during acute admissions has seen improvements in functional
325 recovery during subsequent rehabilitation (Gunnarsson *et al.*, 2009). However, the
326 populations admitted to acute care and rehabilitation have significant differences in health
327 status and treatment goals, and results cannot be extrapolated from acute care studies to other
328 populations with confidence. In the rehabilitative setting, nutrition interventions delivered to
329 older adults have been found to improve nutrition status, physical function and quality of life
330 at the time of discharge (Babineau *et al.*, 2008; Chasen *et al.*, 2010); however, it is unknown
331 if these effects continue into the community in this population as no interventions with
332 continuing support or a repeat of outcome measures, post-discharge to the community, have
333 been reported. This review highlights there is currently no evidence to suggest that nutrition
334 interventions delivered in the rehabilitation setting have an impact on the long-term nutrition
335 and health status of community dwelling older adults. Therefore no recommendations can be
336 made for best practice to prevent malnutrition in community-dwelling older adults discharged
337 from rehabilitation, thus identifying an evidence gap in the continuum of care for
338 malnourished older adults.

339 *Limitations*

340 This review is limited by publication bias and may have missed potentially relevant papers if
341 they were not coded accurately in each databases controlled vocabulary. The results reported

342 in this review are not supported by clinical trials and are observational in nature; however
343 four of the five studies provide the highest level of observational research and have low risk
344 of bias. Although the studies identified and included in this review were of high quality and
345 strength, the overall contribution to the evidence is limited due to the small number and
346 heterogenic nature of studies measuring outcomes of interest in this field. Only two studies
347 utilised risk analysis as part of their statistical approach, thereby increasing the strength of
348 results for increased risk of institutionalisation and mortality compared to other findings
349 (Charlton *et al.*, 2012; Neumann *et al.*, 2005).

350 *Conclusion*

351 Malnutrition in older adults admitted for rehabilitation is associated with poorer physical
352 function and quality of life and may increase risk of institutionalisation and hospitalisation
353 once discharged to the community. There is a lack of quality evidence for nutrition support
354 along the continuum of care for malnourished older adults, where further observational and
355 intervention research is needed post-discharge from rehabilitation to the community. Studies
356 should determine nutrition status using validated nutrition assessment tools such as the MNA
357 and SGA. Further research of this nature will provide evidence to ensure rehabilitative
358 nutrition services deliver meaningful input and encourage a healthy ageing population.

359

360

- 362 Agarwal, E., Banks, M., Ferguson, M., Bauer, J., Capra, S., Isenring, E. (2012) Nutritional
363 status and dietary intake of acute care patients: Results from the nutrition care day
364 survey 2010. *Clin Nutr* **31**, 41-47.
- 365 AIHW. (2010) *Australia's health 2010, australia's health series, no. 12. Cat. No. Aus 122*.
366 Canberra: Australian Institute of Health and Welfare.
- 367 AND, (2009) *Evidence analysis manual: Steps in the ada evidence analysis process*.
368 Chicago: Scientific Affairs and Research, Academy of Nutrition and Dietetics.
- 369 Babineau, J., Villalon, L., Laporte, M., Payette, H. (2008) Outcomes of screening and
370 nutritional intervention among older adults in healthcare facilities. *Can J Diet Pract*
371 *Res* **69**, 89-94.
- 372 Brynningsen, P.K., Damsgaard, E.M.S., Husted, S.E. (2007) Improved nutritional status in
373 elderly patients 6 months after stroke. *J Nutr Health Aging* **11**, 75-79.
- 374 Cameron, I., Handoll, H., Finnegan, T., Langhorne, P. (2008) Multidisciplinary rehabilitation
375 for older people with hip fractures. Protocol. *The Cochrane database of systematic*
376 *reviews* (DOI)10.1002/14651858.CD007125.
- 377 Charlton, K., Nichols, C., Bowden, S., Milosavljevic, M., Lambert, K., Barone, L., *et al.*
378 (2012) Poor nutritional status of older subacute patients predicts clinical outcomes
379 and mortality at 18 months of follow-up. *Eur J Clin Nutr* **66**, 1224-1228.
- 380 Charlton, K.E., Nichols, C., Bowden, S., Lambert, K., Barone, L., Mason, M., *et al.* (2010)
381 Older rehabilitation patients are at high risk of malnutrition: Evidence from a large
382 australian database. *J Nutr Health Aging* **14**, 622-628.
- 383 Chasen, M.R., Bhargava, R. (2010) A rehabilitation program for patients with
384 gastroesophageal cancer-a pilot study. *Support Care Cancer* **18**, S35-S40.
- 385 Coleman, K., Norris, S., Weston, A., Grimmer, K., Hillier, S., Merlin, T., *et al.* (2005)
386 *NHMRC additional levels of evidence and grades for recommendations for*
387 *developers of guidelines*. Canberra: National Health and Medical Research Council.
- 388 Detsky, A.S., McLaughlin, J.R., Paker, J.P., Johnston, N., Wittaker, S., Mendelson, R.A., *et*
389 *al.* (1987) What is subjective global assessment of nutritional status. *JPEN* **11**, 8-11.
- 390 Donini, L.M., De Bernardini, L., De Felice, M.R., Savina, C., Coletti, C., Cannella, C. (2004)
391 Effect of nutritional status on clinical outcome in a population of geriatric
392 rehabilitation patients. *Aging Clin Exp Res* **16**, 132-138.

393 Finestone, H.M., Greenefinestone, L.S., Wilson, E.S., Teasell, R.W. (1995) Malnutrition in
394 stroke patients on the rehabilitation service and at follow-up - prevalence and
395 predictors. *Arch Phys Med Rehabil* **76**, 310-316.

396 Finestone, H.M., Greene-Finestone, L.S., Wilson, E.S., Teasell, R.W. (1996) Prolonged length
397 of stay and reduced functional improvement rate in malnourished stroke rehabilitation
398 patients. *Arch Phys Med Rehabil* **77**, 340-345.

399 Ferguson, M., Capra, S., Bauer, J., Banks, M. (1999) Development of a valid and reliable
400 malnutrition screening tool for adult acute hospital patients. *Nutr* **15**, 458-464.

401 Guigoz, Y., Vellas, J., Garry, P. (1994) Mini Nutritional Assessment: A practical assessment
402 tool for grading the nutritional state of elderly patients. *Facts Res Gerontol* **4**, 15-59.

403 Gunnarsson, A.K., Lonn, K., Gunningberg, L. (2009) Does nutritional intervention for
404 patients with hip fractures reduce postoperative complications and improve
405 rehabilitation? *J Clin Nurs* **18**, 1325-1333.

406 Jensen, M.B., Hesso, I. (2000) Nutrition and rehabilitation after discharge from the hospital:
407 Accelerating the rehabilitation with nutrition and physical training. *Nutr* **16**, 619-621.

408 Kunert, M.P. (2005). Stress and adaptation. In C.M. Porth (Ed.), *Pathophysiology, concepts*
409 *of altered health states* (Vol. 7th e.d., pp. 187-276). Philadelphia: Lippincott Williams
410 & Wilkins.

411 Marshall, S., Bauer, J., Capra, S., Isenring, E. (2013) Are informal carers and community
412 care workers effective in managing malnutrition in the older adult community? A
413 systematic review of current evidence. *J Nutr Health Aging*, (DOI) 10.1007/s12603-
414 013-0341-z.

415 Neumann, S.A., Miller, M.D., Daniels, L., Crotty, M. (2005) Nutritional status and clinical
416 outcomes of older patients in rehabilitation. *J Hum Nutr Diet* **18**, 129-136.

417 Neumann, S.A., Miller, M.D., Daniels, L.A., Ahern, M., Crotty, M. (2007) Mini nutritional
418 assessment in geriatric rehabilitation: Inter-rater reliability and relationship to body
419 composition and nutritional biochemistry. *Nutr Diet* **64**, 179-185.

420 Nicosia, F., Bonometti, F., Ghisla, M.K., Cossi, S., Romanelli, G., Marengoni, A. (2012)
421 Predictors of survival within 2 years of inpatient rehabilitation among older adults.
422 *Eur J Intern Med* **23**, 519-523.

423 NICE. (2006) *Nutrition support in adults: Oral nutrition support, enteral tube feeding and*
424 *parenteral nutrition*. London: National Collaborating Centre for Acute Care.

425 O'Leary, F., Flood, V.M., Petocz, P., Allman-Farinelli, M., Samman, S. (2011) B vitamin
426 status, dietary intake and length of stay in a sample of elderly rehabilitation patients. *J*
427 *Nutr Health Aging* **15**, 485-489.

428 Olsson, E., Karlstrom, B. (2003) Body composition, dietary intake and estimated energy
429 expenditure in female patients on geriatric rehabilitation wards. *Scand J*
430 *Nutr/Naringsforskning* **47**, 179-187.

431 Rubenstein, L.Z., Harker, J.O., Salvà, A., Guigoz, Y., Vellas, B. (2001) Screening for
432 undernutrition in geriatric practice developing the short-form mini-nutritional
433 assessment (MNA-SF). *Series A: J Gerontol* **56**, M366-M372.

434 Shah, S., Vanclay, F., Cooper, B. (1989) Improving the sensitivity of the barthel index for
435 stroke rehabilitation. *J Clin Epidemiol* **42**, 703-709.

436 Skipper, A. (2012) Agreement on defining malnutrition. *J Parenter Enteral Nutr* **36**, 261-
437 262.

438 Stratton, R.J., Green, C.J., Elia, M. (2003). *Disease-related malnutrition: An evidence-based*
439 *approach to treatment*. Cambridge, MA: CABI Publishing.

440 Stratton, R. J., Hackston, A., Longmore, D., Dixon, R., Price, S., Stroud, M., *et al.* (2004)
441 Malnutrition in hospital outpatients and inpatients: Prevalence, concurrent validity
442 and ease of use of the 'malnutrition universal screening tool ('MUST') for adults. *Br J*
443 *Nutr* **92**, 799-808.

444 Sullivan, D.H., Walls, R.C., Lipschitz, D.A. (1991) Protein-energy undernutrition and the risk
445 of mortality within 1 y of hospital discharge in a select population of geriatric
446 rehabilitation patients. *Am J Clin Nutr* **53**, 599-605.

447 Sullivan, D.H. (1992) Risk factors for early hospital readmission in a select population of
448 geriatric rehabilitation patients: The significance of nutritional status. *J Am Geriatr*
449 *Soc* **40**, 792-798.

450 Vellas, B., Villars, H., Abellan, G., Soto, M., Rolland, Y., Guigoz, Y., *et al.* (2006) Overview
451 of the MNA®-its history and challenges. *J Nutr Health Aging* **10**, 456-465.

452 Visvanathan, R., Penhall, R., Chapman, I. (2004) Nutritional screening of older people in a
453 sub-acute care facility in australia and its relation to discharge outcomes. *Age Ageing*
454 **33**, 260-265.

455 Watterson, C., Fraser, A., Banks, M., Isenring, E., Miller, M., Silvester, C., *et al.* (2009)
456 Evidence based practice guidelines for the nutritional management of malnutrition in
457 patients across the continuum of care. *Nutr Diet* **66**, S1-S34.

458 Wilson, M.-M. G., Thomas, D. R., Rubenstein, L. Z., Chibnall, J. T., Anderson, S., Baxi, A.,
459 *et al.* (2005) Appetite assessment: Simple appetite questionnaire predicts weight loss
460 in community-dwelling adults and nursing home residents. *Am J Clin Nutr* **82**, 1074-
461 1081.

462