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

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

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Abstract

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 (≥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

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 (≥65y (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

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

This review aimed 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. Secondary objectives were to explore extent to which malnutrition-focused interventions may impact upon these post-discharge outcomes in older adults and to describe the types of interventions used.

Materials and methods

A systematic literature review of current evidence was conducted.

Search strategy

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

PubMed and CENTRAL was searched using the MeSH Terms:

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

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

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

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

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

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

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

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

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

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

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

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

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

Exclusion criteria for types of participants included populations which had cystic fibrosis, were receiving drug and alcohol rehabilitation, ambulatory rehabilitation, enteral or parental tube feeding, haemodialysis or peritoneal dialysis, or where interventions had no nutritional component, or focused on improving control of diabetes or cardiovascular risk factors. Exclusion criteria for types of studies included cross-sectional, as the design does not allow for outcomes to be assessed during rehabilitation and post-discharged to the community, protocol studies, abstracts, conference papers and review papers. Studies which reported malnutrition by using a nutrition screening tool or single maker such as serum albumin or weight loss were excluded, as were those which failed to assess nutrition status during rehabilitation or any outcome of interest once discharged to the community.

Selection of studies and data synthesis

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

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

Review of study strength and quality

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

Results

Search results

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

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

Review of study strength and quality

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

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

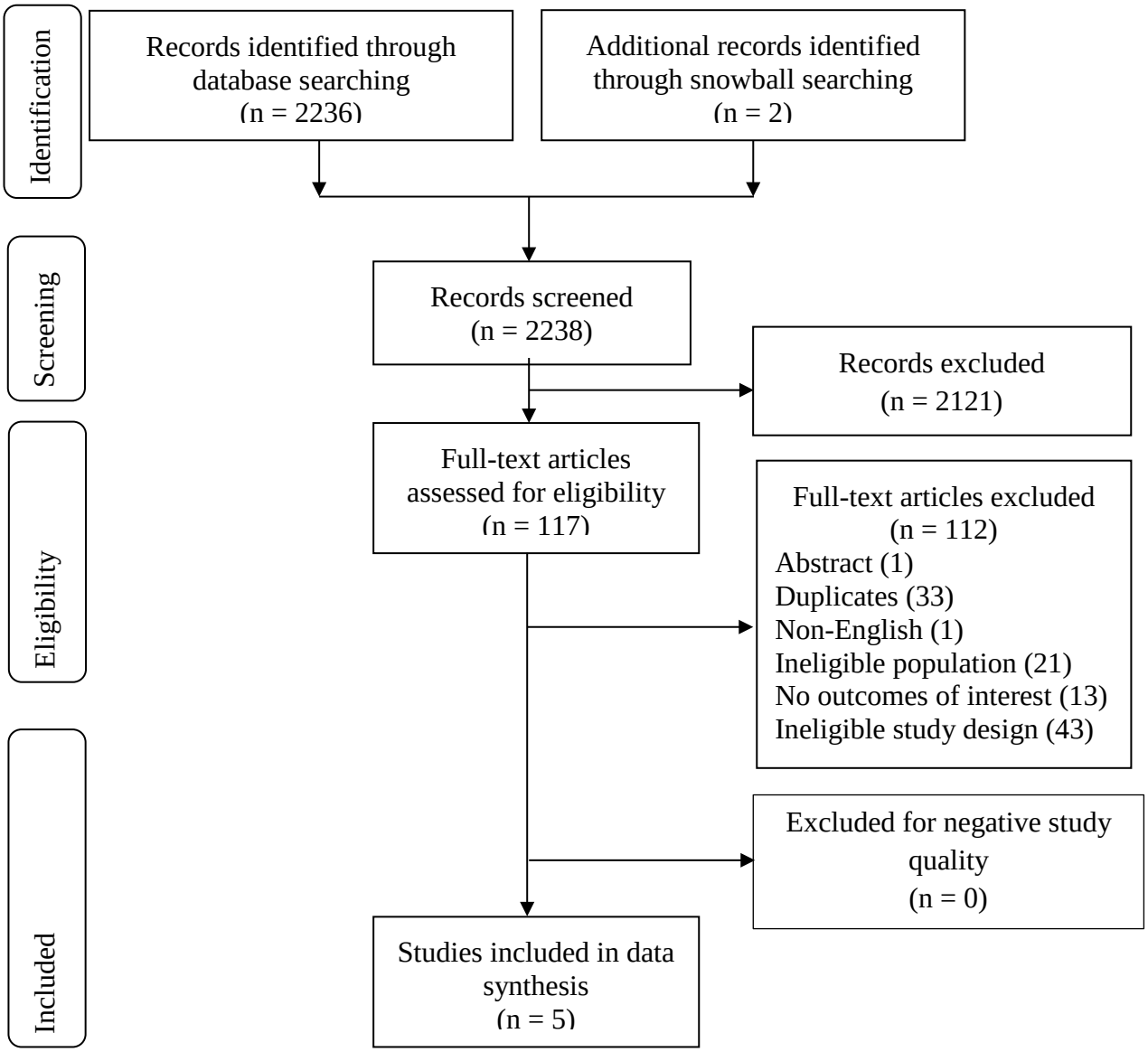

Figure 1: Study flow diagram

The consequences of malnutrition following discharge from rehabilitation to the community

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

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

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

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

Table 1: Characteristics of Identified Studies

Citation	Setting	Study Design	Study Sample	Attrition	NHMRC Level (Coleman *et al.*, 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

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

265 **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 MBI[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%

[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 nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

[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 nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

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

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

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

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

Discussion

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

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

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

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

Limitations

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

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

Conclusion

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

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462