**Abstract**

Background

Undernutrition affects over 44% of hospitalised older people, who often dislike oral nutritional supplements (ONS). This review summarises the evidence for an alternative strategy, using energy and protein dense meals (via fortification) or snacks (supplementation) to increase the dietary energy and protein intake of older inpatients.

Methods

A search was conducted through PubMed, EMBASE, CINAHL and the Cochrane Database of Systematic Reviews for studies (May 1996 - May 2016) that used fortification or supplementation to increase the energy or protein intake of patients (mean age > 60) in hospitals or rehabilitation centres.

Results

10 articles (546 patients, mean age 60-83 years) were identified. Compared with usual nutritional care, six studies using either energy or protein based fortification and supplementation significantly increased intake of energy (250–450kcal/day) or protein (12–16g/day). Two studies enriched menus with both energy and protein, and significantly increased both energy (698kcal/day and 21 kJ kg-1) and protein (16g and 0.2g kg-1) intake compared to usual care. ONS was similar to supplementation in one study, but superior to fortification in another. Four studies reported good acceptability of enriched products, and two studies found they were cost-effective.

Conclusions

Compared with usual nutritional care, energy- and protein-based fortification and supplementation could be employed as an effective, well-tolerated and cost-effective intervention to improve dietary intake amongst older inpatients. This strategy may be particularly useful for patients with cognitive impairment that struggle with ONS, but trials are required to formally compare these approaches and establish their impact on functional outcomes.

**Introduction**

Undernutrition (defined as a state of poor health due to a deficiency of energy, protein or other nutrients) amongst hospitalised patients continues to be a significant problem worldwide, especially amongst older people (1). It was recently estimated that over 44% of patients admitted to geriatric medicine hospital wards are at risk of undernutrition, with 6% already undernourished (2). The reasons for this high prevalence amongst older people are complex and multifactorial, and include dementia, depression, functional dependence and multiple co-morbidities (3). This problem is confounded by the fact that, irrespective of nutritional status on admission, nutritional status often declines significantly whilst in hospital (4,5).  Poor nutrition has been implicated in the development of complications including pressure ulcers (6), health care associated infections (7,8) and death (9,10). Additionally, undernutrition is associated with longer hospital stays and slower functional recovery (11,12), as well as re-admission (13). The National Institute of Health and Care Excellence (NICE) has calculated that more than £70 million could be gained in efficiency savings in the UK alone if their guidelines for the systematic screening, assessment and treatment of malnourished patients were implemented (14).

Oral Nutritional Supplements (ONS) in the form of energy- and protein-dense sip feeds are a mainstay of treating undernutrition in hospital settings. Meta-analyses have shown reductions in mortality, readmissions and complications in the acute setting (15,16), however this approach has been challenged due to their poor acceptability and tolerance amongst older patients, as they are often incompletely consumed in clinical settings (17). Poor concordance is likely exacerbated by delirium, and, patients with cognitive impairment may not have been represented fully in trials with ONS. This may be mediated by a lack of familiarity with sip feeds (18). Older people are particular reliant on visual cues when judging flavour and food liking (19), and therefore distrust foods that do not appear to be food they are used to consuming (20). Palatability is also an issue, with significant proportions of hospitalised patients disliking sip feeds due to their taste, texture, and tendency to induce nausea or abdominal bloating (21). Furthermore sip feeds may offer little sensory variety, and ‘taste fatigue’ due to monotony may quickly develop (22).

An attractive alternative strategy is the use of energy- and protein-dense meals (via fortification) or snacks (supplementation). Ingredients can either be in the form of natural foodstuffs, or powders/syrups of high protein or carbohydrate content, such as whey protein. Examples include the use of fortified bread (23,24), soups (25) and sauces (26), protein and dairy-enriched main meals (27,28), and high-calorie between-meal snacks or desserts, such as biscuits (29), yogurt (23,24) and ice cream (30). This strategy could increase the recognisability and acceptability of the supplementation and so encourage consumption, especially in patients with delirium. Therefore, we conducted a systematic review of the literature to summarise the evidence for the use of energy and/or protein dense meals (via fortification) or snacks (supplementation) to increase the dietary energy and protein intake of older people in hospital or rehabilitation facilities.

**Material and Methods**

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines (31) and was registered on the PROSPERO database (reference number: 42016043503). The final search was completed on the 20th May 2016.

**Data sources, search strategy and selection criteria**

A literature search was conducted through PubMed, EMBASE, CINAHL and the Cochrane Database of Systematic Reviews for articles published between 1st May 1996 and 20th May 2016. Keywords, search terms and Medical subject headings (MeSH) terms were developed with the assistance of a medical librarian and adapted for use with each database. The full search strategy for Cochrane database can be viewed in Appendix 1.

Inclusion criteria are shown in Figure 1. Articles were eligible for inclusion if they reported on the use of energy and protein dense meals (via fortification) or snacks (supplementation) to increase the energy and/or protein intake of inpatients (mean age > 60 years) in acute hospitals or rehabilitation units. Articles reporting any, or no, comparator group were considered. There was no restriction on study design and articles in all languages were included. Articles suspected to arise from a single study or dataset were evaluated and the most comprehensive article was included. Published abstracts arising from conference presentations were included only if a complete article arising from the same study could not be identified. Studies involving fortification with micronutrients only or addition of flavour enhancers only were excluded.

The details of the search strategy are displayed in Figure 2. Duplicates were removed, then two authors (CW, SM) independently screened the titles of all articles identified by the search criteria. Abstracts of any potentially relevant articles were similarly independently assessed for inclusion. Full copies of any articles that appeared to be eligible were obtained and again assessed independently for inclusion. In addition, the reference lists of relevant articles and similar reviews identified in the search process were thoroughly hand searched for potentially relevant articles. To confirm the validity of our search strategy, we ensured that all relevant articles identified in scoping searches were captured by the final search. Any disagreement between these authors was resolved upon discussion with the senior authors KI and HR.

**Data extraction & Quality assessment**

Data extraction and quality assessment was undertaken independently and in duplicate for each study using a standardised form, and any discrepancies were resolved by discussion. Quality assessment was performed using standardised checklists from the Joanna Briggs Institute (JBI) (32).

**Data synthesis**

The heterogeneity of study design and outcome measures meant that a formal meta-analysis was not feasible. Table 1 summarises the characteristics of the included studies. Narrative format was used to synthesis data extracted from these studies.

**Results**

The database searches identified 14340 articles of potential interest after removing duplicates (Figure 2). 632 articles were selected for abstract review, 73 articles were selected for full text review, and 10 articles met the inclusion criteria.

**Study characteristics**

The characteristics of the 10 articles included in the review are summarised in Table 1. Publication date ranged from 1996 to 2015. The included articles reported on 546 participants (range 10 to 143 in each study), 40% of whom were male. The mean age of participants in the studies ranged from 60 to 83 years. Eight studies compared a diet enrichment intervention with usual nutritional care, or the same products in a non-enriched format. Six of these studies assessed either energy- or protein-based fortification and supplementation alone, and two (Lorefalt and Munk) assessed a menu enriched with both energy and protein. Two studies used oral nutritional supplements as a comparator (33,34). Studies were conducted in a number of countries across a number of care settings. Four studies were randomised controlled trials (RCTs) (23,24,33,35) and six were non-randomised experimental studies (NRES) (27,28,36–39). The quality of articles was variable ranging between 3/13 and 9/9. Further information about the study characteristics is presented in Table 1 and in the online supplementary material (see appendix 2).

**Outcomes**

***Energy and protein intake***

All ten articles reported on energy and protein intake (Table 2).

Three studies compared fortification and supplementation with usual nutritional care (standard hospital menus) using energy-based enrichment alone. All three demonstrated a statistically significant increase in dietary energy intake, but no significant difference in protein intake. One of these studies (Olin) enriched their main meals with a combination of cream, oil and margarine, and reported an increased energy intake of >450 kcal/day (p<0.001) (36). The other two studies (Gall and Barton) fortified using dairy products alone. Gall (37) added products such as cream to dessert, and milk powder to soups (increase of 250 kcal/day, p=0.007). Similarly, Barton used butter, cream, cheese and glucose in their fortified meals, with an increase of approximately 300 kcal/day (p<0.001) (39). With regards to portion sizes, Barton offered smaller portion sizes for their fortified meals, whereas both Olin and Gall used no reduction in portion size but also offered energy-dense between-meal snacks (Olin offered cakes and Danish pastries, and Gall offered cheese sandwiches and sponge cakes). In a separate arm of Barton’s trial, they offered a cooked breakfast to patients, which significantly increased energy intake (approximately 300 kcal/day, p<0.001) and protein intake (2.7g/day, p<0.05) (39).

Another three of the studies compared usual nutritional care with food products which were protein-enriched but did not differ significantly with regards to their energy content. All three showed a statistically significant increase in protein intake but, understandably, no difference in energy intake. Two of these studies (Van Til and Stelten) compared the use of protein enriched yoghurt (8 g protein vs 3 g) and bread (7 g vs 4 g) with otherwise identical control products. Van Til (24) achieved a protein increase of 40 g/day in a rehabilitation setting (p<0.01), and Stelten (23) found an increase of 16 g/day in an acute hospital setting (p=0.039). Similarly, Beelen (27) assessed a specifically protein-enriched menu and found the daily intake increased by 11.8g/day (p=0.003).

Two of the studies assessed a menu enriched with both energy and protein. Lorefalt (28) demonstrated a significant mean daily increase in both energy (698 kilocalories, p=0.01) and protein (16g, p<0.05) using half-sized portions of regular meals with added protein and energy (mainly cream, butter and mono and poly unsaturated oils). Munk tested a supplementary protein and energy enriched à la carte menu in addition to the normal hospital menu (35). When adjusted for body weight, both energy intake (21 kJ kg-1, p=0.013) and protein intake (0.2g kg-1) increased significantly, with the number of patients meeting their protein requirements increasing by 36% (P=0.001).

The final two studies compared food fortification or supplementation to the use of traditional sip feeds. Campbell (34) compared the use of energy-dense between meal snacks (containing 70-120 kcal) to traditional ONS (1 kcal/mL) and MedPass supplements (delivered by 60mL cartons four times a day with medication). They found absolute protein and energy was not significantly different between snack supplementation and sip feeds (p>0.05), although this is confounded by differences in baseline energy requirements and BMI. Cots (33) reported that ONS provided a higher energy and protein intake than fortified conventional foods in a RCT. However, this article was only available as a conference abstract and is difficult to interpret due to its lack of detail regarding patient characteristics, intervention, outcome measurement, setting and results (no absolute values given).

**Acceptability of fortified food**

In this review, four studies reported participants’ compliance and tolerance of fortified food. Two of these studies (Stelten and Van Til) assessed taste preferences. Stelten (23) found that the there was no significant difference between the acceptability of fortified bread and yoghurt compared with control products. The majority of their hospitalised participants (77%) were neutral or positive about the taste of protein-enriched bread, and 87% of patients reported being positive or neutral about protein-enriched yoghurt. Using identical products, Van Til (24) also showed good compliance amongst participants in a rehabilitation setting. The other two studies (Gall and Campbell) assessed consumption. Gall found that 51/62 (82%) of their intervention patients ate more than one third of fortified foods offered in addition to usual nutritional care. When compared with traditional sip feeds, Campbell (34) found that consumption and patient satisfaction was significantly higher with between-meal snacks than MedPass supplements and traditional ONS.

**Cost effectiveness**

Two studies reported the cost of interventions and both showed that fortified food could be cost-effective among older people in hospital. Campbell (34) performed a cost analysis, based on supplement cost and staff time and found between-meal snacks to be more cost-effective than traditional ONS or Medpress supplements (cost per calorie consumed). Olin (36) also found a reduced cost per calorie when using higher density food compared to all other means of increasing energy intake, and the cost per calorie was just 15% compared with ONS.

**Discussion**

This is the first review to focus on the effectiveness of energy and protein dense meals and snacks to increase the dietary intake of hospitalised older people. Previous systematic reviews and meta-analyses have studied the use of fortification and supplementation in community dwelling older people or those in care homes, in whom the prevalence of undernutrition varies considerably (40,41), or the use of ONS in acute medical patients of any age (5). The results of this review suggest that food fortification and supplementation may indeed be an acceptable, effective and economical strategy to ensure that older inpatients meet their nutritional needs.

Seven studies compared either energy- or protein-based fortification and supplementation with usual nutritional care, and demonstrated significantly increased dietary energy and protein intake, respectively. These fortifications are not mutually exclusive however, and we would recommend dual enrichment, as was used by Munk and Lorefalt who both achieved a significant increase in both energy and protein intake (28,35). Interestingly, in previous reviews that assessed food fortification and/or supplementation for older people in other settings, statistically significant improvements in energy intake but not protein were reported. This could be attributed to the type of fortification used as a statistically and clinically significant improvement in protein intake can indeed be achieved as evidenced by Van Til, Stelton and Beelen’s trials.

Making comparisons with ONS is challenging as the two articles to do so are limited by poor quality, with Cots reporting little detail on its interventions and results, and Campbell’s study having different baseline nutritional requirements and BMI between the groups. Protein enhancement may result in a strong taste of aromatic amino acids in high-quality protein powder (42); whereas it may be easier to increase energy intake without compromising taste. Recent studies have demonstrated that fortified soup, gravy and tomato sauce were equally liked or actually preferred to unfortified versions (25). However, another comparison of protein and micro-nutrient enhanced oat biscuits against a commercial alternative found the enhanced biscuits to be acceptable, but significantly less liked (26). The four studies in this review that reported participants’ compliance and tolerance of fortified foods were encouraging (23,24). In contrast, traditional sip feeds are known to have poor acceptability and tolerance, particularly amongst older inpatients with cognitive impairment, and wastage may be high (17). The taste, variety and familiarity of fortified foods and snacks may offer significant advantages, leading to higher rates of consumption and patient satisfaction (22,34).

It is worth noting that studies amongst older people have shown a gradual decline of taste sensitivity with age, with taste thresholds (e.g. salt and sweet) increasing (43). However, the extent of the decline and whether it has an impact on food selection remains unclear (44). Some medical conditions and drugs may also impair the senses of taste, smell and appetite in older people, which may alter food preferences during acute illness (45), as such it may be difficult to extrapolate acceptability data from physically well older people or unwell younger adults.

**Strengths and Limitations**

This is the first systematic review to study the use of food fortification and supplementation in this important patient group. Although every effort was made to retrieve papers relevant to our research questions, the lack of standardised terminology, keywords and MeSH terms means that we may have missed some articles that were eligible for inclusion. Additionally, we recognise that publication bias may exist in the literature.

Much of the variability in the outcomes of these studies is likely to be due to the heterogeneity of the study populations, interventions, comparators, and outcome assessment. A number of the studies used a crossover design, and these trial designs have the benefit of using patients as their own baselines and correcting for individual differences. However, the introduction of novelty by changing the menu, particularly in long stay patients, may have confounded these results.

**Recommendations for future research**

To-date, the majority of studies to-date have compared fortification and supplementation to usual nutritional care, and therefore making clear comparisons with ONS is challenging. Further trials are certainly required to formally compare these approaches and establish their impact on dietary intake, as well as acceptability/patient satisfaction, cost-effectiveness, and functional outcomes (such as length of hospital stay and quality of life). Secondly, only two studies trialled fortified menus consisting of dual enrichment with both energy and protein, therefore further work on larger sample sizes may be required to optimise such menus.

**Conclusion**

Compared with usual nutritional care, we suggest that combined energy- and protein-based fortification of main meals, as well as supplementation with snacks, could be employed as an effective and feasible intervention to improve dietary intake amongst older inpatients. Furthermore, this can be achieved in a way that is both acceptable to older inpatients and cost effective for healthcare services. This strategy may be particularly useful for patients with cognitive impairment that struggle with ONS, but further trials are required to formally compare these approaches and establish their impact on functional outcomes.

**Conflict of interests**

None

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