How effective is nutrition education aiming to prevent or treat malnutrition in community-dwelling older adults? A systematic review

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Competing interests

The authors have no conflict of interest to declare.

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Abstract

Background: While malnutrition is associated with adverse health outcomes in older adults, little is known about the effectiveness of nutrition education. This systematic review examines the evidence for educational interventions to improve nutritional and other health-related outcomes in community-dwelling older people.

Methods: Systematic searches of three databases (Embase, Medline and CINAHL) were conducted. Studies testing educational interventions targeting older adults (mean age ≥ 60 years) or their caregivers were eligible for inclusion. Two authors independently assessed trial eligibility, risk of bias and extracted data. Study heterogeneity was high precluding meta-analysis, therefore a narrative synthesis was conducted.

Results: Nine articles reporting on eight studies (n=7 trials; 1 pre-post intervention study) met inclusion criteria. There was considerable variability in the format of educational interventions. Nutrition education was either generic or personalised and the intensity was variable (1-6 sessions). We found some evidence (in 5/8 studies) that nutrition education may improve nutrition-related outcomes. Nutrition education involving caregivers was found to reduce nutritional risk in one study, and nutritional counselling following discharge from hospital was found to reduce the risk of readmission in another study. However, the overall quality of the studies was hampered by poor methodology, low sample size and attrition bias, and results need to be interpreted with caution.

Conclusions: Educational interventions may have potential to improve malnutrition-related outcomes in older people, but the strength of evidence is poor. More robust, larger studies are needed to ascertain the effectiveness of nutritional education interventions in this population.

Key words: Malnutrition, nutrition education, older adults, community, systematic review.

BACKGROUND

Malnutrition (or undernutrition) can be defined as 'a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome' [1]. It is estimated that malnutrition currently affects over 3 million people in the UK, and nearly half of these (1.3 million) are over the age of 65 years and living in the community setting [2]. Malnutrition in later life can be a result of many contributing factors, such as frailty, reduced appetite, sensory impairment, poor dentition, swallowing problems, depression, dementia, social isolation and deprivation [3,4,5,6,7,8].

There are variations in the presentation and severity of malnutrition, and it is commonly underdiagnosed in the community [9]. Affected individuals can experience fatigue, cognitive impairment, immune compromise and low mood [10,11]. Both muscle mass and bone strength decline, leading to reduced physical ability and increased risk of both falls and fractures [12,13]. Overall, malnutrition is associated with frailty, reduced ability to perform activities of daily living (ADLs) [14], reduced autonomy [15], and poor quality of life [16]. Malnutrition is associated with longer and more frequent hospital attendances [17] that potentiate further decline in nutritional status and physical function, necessitating more intensive support on discharge and greater vulnerability to future admission [18,19].

Nonetheless, many older people affected by malnutrition are unaware of the risks associated with inadequate oral intake. Long established beliefs around 'healthy eating' conveyed via the media [20] and perceptions of the body, especially among women [21], can lead to self-imposed dietary restrictions that can compromise their nutritional status as dietary requirements change [22]. Nutrition education can take different forms, such as for example training in cooking skills, provision of information on dietary requirements adjusted to the needs of older people, verbal or written advice to increase protein or calorie intake, and instructions on how

to achieve this. Although nutrition education approaches could represent a simple solution to treat or prevent nutritional decline in community-dwelling older adults, especially for those who do not need or cannot tolerate oral nutritional supplements (ONS), the effectiveness of such interventions is unknown. Our systematic review sets out to establish the effectiveness of primary care and community based educational interventions aiming to prevent or treat malnutrition in community-dwelling older adults. We also aimed to identify the components of such interventions and their individual impact on nutritional and other health-related outcomes, with a view to presenting the evidence base and informing clinical practice in community settings.

METHODS

Searches

A search strategy employing an organised structure of key terms was created to combine the following concepts: older people; community; malnutrition; and nutrition education. This search was applied to three databases: Embase, Medline and CINAHL. Initial searches were performed in June 2017, which were later updated on 14th December 2018. The detailed search strategy for Medline and Embase is presented in Appendix 1. Forwards and backwards citation tracking of publications from included papers was also undertaken. No restrictions on publication period or language were applied in searches. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [23] were followed.

Study selection

Two reviewers (JR and CA) independently screened titles, abstracts and full texts and selected studies meeting the inclusion criteria. The reviewers met and discussed, and any disagreements

were resolved by discussion between the reviewers and with a third reviewer (KW), where needed. We excluded studies where we were unable to source a full-text version in English.

Types of studies included

Design: Randomised controlled trials (RCTs) and quasi-experimental studies.

Participants

Inclusion criteria: People aged 50 years and above, living in the community setting (provided that mean age of study participants was ≥ 60 years).

Exclusion criteria: People with terminal cancer or end stage organ failure; Use of enteral or parenteral nutrition.

Interventions

Inclusion criteria: 1) Interventions targeted to address malnutrition and/or involuntary weight loss; 2) Interventions targeted at the individual and/or their caregiver (either paid or informal carers permitted); 3) Interventions delivered by primary health care workers (e.g. GPs, practice nurses, community matrons or healthcare assistants), trained researchers or dieticians; 4) Interventions that included a nutritional education component.

Exclusion criteria: 1) Interventions that utilise oral nutritional supplements or vitamin supplements; 2) Composite interventions combining nutritional education with other factors, e.g. physiotherapy, psychological or occupational therapy assessment, where the impact of the nutritional component could not be isolated; 3) Interventions delivered in the hospital, community hospital, residential or nursing home setting; 4) Interventions targeted at improving diet for those with malnutrition related to a cancer diagnosis or severe end-stage chronic disease e.g. renal failure; 5) Interventions targeting malnutrition in people with specific chronic

conditions e.g. COPD or heart failure; 6) Nutritional interventions promoting dietary change specifically for individuals with diabetes, hypertension or cardiovascular disease, as well as interventions for weight loss and reduction of cardiovascular risk; 7) Interventions that included delivery of meals.

Comparator

Inclusion criteria: Studies comparing the intervention group to baseline care, usual care or a comparator nutritional intervention.

Exclusion criteria: Studies without a comparator group.

Outcomes

Any relevant nutritional, dietary, behavioural or clinical outcome, expected to be related to, but not restricted to: weight, body mass index, other anthropometric measures, dietary risk scores, self-reported calorie or food intake, self-reported change in dietary knowledge or behaviour, biochemical markers, physical performance measures, hospital readmission rate, quality of life, depression, loneliness, and/or cognitive function.

No time limit for the duration of the intervention and/or length of follow-up was set.

Data extraction

The following data were extracted independently by two reviewers (JR and CA): first author, year of publication, country, proportion of female participants, mean age, age range, number of people (randomised/receiving the intervention/completing follow up), type of intervention, number of sessions, period of follow up, outcome measures and statistical measures of effectiveness.

Study quality assessment

The methodological quality of the included studies was assessed independently by two reviewers (JR and CA) using the Cochrane Risk of Bias Tool for Randomised Controlled Trials [24].

Data synthesis and presentation

We aimed to perform a meta-analysis if possible, however both the lack of high quality studies, and the heterogeneity of study interventions and/or outcomes precluded this, and therefore a narrative synthesis was conducted.

Study Registration

The study protocol was registered on the PROSPERO International Prospective Register of Systematic Reviews website (Registration ID: PROSPERO 2017 CRD42017072630) [25].

RESULTS

Selection process

A total of 9,389 titles and abstracts were identified in searches. After duplicates (n=2,503) were removed, a total number of 6,886 abstracts were screened against the inclusion/exclusion criteria. Of these, 6,807 abstracts were excluded and the remainder (n=79) went on to full text screening. A total of 71 studies were then excluded, including two potentially relevant abstracts of papers published in other languages, one in Japanese [26] and one in Chinese [27], where full-text in English was not available. A further 14 potentially relevant full papers were identified through citation tracking, among which 13 were excluded and 1 was included. Two papers reporting on different outcomes from the same study were identified [28,29] but were not included, because they were secondary publications from the same RCT [30] and their

objectives and outcomes were not relevant to our inclusion criteria. We identified one further study from China [31] that we excluded because the intervention included provision of free food samples, additional to the educational intervention consisting of seminars on nutrients and demonstration of cooking skills. From a total of 93 full text papers, we excluded 84 and included 9 papers. **Figure 1** is the PRISMA flowchart showing the study selection process and reasons for exclusion.

Study characteristics

We included 9 papers reporting on data from eight studies, among which seven [30, 32,34,35,36,38,39] were randomised controlled trials and one was a pre/post-intervention study [33]. The included studies comprised 772 participants and follow-up ranged from 1 month to 1 year. Three studies were from the U.S. [32,34,35], and one each from Sweden [30], Canada [33], Spain [38], and Finland [39]. Two papers from the same study reporting different outcomes were from Denmark [36,37]. **Table 1** shows the characteristics of the included studies.

There was considerable heterogeneity in the format of educational interventions. One utilised written materials alone [33], while the majority delivered dietary counselling either individually, face-to-face [34,36,37], via telephone [36,37], by post [33], in a group setting [32,35], or via a combination of individual and group sessions [30,38,39]. The nutrition education provided was either generic or personalised and the intensity of interventions was variable, ranging from 1 to 6 sessions. Details on the content, intensity and frequency of the interventions are presented in **Table 1**.

Participants

The majority of included studies [32,30,34,36,37,38] recruited people who were at risk of malnutrition, although different definitions of malnutrition or inadequate diet were adopted across studies. More specifically, three studies [36,37,38] recruited people at risk of malnutrition as defined by Mini Nutritional Assessment (MNA) score [40], one study focused on housebound people with reduced caloric intake or weight loss [34], and another study recruited people with unintentional weight loss/low Body Mass Index (BMI) and low physical activity [30]. A further study targeted people who were eating inadequately, defined by consuming less than 67% of the Recommended Daily Allowance (RDA) for each of the eight nutrients that were investigated (protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, and ascorbic acid) based on 24-hour dietary recall [32]. In another study [33], participants were defined as older adults attending local community centres who were screened for nutritional risk based on the tool SCREEN II (Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II) [41], and 62.3% of them were found to be at risk of malnutrition at baseline. In another study [34] participants were recipients of a local community meal programme who were screened with the Dietary Screening Tool (DST) [42] and slightly over one third of them was found to be 'at nutritional risk' at baseline. Finally, in one study participants were caregivers aged 65 and above who were identified having a protein intake less than the recommended 1.2 g/kg body weight/day according to three-day food diaries. Although the mean reported protein intake was insufficient (0.86 g/kg body weight/day in the intervention group and 0.85g/kg body weight/day in the control group), most study participants (85.5%) had a good nutritional status based on MNA assessment, whereas a minority 12.7% were at risk of malnutrition and 1.8% malnourished [39].

In the majority of studies, participants were predominantly female (ranging from 56-82% female). One of the included studies (reported in two papers) directed education strategies for

both participants and their home carers [36,37], and another trial was focused entirely on educating caregivers [38].

Intervention length, adherence and follow up

The length of the intervention varied from 3 weeks to 6 months. In more than half of the studies the length of the intervention was 1 month or shorter [32,33,34,36,37], in one study it was 12 weeks [30] and in three studies it was 6 months [35,38,39].

Overall, adherence to the interventions was either poor (n=4) or not reported (n=4). In the study involving both older people and their home carers approximately between a quarter and a third of participants (27% in the home visit group and 32% in the telephone group) did not complete all three sessions, and adherence of the home carers to the intervention was very low (only 26% took part in one session, 12% in two, and 6% in three sessions) [36,37]. In other studies, overall participation was higher, but compliance rate was not reported specifically for the nutrition intervention arm [30,35]. Adherence was not reported for the remaining interventions [32,33,38,39]. The length of the follow up varied from 1 month [33] to 12 months [38].

Risk of bias

The overall risk of bias was high or unclear for the majority of included studies **(Figure 2)**. The domains with an unclear risk of bias were random sequence generation (n=4), allocation concealment (n=8), blinding of outcome assessment (n=5), selective reporting (n=6) and incomplete outcome data (n=2). Risk of bias was low in the domains of random sequence generation for 4 studies, outcome data in 3 studies, selective reporting of data in 2 studies, and blinding of outcome assessment in 1 study. All included studies were at high risk of bias for blinding of participants due to the nature of the interventions.

Outcomes

Nutritional risk (including anthropometric measures and reported dietary intake)

There were mixed findings across a range of outcomes on the nutritional status of older adults following nutritional education interventions. Nutritional risk was assessed by a validated tool in 6/8 studies [30,33,35,36,38,39], although in one of them MNA was part of the initial assessment but not a criterion for participant inclusion [39]. Nutritional risk was assessed via self-reported intake in three studies [32,34,39], although one of them also used weight measurement [34]. Nutritional risk was a primary outcome in 5/8 studies (4 RCTs and 1 pre-post intervention study), among which there were some positive results in 4/5 studies [32,33,35,38], and negative in 1/5 [34]. In a further two studies nutritional risk was a secondary outcome with non-significant results [34,36]. Detailed information on outcome measures is provided in **Table 1**.

Data from RCTs

Nutritional risk was a primary outcome in four out of seven RCTs included in this systematic review [32,34,35,38]. Positive outcomes were found in 3 out of 4 [32,35,38]. The one study with no significant results was a feasibility trial with small numbers [34]. There was a further study having self-reported protein intake as the primary outcome [39].

In Fernandez-Barres et al (2017), group education of caregivers of dependent community-dwelling older adults (n=173), followed by individual dietary monitoring over a 6-month period, was associated with a significant improvement in nutritional risk measured by MNA compared to the control group. At 6 and 12 months of follow-up mean MNA scores increased from 20.6 in the intervention group to 21.7 and 21.4 respectively ($p<0.001$), whereas the intake of egg, protein, polyunsaturated fatty acid folate and vitamin E improved significantly over time in the intervention group compared to control [38]. However, despite the difference in the

MNA score being significant, both MNA scores pre- and post-intervention fall under the category 17-23.5 which translates to being ‘at risk of malnutrition’ [40].

In Francis et al (2014) (n=73) a theory-based nutrition education programme (involving monthly newsletter discussed by an educator, incorporating behaviour change techniques) was more effective in reducing the nutritional risk measured by the Dietary Screening Tool (DST) [42] compared to a traditional programme [35].

Group education sessions delivered over a period of 4 weeks improved adequate eating of participants both immediately after completion of the programme and 6 weeks later ($p<0.05$) in Mitic et al (1985) (n=66) [32].

In a feasibility RCT, Locher et al (2013) tested individualised dietary counselling (involving self-management education and collaborative goal-setting) delivered by a dietitian to housebound older people (n=40). They found that the intervention was feasible, but there was no difference in weight or caloric intake between groups [34].

In Kunvik et al (2018) (n=55), the effectiveness of an intervention aiming to increase protein intake in caregivers (aged 65 and above) was tested with self-reported protein intake as the primary and self-reported energy intake as the secondary outcome. Although there were no significant differences between the intervention and the control group, there was a difference in the reported protein and energy intake within the intervention group. Subgroup analyses focusing on male caregivers only showed a significant difference in protein intake and a borderline difference for energy intake between the male intervention and control groups [39]. However, as mentioned above, only a minority of participants were at risk of malnutrition based on MNA and a formal assessment of the risk of malnutrition is not reported in the paper as part of the outcome assessment.

In the remaining two RCTs nutritional risk was a secondary outcome [30,36], therefore results need to be interpreted with caution. A nutritional education intervention delivered in both

individual and group settings explored by Rydwik et al (2008) (n=96) did not show any significant effect on nutritional measures (body weight, fat free mass or energy intake) [30]. Nutritional risk measured by MNA as a secondary outcome in the Pedersen 2016 study (n=208) was not significantly different for people who received home visits or telephone consultations after discharge from hospital compared to control [36].

Data from pre/post intervention studies

Self-help education via personalised letters with or without a booklet reduced nutritional risk (measured by SCREEN II) [41] post intervention (p=0.040), but the effect on nutritional status was not altered by the intervention type [33].

Dietary knowledge and other nutrition-related outcomes

Dietary knowledge was assessed in two studies [33,38]. Nutritional education of caregivers was shown to significantly increase their nutritional knowledge by 1.5 points according to an 11-item questionnaire on basic concepts explained by the nutrition education intervention ($p<0.001$). However, this questionnaire was developed by researchers and it is not known whether it was validated or not [38]. Southgate et al 2010 identified that self-help education could similarly improve dietary knowledge on an individual level post intervention ($p<0.0001$), although they used a tool (Dietary Knowledge Questionnaire) that was developed and validated for the purposes of the study [33]. Finally, self-efficacy and food security were measured as secondary outcomes in one study and no difference was found between the intervention and control group [35].

Admission to hospital

Admission to hospital was an outcome in one study only, where individualised nutritional counselling via home visits to malnourished older adults/caregivers following discharge from hospital was found to significantly reduce the risk of readmission to hospital at 30 days (HR=0.4, 95%CI 0.2-0.9, p=0.03) and 90 days (HR=0.4, 95%CI 0.2-0.8, p<0.01) compared to standard care [37].

Functioning

Functioning was an outcome in 3/8 studies: primary in 1/8 [36] and secondary in 2/8 [30,38]. Overall, evidence on the impact of nutrition education on functional abilities was either insufficient or unconvincing. In Pedersen et al 2016 (n=208) the proportion of older adults who maintained or improved their Activity of Daily Living (ADL) score (measured by the modified Barthel-100 index) was higher (96%) in those who received a nutritional intervention via home visit following discharge from hospital compared to those who had either a telephone consultation (75%) or standard care (72%) (p<0.01). However, the median change in Barthel-100 score was not different across groups (p=0.3) [36]. Similarly, Fernandez-Barres et al found no difference in functioning between the intervention and control group following education of caregivers [38].

Physical performance

Physical performance was assessed in two studies, one as a primary [30] and another as a secondary outcome [36]. A nutrition intervention alone (comprising one individual dietary counselling session and 5 group sessions over a 12-week period) was not found to have any significant effect on physical performance (muscle strength, balance, and mobility) compared to control. Physical training had a positive effect on muscle strength, but this was not augmented by the addition of a nutritional component to the intervention [30].

Pedersen et al (2016) measured physical performance as a secondary outcome but found no differences in chair stand, grip strength or mobility-tiredness score between those who received a nutritional intervention following discharge from hospital (home visit/telephone consultation) and the control [36].

Cognition

Cognition was measured as a secondary outcome in one study [38]. Nutritional education of caregivers made no difference in cognition scores of older adults as measured by Pfeiffer's test [38].

Mood

Mood was a secondary outcome in two studies [36,38]. Education of caregivers had no effect on depression scores measured by Yesavage Depression Scale in Fernandez-Barres study [38]. Depression was also measured by Geriatric Depression Scale (GDS) as a secondary outcome by Pedersen et al (2016) and no difference was found between participants who received a home visit, a telephone consultation and the control group [36].

Quality of life

Quality of life was assessed in one study only as a secondary outcome, measured by Short Form health survey (SF-36), and no difference was found between people who received a home visit, telephone consultation and the control group [36].

DISCUSSION

In this systematic review we identified nine papers reporting on eight studies (7 RCTs and 1 pre/post intervention study) testing the effectiveness of nutritional education interventions to

prevent or treat malnutrition in community-dwelling older adults. We found some evidence that nutritional education may have a positive effect on the nutrition status of older people, although findings were not consistent across the studies and there were methodological limitations. Group education was shown to improve reported dietary intake in older people who were attending a community centre for lunch and eating inadequately [32]. Nutrition education incorporating behaviour change techniques was found to be more effective in reducing nutritional risk compared to traditional education [35]. Group education of caregivers, followed by individual dietary monitoring for 6 months, was found to improve the MNA score in dependent older adults [38]. However, the change was small and may not have been clinically significant because the mean MNA score post-intervention still stratified participants as 'at risk of malnutrition'. Nutritional counselling delivered at home following discharge from hospital may reduce the risk of readmission and help maintain functioning [36,37]. Self-help education via personalised letters (with or without a booklet) may reduce nutritional risk [33]. Education aiming to increase protein intake did not achieve significant results compared with standard care, although an increase in protein and energy intake was reported in the intervention group at 6 months compared to baseline, and there was significant effect seen within the male caregiver subgroup. Although dietary knowledge was reported to increase following delivery of nutritional education, nutritional education alone was not found to have any effect on physical performance. There is insufficient evidence available to reliably comment on the effect nutritional education has on mood, cognition and quality of life of older people and no studies that report on the cost-effectiveness of such interventions.

We identified two other potentially eligible studies for inclusion in this review, but we were unable to source a full-text in English to assess in detail. From their abstracts, one was an uncontrolled pre- post- evaluation (n=70) of a community-based nutrition education programme on the quality of the diet of older people in Shanghai, China. The education

consisted of bimonthly nutritional guidance in combination with community publications, panel discussions and individual interviews. They reported that the intervention improved dietary quality based on 3-day self-reported intake, scored using the Diet Balance Index (DBI) at baseline and 12 months after the intervention [27]. The other study was an intervention study (n=183) testing the effect of nutrition education on community-dwelling elderly women in Korea, where the intervention group received a weekly home visit nutrition education delivered by a dietitian over 4 months. The intervention was reported to increase nutritional knowledge and attitude, as well as intake of energy, protein, calcium, iron, phosphorus, thiamine and riboflavin ($p<0.05$). Whereas the MAR (Mean Adequacy Ratio) for nutrient intake increased significantly in the intervention group compared to control, differences in the mean change of anthropometric and biochemical indices between the intervention and control groups were not significant [26]. For both of these studies we were unable to assess risk of bias or study quality. From research of the literature, it is clear that nutrition education is most often delivered and its impact assessed as part of a wider intervention. For example, a study that was not included in this review examined the effect of education with cooking demonstrations and provision of food samples. Nutritional status measured by MNA was found to improve only when three 1-day free food samples were provided each week for 3 weeks, as opposed to one 1-day free food sample a week for 3 weeks. However, adherence to the intervention was very poor [31]. A previous systematic review including RCTs before 2008 with much broader inclusion criteria (e.g. including disease-specific dietary interventions and interventions where nutritional education was part of a more complex intervention) reported that nutrition education or advice can be used to positively influence diet and improve physical function [43].

Moreover, a number of relevant excluded studies combined nutrition education with oral nutritional supplementation (ONS). One systematic review and meta-analysis of nutritional intervention studies in malnourished, community dwelling older people, consisting of dietary

advice and/or oral nutritional supplements (ONS) showed a modest effect on weight gain (standardized mean difference 0.210 kg; 95% CI 0.03,0.40) and no effect on grip strength, whereas the effects on nutritional intake and activities of daily living were inconsistent across studies [44]. An older Cochrane review of RCTs (2011) investigating dietary advice (with or without ONS) in people with disease-related malnutrition also had positive findings; it identified a significant change in weight and improved mid-arm circumference between groups when comparing dietary advice to no advice for interventions lasting greater than 12 months, and when all studies were combined, although there was significant heterogeneity in the combined analysis [45].

The impact of individualised dietary counselling combined with varied food fortification for at-risk older patients following discharge from hospital was investigated by a further systematic review and meta-analysis, combining data from four RCTs testing food fortification advice and/or additional snacks or drinks (either homemade or ONS), which showed a significant increase in energy intake ($p<0.001$), protein intake ($p<0.001$) and body weight ($p=0.03$). There was no significant effect identified on physical function assessed using hand grip strength, and no effect on mortality [46]. However, it is not possible in any of these reviews [44,45,46] to distinguish between the impact of dietary counselling alone and that of ONS administration.

A more recent systematic review and meta-analysis of RCTs across different health care settings (hospital, community, institutional care), investigated the effect of dietary counselling, ONS or both on energy intake and weight. Stratified analysis by type of intervention demonstrated a significant increase of energy intake only for dietary counselling in combination with ONS (OR:2.28; 95% CI 1.90, 2.73), and the intervention effect was greater for women, older participants, and those with lower BMI. Regarding weight gain, a significant intervention effect was observed for dietary counselling (OR:1.40; 95% CI 1.14, 1.73) and dietary counselling in combination with ONS (OR:2.48; 95% CI 1.92, 3.31) [47]. Four studies

were included in this subgroup meta-analysis studying the effect of dietary counselling, among which one was conducted in a hospital setting [48], two studies had recruited patients before discharge from hospital and followed them on in the community [49,50] and one recruited participants in the community [51]. These interventions were assessing the effect of dietitian input, including education but also including other complementary interventions where indicated, such as meals-on-wheels [50], additional nutritional supplements [48,49,50,51] or tube feeding [51] if needed. Other systematic reviews of studies identified conducted in other settings (e.g. hospital) [52] and in specific populations (e.g. dementia) [53,54] have shown variable results and they do not focus on nutrition education in particular.

Strengths and limitations of the review

The main strength of this review is the rigorous methodology. Two independent reviewers assessed titles and abstracts, read full texts, assessed risk of bias and extracted data from the studies. Meta-analysis was not possible due to the heterogeneity of interventions, methodologies and outcome measures.

The quality of a systematic review is always affected by the strengths and weaknesses of the included studies. In this case most of the studies we identified were hampered by poor methodology, low sample size and high rates of loss to follow-up. The majority of trials were either underpowered or without a power calculation. Two of the included studies were small pre-/post-intervention studies, and the limitations of assessing risk of bias in this type of studies by using existing tools such as the Cochrane Collaboration's Tool have been recently described [55]. Other limitations were the lack of consensus around definition of malnutrition across different studies and the low or insufficiently reported adherence to the interventions tested.

Another limitation is the lack of evidence of effectiveness in hard health outcomes, for example physical performance and functioning. Outcome measures such as reported dietary intake may

be subject to recall bias, whereas outcomes such as dietary knowledge contain a subjective element and do not necessarily translate into improved dietary intake. Moreover, most of the studies had a short period of intervention and/or follow up which does not allow for any conclusions to be made on whether any difference in health outcomes would be sustainable over time. Finally, we did not search grey literature which means some smaller studies may have been missed.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The research studies that we identified showed that nutritional education can be delivered by a range of community professionals including nurses, dietitians, or other trained staff. Findings were mixed with three of these studies [32,33,35] showing some evidence that nutritional education may reduce nutritional risk. In two studies the intervention included training caregivers of dependent older adults. Among the latter, one intervention was targeted at caregivers only [38], which was reported to reduce nutritional risk of older adults, and another was targeted at older people and their home carers [36,37], which was found to reduce the risk of readmission and maintain functioning. This could prove especially important for the delivery of good quality care and nutrition support for those older adults who have complex needs and are at risk of malnutrition. Although the number of studies investigating the effectiveness of methods aimed at changing behaviour in the older population is limited, the implementation of goal-setting and other behaviour change techniques to support nutrition in later life is worthy of further exploration.

However, the above findings need to be interpreted with caution. No recommendations to inform practice can be made at present based on the existing studies which are of low or moderate quality, of short intervention length and follow-up. Better quality studies are needed in the future, with careful selection of study participants. In order to determine if nutrition

education is effective to reverse or reduce the risk of malnutrition, only participants who are at risk of malnutrition/malnourished based on a formal assessment with a validated tool should be included. Selection of a clinically meaningful primary outcome measured via a validated tool is very important and necessary for an appropriate sample size calculation.

Given the rising social care demands and health-related costs associated with frailty and malnutrition, focussing on hard health outcomes is of the essence to test the effectiveness of nutrition education. Furthermore, longer periods of follow up would allow the sustainability of such interventions to be tested. Finally, adherence to the interventions was generally low. Although this may be in part attributed to the frailty status of the older population at risk of malnutrition, it may also be due to limitations in the design of the interventions themselves. Further consideration should be given to suitability and acceptability of interventions and the steps that need to be taken to optimise engagement in future trials.

CONCLUSION

Although nutritional education interventions in community-dwelling older adults may have the potential to improve outcomes such as nutritional risk and risk of readmission to hospital, the strength of currently available evidence is poor, with significant methodological limitations, and it does not allow for specific recommendations to be made. It is evident from this review that we need further high quality randomised controlled trials to test the clinical and cost-effectiveness of community-based nutritional education for older adults living in the community, with sufficient follow-up to determine longer-term outcomes.

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Figure 1. PRISMA flow diagram.

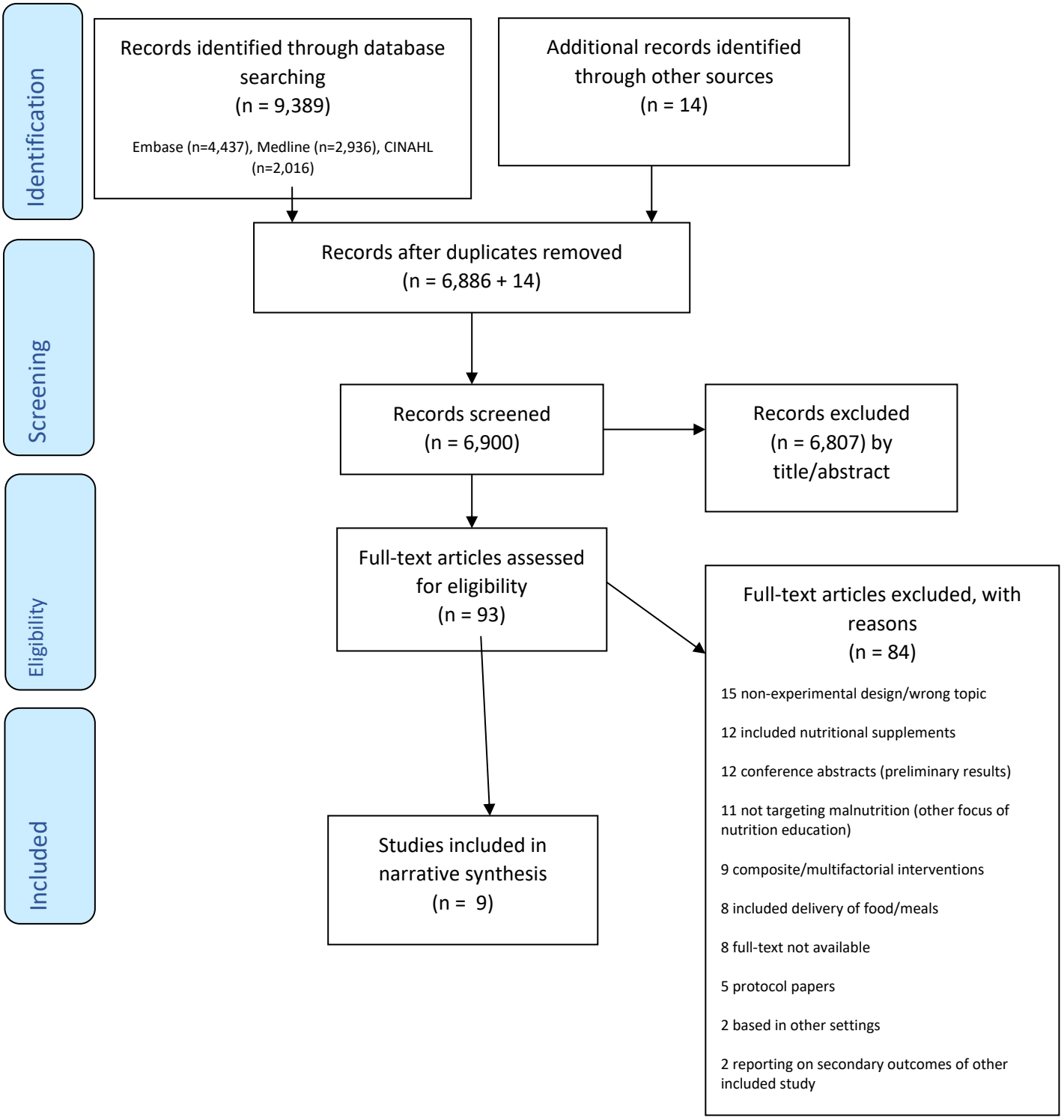

Figure 2. Risk of bias assessment.

Table 1. Description of studies and interventions included in the review.

First author, year Setting, country	Study design	Study population	Sample size (n randomised) Mean age (years) Women (%) (I: Intervention, C: Control)	Intervention (content)	Duration of intervention Professional delivering the intervention Frequency/ duration of sessions	Control	Follow up period n (%) completing follow up (f/u) Outcomes assessed	Main findings
Kunvik, 2018 [39]	RCT	Community-dwelling caregivers aged ≥65, living at home, normal cognition (MMSE ≥25)	N=79 (I: 40, C: 39) 73.9 54.5%	Tailored nutritional guidance consisting of 1 home visit + group discussions/ cooking courses	6 months Trained nutritionist Home visit lasting 1-2 hours + Either 4 group discussions (each lasting 1.5-2 h) or 2 cooking courses focusing on protein-rich and traditional foods (each lasting 2.5 h)	Normal community care if necessary + a booklet about healthy nutrition	6 months Intervention: n=34 (85%), among whom 28 (70%) had insufficient protein intake at baseline Control: N=35 (89.7%), among whom 27 (69.2%) had insufficient protein intake at baseline 1°: Protein intake 2°: Energy intake	• There were no significant differences between the groups, but there was a significant increase in protein intake within the intervention group (p=0.038). • There was no significant difference in energy intake between I and C groups, but there was a significant difference in energy intake within the intervention group (p=0.043). • Subgroup analyses made with male caregivers showed that protein intake increased among the male intervention group and decreased in the male control group (p=0.007). There was

								also a borderline significant change in energy intake, which increased among the male intervention group and decreased among the male control group (p=0.05).
Fernandez-Barres, 2017 [38] 10 primary care centres, Spain	RCT	Aged ≥65, enrolled in local home care programme, dependent on a caregiver, at risk of malnutrition	n=173 (I: 101, C:72) I: 84.3yrs C: 85.4yrs I: 71.3% C: 63.9%	Nutrition education (general information about food, healthy diet and food choices, dietary adaptation, basic cooking techniques)	6 months Nurses • Individual session • One-hour group session in a group of 15 caregivers Monthly dietary monitoring of the patient for 6 months in the presence of the caregiver	Regular home care visits, where nurses and doctors provided care to patients	6 and 12 months n=139 (80.3%) completed 6m f/u n=111 (64.2%) completed 12m f/u <u>1°</u>: Nutritional risk (MNA) <u>2°</u>: Anthropometric measurements (BMI, MUAC, CC) Consumption of food (food frequency questionnaire) Biochemical markers (serum albumin, prealbumin, haemoglobin, cholesterol) Physical functioning: ADL (Modified Barthel-100)	• Significant improvement of nutritional risk in the intervention group, compared to control. At 6 and 12 months of follow-up mean MNA scores increased from 20.6 in the intervention group to 21.7 and 21.4 respectively (p<0.001) • Increase in nutritional knowledge by 1.5 points (8.2±1.4 vs. 9.7±1.2, p<0.001) • Increased egg consumption (p=0.018), protein intake (p=0.050), polyunsaturated fatty acid intake (p=0.006), folate (p=0.041), and vitamin E (p=0.002) • No differences in functioning, cognition, mood or biochemical markers

							Cognitive function (Pfeiffer's test) Mood (Yesavage Depression Scale) Dietary knowledge (11-item questionnaire designed by researchers)	
Pedersen, 2016, 2017 [36,37] Participants' homes or by telephone, Denmark	RCT	Malnourished or at risk of malnutrition, aged >75 living at home and alone, able to speak Danish and communicate by phone	n=208 (HV:73, TG: 68, CG: 67) 86.1 years (HV: 86.4yrs TG: 85.6yrs CG: 86.3yrs) HV:78% TG:90% CG:82%	Individualised nutritional counselling delivered as follow up home visits after discharge from hospital The intervention was delivered to patient and their daily home carer	4 weeks Clinical dietitian • Home visit at 1, 2 and 4 weeks post discharge from hospital • 3 sessions were scheduled • Home visits lasted 45 minutes Telephone consultations lasted 15 minutes	Standard care during hospital stay and no follow up at home	8 weeks n=157 (75%) completed 8-week f/u 1° [36]: Functioning (ADL) (Modified Barthel-100 Index) 1° [37]: Readmission to hospital at 30 days and 90 days 2° [36]: Physical performance (chair stand, hand grip strength, CAS) Quality of life (SF-36) Depression (DL, GDS) Tiredness (Mob-T)	• All three groups improved their ADL scores, but the median change in Barthel-100 was not significant across groups • Home visit participants had a lower risk of readmission to hospital compared to control at 30 days after discharge (HR 0.4, 95% CI 0.2-0.9, p=0.03) and 90 days after discharge (HR 0.4, 95% CI 0.2-0.8, p<0.01) • No change in mean MNA score across the groups • No significant difference was found between the telephone consultation group and the control group at either 30 days or 90 days after discharge.

							Nutritional status (MNA)	
Francis, 2014 [35] 4 urban congregate meal centres, Iowa, USA	RCT	Recipients of local community congregate meal programme, aged 55-88	n=73 72.6 56%	Theory-based newsletter nutrition education (revised Chef Charles programme) Newsletter based group nutrition education programme. An educator discusses the content of the newsletter following an instructor's guide. The revised programme includes easier to prepare recipes, utilisation of more lists than paragraphs, and goal-setting.	6 months Chef Charles educator Duration: 30 min Frequency: Once a month	Traditional CC (Chef Charles) programme	6 months n=60 (82.2%) (I: 29, C: 31) completed the programme <u>1°</u>: Nutritional risk and reported dietary intake (DST) <u>2°</u>: Self-efficacy for preventive nutrition (5-question self-efficacy scale) Food security (US Household Food Security Survey Module: Six-Item Short Form) Programme satisfaction (evaluation about their experience)	• Participants in the intervention group reported a higher proportion of vegetable (1.93 DST points; p=0.019) and dairy (0.07 DST points; p=0.044) consumption and an overall significant improvement in dietary intake (4.2 DST points; p=0.042) compared to the control • No differences were noted for self-efficacy or food security and programme satisfaction between the two groups.
Locher, 2013 [34]	Feasibility RCT	Aged ≥65, homebound with	n=40	Behavioural Nutrition	4 weeks	Usual care (whatever	60 days	

Participants' homes, Alabama, USA		insufficient caloric intake or weight loss >2.5% over 6 months, either acute illness or chronic condition, able to communicate alone or with aid of a carer, receiving Medicare Home Healthcare	(initial sample size calculation 42, 40 were randomised, 34 included in analyses 81.4 82.3%	Intervention for Community Elders (B-NICE) Initial home visit by a dietitian, self-management education approach, providing both verbal and written instructions on how to improve caloric intake, collaborative goal-setting with participant/caregiver (maximum of 3 goals were set that were short-term, specific and measurable) Self-management support call at 1,2 and 4 weeks	Dietitian Initial home visit and 3 follow up visits at 1, 2, and 4 weeks Duration of sessions not specified	care or treatment a patient was receiving for any reason, not specific to nutrition)	n=34 (85%) (I: 18, C: 16) <u>1°</u>: Caloric intake (self-reported using aggregated data from three 24-h dietary recalls) Weight (measurement)	• No differences in caloric intake or body weight between groups

Southgate, 2010 [33] Questionnaires, letters and booklets sent by post Ontario, Canada	Pre/post intervention study	Non-institutionalised members of one local recreation centre for seniors	n=61 (Pre-test A: 30 B: 31) 49.2% >75y 50.8% <75y A: 70.4% B: 57.1%	Group A: Personalised letters and booklets ('Food for aging well: A guide to healthy eating for older adults') Group B: Personalised letters only	1 month Self-help education One-off educational material posted to participants 2-4 weeks after initial questionnaire	n/a (pre- post-intervention comparison)	1 month n=44 (72%) Post-test A: 22 B: 22 1°: Nutritional risk (SCREEN II) 2°: Dietary knowledge (DKQ)	• Nutrition risk measured by SCREEN II was significantly lower post intervention (p=0.040). • Dietary knowledge improved post intervention (p<0.0001). Group A participants who received the full intervention experienced a greater increase in knowledge than Group B participants (p=0.018).
Rydwik, 2008 [30] City of Solna, Sweden	RCT	People receiving home services with: a) Unintentional weight loss ≥5% and/or BMI ≤20, and b) low physical activity	n=96 (N: 25, T: 23, T&N: 25, C: 23) 83.2 60.4%	Three groups: Nutrition (N) Training (T) Training and Nutrition (T&N) Specific individualised diet counselling and group session education, plus general physical training advice Individual dietary counselling session based on food	12 weeks Dietitian One individual session lasting 1 hour + Five group sessions	Control C (n=23): general physical training advice and general diet advice	12 weeks and 6 months after the end of the intervention n (%) completed f/u: not reported Physical performance (muscle strength, chair-stand test, balance, TUG, walking speed) [26] Functioning: ADL (FIM), IADL (IAM) [26] Nutritional measures: anthropometry (BMI, skin folds, FFM), energy intake (four-day food record) [26]	The nutrition intervention did not show any significant results.

				record, advice as per individual's needs Five group sessions on nutritional needs of older people, meal frequency and cooking methods			Health beliefs (barriers, benefits, self-efficacy and social support - put into statements, rating 1-10) [26]	
Mitic, 1985 [32] Salvation Army Centre, Buffalo, New York, USA	RCT	Older people who were attending for lunch at a local community centre and were classified as eating inadequately	n=66 (I: 34, C:32) range 67-74 gender % not reported	Phase I (Nutrition skills experiences): dietary categorisation and meal preparation. Phase II (Cognitive nutrition instruction): introduction to nutrients, myths and misconceptions re. nutrition, economical/ wise methods of shopping - via lectures, slide presentations,	4 weeks not reported Group sessions (length and frequency not reported)	No instruction	10 weeks (6 weeks after the end of the intervention) n (%) completed f/u: not reported 1°: Reported dietary intake (24-h dietary recall)	• Improved adequate eating (62% of those who attended the programme vs. 9% of those who had not attended, p<0.05). • Improved adequate eating at the end of the follow up period (73% of the experimental group vs. 9% of those in the control group, p<0.05).

				demonstrations, questions and group discussions. Phase III: (Affective instruction): small group discussions on personal dietary habits, allowing to accept responsibility for own nutritional wellbeing.				

Abbreviations

ADL: Activities of Daily Living

BMI: Body Mass Index

C: Control

CAS: Cumulated Ambulation Score

CC: Calf Circumference

CG: Control Group

DKQ: Dietary Knowledge Questionnaire

DL: Depression List

DST: Dietary Screening Tool

FFM: Fat-Free Mass

FIM: Functional Independence Measure

GDS: Geriatric Depression Scale

HV: Home Visit

I: Intervention

IADL: Instrumental Activities of Daily Living

IAM: Instrumental Activity Measures

MNA: Mini Nutritional Assessment

Mob-T: Avlund Mobility-Tiredness Scale

MUAC: Middle-Upper Arm Circumference

N: Nutrition

RCT: Randomised Controlled Trial

SCREEN II: Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II

SF-36: 36-item Short Form Survey

T: Training

TG: Telephone Group

T&N: Training and Nutrition

TUG: Timed Up and Go