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SPECIAL ISSUE REVIEW

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Interventions to prevent and treat malnutrition in older adults to be carried out by nurses: A systematic review

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Abstract

Aims and objectives: To identify interventions to prevent and treat malnutrition in older adults, which can be integrated in nursing care, and to evaluate the effects of these interventions on outcomes related to malnutrition.

Background: Older adults are at great risk for malnutrition, which can lead to a number of serious health problems. Nurses have an essential role in nutritional care for older adults. Due to a lack of evidence for nursing interventions, adequate nursing nutritional care still lags behind.

Design: Systematic review.

Method: We searched for and included randomised controlled trials on interventions, which can be integrated in nursing care for older adults, to prevent and treat malnutrition. We assessed the risk of bias with the Cochrane tool and evidence for outcomes with the GRADE. The PRISMA statement was followed for reporting.

Results: We included 21 studies of which 14 studies had a high risk of bias. Identified interventions were oral nutritional supplements, food/fluid fortification or enrichment, dietary counselling and educational interventions. In evaluating the effects of these interventions on 11 outcomes related to malnutrition, significant and non-significant effects were found. We graded the certainty of evidence as very low to moderate.

Conclusion: Although slight effects were found in protein intake and body mass index, there is no convincing evidence about the effectiveness of the four identified interventions. There seems no harm in using these interventions, although it should be kept in mind that the evidence is sparse. Therefore, there is a need for high-quality research in building evidence for interventions in nursing nutritional care.

Relevance to clinical practice: Nurses can safely provide oral nutritional supplements and food/fluid fortification or enrichment, and give dietary counselling and

education to older adults, as they are well placed to lead the essential processes of nutritional care to older adults.

KEYWORDS

basic nursing care, fundamental care, malnutrition, nurses, nursing care activities, nutritional care, older adults, oral nutrition, systematic review

1 | INTRODUCTION

Malnutrition is a frequent and major problem among older adults (The Dutch Malnutrition Steering Group, 2017; Volkert et al., 2019). The prevalence of malnutrition and risk for malnutrition in older adults across settings varies considerably: up to 30% of older adults in the community (Cereda et al., 2016), 56%–63% of older community-dwelling adults who receive home care (Cereda et al., 2016; Yang et al., 2011), 48%–76% of older adults in hospitals (Burks et al., 2017; Cereda et al., 2016; VanderWee et al., 2010), up to 78% of older adults in nursing homes and institutional long-term care (Cereda et al., 2016). In older adults with cognitive impairment and geriatric syndrome, the prevalence is up to 83% and 44%, respectively (Meyer, Gräske, Worch, & Wolf-Ostermann, 2015; Saka, Kaya, Ozturk, Erten, & Karan, 2010). This substantial variance in malnutrition prevalence data reported across studies could be explained by genuine population differences, combined with the lack of a gold standard for malnutrition screening, diagnosis and monitoring (Cederholm et al., 2015).

Malnutrition is a complex issue in older adults due to diversity in aetiology and wide range of determinants (Volkert et al., 2019). Malnutrition is associated with a variety of diseases and related conditions such as poor oral health (Burks et al., 2017), change in taste (Vanderwee et al., 2010), difficulties chewing and swallowing (Vanderwee et al., 2010), lower cognitive and functional status (Naseer, Forssell, & Fagerström, 2016), infections (Vanderwee et al., 2010) and depressive symptoms (Vanderwee et al., 2010). Also, social factors such as living alone are associated with malnutrition (Westergren, Hagell, & Sjödahl Hammarlund, 2014). The presence of malnutrition leads to a reduced quality of life (Luger, Haider, et al., 2016), increased morbidity (Naseer et al., 2016; Vanderwee et al., 2010), mortality (Yang et al., 2011), use of healthcare facilities and costs (Vanderwee et al., 2010; Yang et al., 2011).

Nurses have an essential role in malnutrition risk screening, nutritional treatment and monitoring to ensure appropriate delivery of oral nutritional care (Cederholm et al., 2017; The Dutch Malnutrition Steering Group, 2017; Volkert et al., 2019), which is the first choice in nutritional treatment for older adults with malnutrition and risk for malnutrition (Volkert et al., 2019). Nurses perform this role in different nursing care settings (Volkert et al., 2019). Nursing activities regarding nutritional care are essential elements of basic nursing care (Kitson, Conroy, Wengstrom, Profetto-McGrath, & Robertson-Malt, 2010) and should be supported by evidence for effectiveness. However, this evidence is often lacking (Zwakhalen et al., 2018).

What does this paper contribute to the wider global clinical community?

- Malnutrition can be a major problem to vulnerable groups of older adults. Nurses can perform nutritional care to prevent and treat malnutrition in older adults.
- In this review, four types of interventions, which can be used in nursing nutritional care, were derived from randomised clinical trials. These interventions have contradictory effects on 11 outcomes related to malnutrition. The evidence is not convincing, due to high risk of bias and low certainty of evidence, but there seems no harm in using these interventions.
- In preventing and treating malnutrition in older adults, nurses should provide oral nutritional supplements and food/fluid fortification or enrichment, and give dietary counselling and education in daily nutritional care.

In a number of systematic reviews and meta-analyses, one or more evidence-based interventions for the prevention and treatment of malnutrition to support oral nutritional care are described (Allen, Methven, & Gosney, 2013; Avenell, Smith, Curtain, Mak, & Myint, 2016; Bandayrell & Wong, 2011; Howson, Sayer, & Roberts, 2017; Milne, Potter, Vivanti, & Avenell, 2009; Morilla-Herrera et al., 2016; Munk et al., 2016; Rasmussen et al., 2018). These systematic reviews and meta-analyses have illustrated contrasting results with both significant and nonsignificant effects on outcomes related to malnutrition. Studies with sufficient risk of bias were included in these systematic reviews and meta-analyses, which makes cautious interpretation of the results necessary. Most of the systematic reviews and meta-analyses focus on rather specific populations and/or specific conditions and/or specific care settings.

None of the systematic reviews and meta-analyses focuses on all types of interventions. In the current healthcare environment, nursing care is increasingly directed towards older adults with multiple comorbidities. This population has been excluded from these previous systematic reviews and meta-analyses. Moreover, the results have not been translated into nursing care activities, and as a consequence, these results are not applied into nursing practice. This is unfortunate, as multimorbidity among older adults is common, and malnutrition is a serious disease (Volkert et al., 2019).

In conclusion, evidence-based nursing interventions to support oral nutrition that might be effective for prevention and treatment of malnutrition in older adults with various conditions, across diverse settings are lacking. Also, the interventions evaluated in existing literature have no explicit conceptualisation of the role of nurses in nutritional care for older adults. Therefore, a complete overview of interventions, which can be incorporated in nursing care, is missing.

2 | AIMS

We systematically reviewed the literature to identify interventions to prevent and treat malnutrition in hospitalised, institutionalised and community-dwelling older adults with different health conditions, which can be integrated in nursing care. We also evaluated the reported effects of these interventions on outcomes related to malnutrition.

3 | METHODS

In conducting and reporting this systematic literature review, we followed the PRISMA Statement (see File S1) and Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011; Moher et al., 2009).

3.1 | Search strategy

For identifying eligible studies, a systematic search was performed in the databases PubMed, EMBASE, CENTRAL, CINAHL and PsycINFO. The search queries were formulated by one reviewer (DtC) using the PICO framework and validated independently by another reviewer (RE). Search queries included keywords from the title and abstract, and index terms from the databases. Limitations to the search were made on publication type ((controlled clinical) trial) and language (English). In the last decades, nursing care has changed under influence of huge changes in health care (Zwakhalen et al., 2018). Therefore, the publication date was limited from September 2005–September 2018 to find up-to-date publications with potential interventions, which might fit with current nursing care. The PICO, search queries and outcomes of the search strategy can be found in Appendix S1. In addition, reference lists of assessed articles were screened manually (DtC) and study authors were contacted (DtC) to identify relevant studies.

3.2 | Eligibility criteria

The eligibility criteria are displayed in Table 1. We included adults aged 70 and above, because malnutrition is related to frailty and multimorbidity, which amongst other factors, is dependent on increased age (Volkert et al., 2019). Also, inclusion required the intervention to be feasible for nurses to deliver in direct client or patient care. Feasibility was assessed using three items from the feasibility section of the Dutch version of the checklist for randomised clinical trials of the Cochrane Collaboration (Higgins & Green, 2011). These items were as follows: "Similarity between the patients of the study and own patient(s)", "Feasibility in own clinical practice" and "Advantages and disadvantages of treatment for the patient". We extended the terms "own patient(s)" and "own clinical practice" to patients or clients who met the eligibility criteria of our study and who are users of the Dutch healthcare system. This was to prevent excluding patients or clients in advance and hence create selection bias. A different composition of two reviewers with considerable work experience within nursing practice and/or nursing education discussed feasibility until agreement was reached. These two reviewers were DtC with RV or AO; DtC or RV with another member of the project group. The project group consisted of nurse lecturers and/or researchers. Their role in this systematic review was to assess methodological quality of studies and feasibility of interventions in nursing care. A study was included if the effects on malnutrition-related outcomes, which can potentially be assessed by nurses, were reported. Malnutrition-related outcomes were derived from national and international guidelines (Cederholm et al., 2017; The Dutch Malnutrition Steering Group, 2017). Assessment of these outcomes by nurses was judged by two reviewers (DtC and RE) based on: (a) the outcome belongs to the domain of nursing nutritional care; and (b) the outcome is not reserved for other professions. Per outcome, both criteria were also discussed with a dietitian and a physiotherapist, who are both scientific researchers, until agreement was achieved. These outcomes were as follows: (a) outcomes on nutritional assessment; (b) outcomes on nutrition intake: body weight, energy and protein intake; (c) outcomes on body composition: body mass index (BMI), mid-upper arm circumference, calf circumference, waist circumference, triceps skinfold; and (d) outcomes on physical function: handgrip strength and activities of daily living (ADL) function. Studies were included when sample size was sufficiently based on an a priori analysis. This was calculated in the statistical package R by one reviewer (DtC) and validated by a second reviewer (RE). Power was determined at 80% and the *p*-value at 5% (two-sided). Information to calculate sample size was abstracted from the study itself. A prerequisite was reporting of this information in the article. Studies on older adults diagnosed with a rare disease or in the end-stage of a disease were excluded. In these older adults, nutritional care might be different than in older adults with more common conditions, like chronic obstructive pulmonary disease, diabetes mellitus, cardiovascular diseases or with older adults who were healthy. We excluded studies focussing on cost-effectiveness and economic health care. However, we did use these studies as a source to find randomised clinical trials on which these studies were based.

3.3 | Study selection

After selection on titles, all titles and subsequent abstracts from studies remaining were screened for eligibility in three rounds by two reviewers per round (DtC with RE [1st], RV [2nd], AO [3rd]). Differences in judgement were discussed and resolved by consensus.

TABLE 1 Eligibility criteria

Inclusion criteria	Exclusion criteria
• Older adults (mean or median age ≥70 years), who were in hospital, institutionalised care or living in the community • Older adults with various common ageing conditions, like chronic obstructive pulmonary disease, diabetes mellitus, cardiovascular diseases or those who were healthy • The intervention described could potentially be carried out by nurses • Studies reporting the effects on malnutrition related outcomes, which can potentially be assessed by nurses: nutritional assessment, body weight, energy and protein intake, BMI, mid-upper arm circumference, calf circumference, waist circumference, triceps skinfold, handgrip strength and ADL function • Randomised intervention studies with comparison between an intervention and control group • Studies with sufficient sample size based on an a priori power analysis	• Older adults diagnosed with a rare disease or in the end-stage of a disease • Studies in which an intervention was part of a multicomponent intervention where this intervention could not be distinguished from the other components • Medication studies • Studies where the method of administration of the intervention was enteral by tube or through parenteral route • Intervention studies focusing on general healthcare services • Intervention studies focusing on material and technique • Intervention studies focusing on (quality) management • Intervention studies focusing on cost-effectiveness and economic healthcare

Abbreviations: ADL, activities of daily living; BMI, body mass index.

Next, full-text articles were read and screened by two reviewers (DtC with RV or AO).

3.4 | Assessment of methodological quality of studies

Methodological quality was assessed using the Dutch version of the checklist for randomised clinical trials of the Cochrane Collaboration (Higgins & Green, 2011). Full information about the methodological features of this checklist is illustrated in Appendix S2. The CONSORT 2010 checklist of information (Schulz et al., 2010) was used for judgement on reporting. A pilot for using both checklists was done on two included studies by three reviewers (DtC, RV, RE). The methodological quality of studies was independently assessed by two reviewers (DtC with RV or AO; DtC or RV with another member of the project group). Agreement was achieved in consensus meetings. Both the Cochrane Collaboration and the CONSORT 2010 checklist were used to fill in the revised Cochrane risk-of-bias tool for randomised trials (Higgins et al., 2016) and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method (Schünemann, Brożek, Guyatt, & Oxman, 2013). The risk of bias was determined with the Cochrane tool. The five domains of the risk-of-bias tool are presented in Appendix S3. The GRADE was used to rate evidence for outcomes across included studies.

3.5 | Data extraction

Using a structured process by one reviewer (DtC) and checked by another reviewer (RE), the following data were extracted: first author, year of publication, country of data collection, source of funding, study design, participant characteristics such as age, gender, nutritional status at baseline and screening or assessment tool used, number of participants in the study groups, setting, description of the intervention and control including intervention period, method of data collection and analysis, outcomes related to malnutrition, which could be assessed by nurses, methods used for measurement of outcomes and length of follow-up. For the results, a narrative synthesis method was employed, because data were not comparable due to heterogeneous interventions and outcomes.

4 | RESULTS

4.1 | Results of search

The searches in the databases yielded 2,535 citations (Figure 1). By contacting study authors, three additional records about ongoing trials were identified. Additionally, 86 articles were manually identified through reference lists of assessed articles. After removing 671 duplicates and excluding 1,855 articles after screening for eligibility, 98 articles remained. These were reviewed full text for eligibility and methodological quality assessment. Based on the eligibility criteria, 77 articles were excluded. A total of 21 articles were included in the narrative analysis.

4.2 | Characteristics of the studies

Table 2 shows the main characteristics of included studies. Of the included studies, 16 studies had a two-arm randomised controlled trial (RCT) design (Andersson, Hulander, Rothenberg, & Iversen, 2017; Beelen et al., 2018; Cramer et al., 2016; Deutz et al., 2016; Ekinci et al., 2016; Fernández-Barrés et al., 2017; Gariballa, Forster, Walters, & Powers, 2006; Kim & Lee, 2013; Luger, Dorner, et al., 2016; Munk et al., 2014; Myint et al., 2013; Neelemaat, Bosmans, Thijs, Seidell, & van Bokhorst-de van der Schueren, 2011; Rondanelli et al., 2016; Sharma et al., 2017; Stange et al., 2013; Veronese et al., 2014). One study had a two-arm cluster RCT design (Salvà et al., 2011), and three studies had a three-arm RCT design (Botella-Carretero et al., 2008; Hin et al., 2017; Pedersen, Pedersen, & Damsgaard, 2016). One study had a randomised crossover design (Ziylan, Kremer, Eerens, Haveman-Nies, & de Groot, 2016). The number of included participants ranged from

39–946. The percentage of participants who dropped out, were lost to follow-up or discontinued the intervention ranged from 0%–35.8%.

4.3 | Risk of bias of included studies

Three studies were considered to have a low risk of bias (Hin et al., 2017; Luger, Dorner, et al., 2016; Neelemaat et al., 2011), whereas four studies showed some concerns (Andersson et al., 2017; Deutz et al., 2016; Gariballa et al., 2006; Kim & Lee, 2013), and 14 studies were assessed to be at high risk of bias (Beelen et al., 2018; Botella-Carretero et al., 2008; Cramer et al., 2016; Ekinci et al., 2016; Fernández-Barrés et al., 2017; Munk et al., 2014; Myint et al., 2013; Pedersen et al., 2016; Rondanelli et al., 2016; Salvà et al., 2011; Sharma et al., 2017; Stange et al., 2013; Veronese et al., 2014; Ziylan et al., 2016; Table 2). Main threats for the methodological quality were as follows: (a) blinding of participants, caregivers, assessors and/or research data analysts was either not performed in the study or reported in the article; (b) lack of reporting significance of differences in baseline characteristics between intervention and control group; (c) incomplete data for all outcomes and absence of intention-to-treat analysis; and (d) lack of transparency in complete reporting due to absence of detailed information from previously published study protocols. A summary of methodological features and items reported, and an overview of the five reviewed domains of the risk-of-bias tool for each of the 21 included studies is provided in Appendices S2 and S3, respectively.

4.4 | Participants

As shown in Table 2, the mean age of the participants ranged from 70.5–87 years. Most studies included participants who were admitted to a hospital, followed by studies including participants living in the community with or without home care, or nursing homes, or admitted to a rehabilitation institution. Included participants were healthy, frail or suffering from different conditions including malnutrition or risk for malnutrition, sarcopenia, dementia, hip or femur fractures, or chronic heart failure, acute myocardial infarction, pneumonia or chronic obstructive pulmonary disease. In most studies, malnutrition or risk for malnutrition at baseline was measured with different screening or assessment tools and ranged from 0%–100%. Additionally, other studies reported the mean score on the MNA, which ranged from 17.8–20.6, or the median score on the MNA short form (MNA-SF), which was 9, all scores indicating a risk for malnutrition. In the remaining studies, outcomes related to nutritional status, such as body weight, BMI, mid-upper arm circumference, triceps skinfold, handgrip strength, albumin or transferrin, were reported.

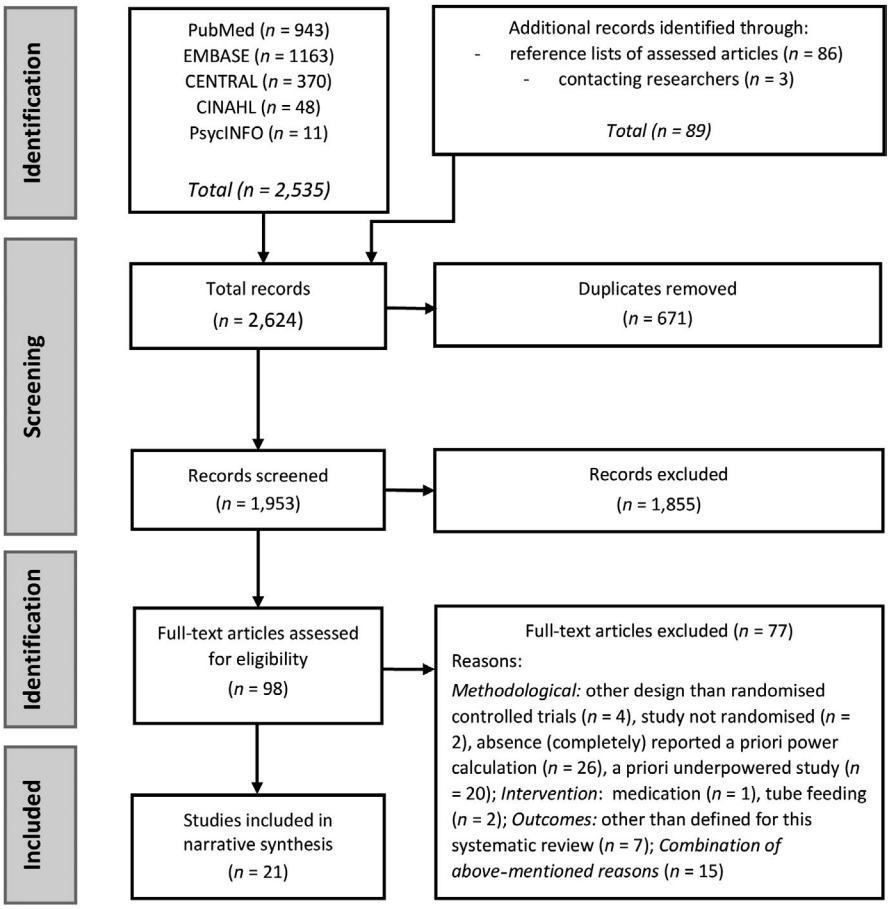

FIGURE 1 Flow diagram of study selection process recommended by the PRISMA Statement (Moher et al., 2009)

TABLE 2 Characteristics of included studies

Author (year), Country	Setting Participants IG, CG, (IG2)	Nutritional assessment[a]: Nutritional status at baseline IG, CG (IG2)	Intervention; Duration Control; Duration	Nutritional outcomes assessed by nurses (Time measurements)	Design Study quality[b]
Andersson et al. (2017) Norway, Sweden	Rehabilitation A (mean): 75.2, 75.5 F (%): 69, 75 C: At risk of malnutrition or malnourished *n*[c]: 52, 48	NRS–2002[d]: Score 3–4:88, 90 Score 5–7:12, 10	IG: Standard care during rehabilitation including general advice on nutrition, and nutritional counselling by telephone and at home with focus on good nutritional status after discharge; 10 weeks after discharge CG: Standard care including general advice on nutrition; during rehabilitation	Body weight (kg) (3 months)	RCT 4
Beelen et al. (2018) The Netherlands	Hospital A (mean): 77.7, 79.2 F (%): 55.2, 55.0 C: Admitted to the departments of geriatrics/internal medicine or pulmonary medicine, LOS ≥ 4 days, without risk of developing refeeding syndrome *n*[c]: 27–67, 32–80	MUST[d]: Score 1:13.4, 11.3 Score ≥2:22.4, 11.3	IG: Protein-enriched products added or replacing regular products besides standard energy and protein-rich hospital menu; 2 days after hospital admission until hospital discharge CG: Standard energy and protein-rich hospital menu; 2 days after hospital admission until hospital discharge	Energy intake (kcal, kcal/kg), protein intake (g, g/kg, EN%), protein intake per meal (g), protein intake: patients reaching 1.2 g/kg/day and 1.5 g/kg/day (%) (At day 4 in hospital)	RCT 1
Botella-Carretero et al. (2008) Spain	Hospital A (mean): 83.1, 83.7, 84.6 F (%): 90, 76.7, 70 C: Hip fracture requiring orthopaedic surgery *n*[c]: 30, 30, 30	MNA[d]: 18.7 ± 4.2, 19.4 ± 3.6, 20.5 ± 2.9	IG: Standard diet; during hospitalisation; protein powder, 10 g packet with 9 g protein and 38 kcal, 4 packets per day; start 48 hr after surgery and maintained after hospital discharge IG2: Standard diet; during hospitalisation; ONS, 200 ml with 18.8 g protein and 250 kcal, 2 bricks per day; start 48 hr after surgery and maintained after hospital discharge CG: Standard diet; during hospitalisation	Body weight (kg), energy intake (kcal/day, kcal/kg), protein intake (g/day, g/kg), BMI (kg/m^2), MUAC (cm), TSF (mm) (during hospitalisation)	RCT 3
Cramer et al. (2016) USA, Spain, Italy, UK	Community A (median): 77, 77 F (%): 62, 62 *C:* Malnutrition, sarcopenia *n*[c]: 39–131, 46–146	SGA[d]: B: 99.4, 100 C: 0.6, 0	IG: ONS, 220 ml with 330 kcal, 20 g protein, 11 g fat, 36 g carbohydrate, 1.5 g CaHMB, 499 IU vitamin D3, and additional nutrients, 2 servings per day; 24 weeks CG: ONS, 220 ml with 330 kcal, 14 g protein, 11 g fat, 44 g carbohydrate, 147 IU vitamin D3, and additional nutrients, 2 servings per day; 24 weeks	Body weight (kg), energy intake (kcal/day), protein intake (g/kg/day), BMI (kg/m^2), HGS (kg) (12 and 24 weeks)	RCT 3
Deutz et al. (2016) USA	Hospital A (mean): 77.7, 78.1 F (%): 52.4, 51.8 C: Congestive heart failure, acute myocardial infarction, pneumonia, or chronic obstructive pulmonary disease, malnutrition *n*[c]: 150–313, 137–309	SGA[d]: B: 87.9, 86.7 C: 12.1, 13.3	IG: HP-HMB ONS, 237 ml with 350 kcal, 20 g protein, 11 g fat, 44 g carbohydrate, 1.5 g calcium-HMB, 160 IU vitamin D and other micronutrients, 2 servings per day; during hospitalisation till 90 days postdischarge CG: Placebo ONS, 237 ml with 48 kcal, 12 g carbohydrate, 10 mg vitamin C, but no other nutrients, 2 servings per day; during hospitalisation till 90 days postdischarge	Nutritional status (SGA) (score), body weight (kg), ADL function (Katz Index) (score) (30, 60 and 90 days)	RCT 4

(Continues)

TABLE 2 (Continued)

Author (year), Country	Setting Participants IG, CG, (IG2)	Nutritional assessment[a]: Nutritional status at baseline IG, CG (IG2)	Intervention; Duration Control; Duration	Nutritional outcomes assessed by nurses (Time measurements)	Design Study quality[b]
Ekinci et al. (2016) Turkey	Hospital A (mean): 82.19, 83.07 F (%): 100, 100 C: Hip fracture treated with hemiarthroplasty, risk of malnutrition *n*[c]: 32, 30	NRS–2002[d]: Score 3:68.8, 53.3 Score 4:31.3, 46.7	IG: ONS, 220 ml with 3 g CaHMB, 1,000 IU vitamin D, and 36 g protein, in addition to the standard postoperative nutrition plan containing 1,900 kcal and 76 g protein, 2 bottles per day; 30 days CG: Standard postoperative nutrition plan containing 1,900 kcal and 76 g protein; NR	Body weight (kg), BMI (kg/m^2), MUAC (cm), CC (cm), TSF (mm), HGS (Kgf) (15 and 30 days)	RCT 1
Fernández-Barrés et al. (2017) Spain	Community with home care A (mean): 84.3, 85.4 F (%): 71.3, 63.9 C: Difficulties to perform ADL, be caregiver-dependent and have a caregiver, at risk of malnutrition *n*[c]: 63, 48	MNA[d]: 20.6 ± 2.0, 19.9 ± 2.7	IG: Nursing nutrition education sessions on preventing the increasing risk of malnutrition in dependent patients with one individual (for caregiver and patient) and one group session (for caregivers) and individual dietary monitoring of the patient at 6 and 12 months; 12 months CG: One visit to complete an initial assessment, receiving regular care during homecare visits and study-specific visits at 6 and 12 months; 12 months	Nutritional status (MNA) (score), body weight (kg), energy intake (kcal/day), protein intake (g/day), BMI (kg/m^2), ADL function (BI) (score) (6 and 12 months)	RCT 2
Gariballa et al. (2006) UK, United Arab Emirates	Hospital A (mean): 77.1, 76.3 F (%): 48.4, 46.4 C: Admitted to the hospital *n*[c]: 119–222, 106–223	Body weight (kg): 65.7 ± 13.7, 66.7 ± 13.1 BMI (kg/m^2): 25.0 ± 4.3, 25.2 ± 4.1 MUAC (cm): 28.0 ± 3.8, 28.3 ± 3.5 TSF (mm): 15.5 ± 6.5, 15.8 ± 6.6 Albumin (g/L): 37.9 ± 4.7, 37.8 ± 4.6 Transferrin (g/L): 2.1 ± 0.5, 2.2 ± 0.5	IG: ONS, 200 ml with 995 kcal and 100% of the reference nutrient intakes for vitamins for a healthy older person, 2 bottles per day; 6 weeks CG: Placebo ONS, 200 ml with 60 kcal and no other nutrients, 2 bottles per day; 6 weeks	Body weight (kg), BMI (kg/m^2), MUAC (cm), TSF (mm), ADL function (BI) (score) (6 months)	RCT 4
Hin et al. (2017) UK, USA	Community A (mean): 71, 72, 72 F (%): 49, 49, 50 C: Healthy, ambulatory *n*[c]: 102, 101, 102	Body weight (kg): 77 ± 17, 79 ± 15, 78 ± 15 BMI (kg/m^2): 27 ± 5, 28 ± 5, 27 ± 4 HGS (kg): 25 ± 11, 25 ± 11, 25 ± 11	IG: Supplementation with vitamin D3, 4,000 IU, daily; 12 months IG2: Supplementation with vitamin D3, 2,000 IU, daily; 12 months CG: Placebo, daily; 12 months	Body weight (kg), BMI (kg/m^2), HGS (kg) (12 months)	RCT 5

(Continues)

TABLE 2 (Continued)

Author (year), Country	Setting Participants IG, CG, (IG2)	Nutritional assessment[a]: Nutritional status at baseline IG, CG (IG2)	Intervention; Duration Control; Duration	Nutritional outcomes assessed by nurses (Time measurements)	Design Study quality[b]
Kim and Lee (2013) Republic of Korea	Community A (mean): 78.9, 78.4 F (%): 79.1, 79.6 C: Low income, gait speed <0.6 m/s, at risk of malnutrition or malnourished *n*[c]: 41, 43	MNA[d]: 17.9 ± 3.0, 17.9 ± 3.3	IG: ONS, 200 ml with 200 kcal, 12.5 g of protein, 4.7 g essential amino acids, 28 g carbohydrate, 4.5 g lipid, and micronutrients, 2 cans per day; 12 weeks CG: No treatment	Body weight (kg), energy intake (kcal/day), protein intake (g/day), MUAC (cm), HGS (kg) (12 weeks)	RCT 4
Luger, Dorner et al. (2016) Austria	Community A (mean): 83.0, 82.5 F (%): 85, 83 C: Recently discharged from hospital, (pre)frail, able to walk, at risk of malnutrition or malnourished *n*[c]: 39, 41	MNA[d]: At risk: 46, 44 Malnutrition: 5, 2	IG: Six strength exercises within a circuit training session and discussion about fluid intake, animal and plant protein intake and energy intake, both performed by nonprofessional volunteers, two times per week; 12 weeks CG: Social contact with nonprofessional volunteers and cognitive training, two times per week; 12 weeks	Nutritional status (MNA) (score and %) (12 weeks)	RCT 5
Munk et al. (2014) Denmark, Sweden	Hospital A (mean): 75, 74 F (%): 61, 55 C: Admitted to the departments Oncology, Orthopaedics, Urology, LOS ≥ 3 days, at risk of malnutrition *n*[c]: 41, 40	NRS–2002[d]: Score 3:29.3, 20	IG: Small dishes enriched with natural energy-dense ingredients and supplemented with protein powder served besides standard hospital food service with no restriction on amount; during hospitalisation with maximum 7 days CG: Standard hospital food; during hospitalisation	Body weight (kg), participants reaching ≥75% energy and protein requirement (%), energy intake (kJ, kJ/kg), protein intake (g, g/kg), HGS (kg) (During hospitalisation)	RCT 3
Myint et al. (2013) China	Hospital A (mean): 80.9, 81.7 F (%): 68.9, 63.3 C: Femur fracture surgically repaired *n*[c]: 54–61, 49–60	MUST[d]: High risk: 21.3, 15.3	IG: Usual care, additional oral vitamin D supplement, 800–1,000 IU and calcium, 1,200 mg, both daily; ONS, 240 ml with 250 kcal and 9–12 g protein, 2 bottles per day; within 3 days after hospital admission till discharge or 28 days CG: Usual care, additional oral vitamin D supplement, 800–1,000 IU and calcium, 1,200 mg, both daily; NR	Energy intake (kcal/day), protein intake (g/day), BMI (kg/m^2), MUAC (cm), TSF (mm) (During hospitalisation, at discharge, 4 weeks after discharge)	RCT 2
Neelemaat et al. (2011) The Netherlands	Hospital A (mean): 74.6, 74.4 F (%): 53.3, 57;1 C: LOS >2 days, admitted to different internal and surgical departments, malnutrition n[c]: 48–73, 31–74	BMI ≤ 20 kg/m^2: 55.2, 53.3 Weight change last month (kg): −4.5, −4.0 Weight change past 6 months (kg): −9.4, −9.1	IG: Standardised nutritional support with energy and protein-enriched diet, during hospital admission; energy and protein-enriched ONS, 2 cans per day and 400 IE vitamin D3 and 500 mg calcium per day, during hospital admission till 3 months after discharge; six times telephone counselling by a dietitian to give advice and to stimulate compliance to the proposed nutritional intake; 3 months after discharge CG: Usual care	Body weight (kg), HGS (kg), ADL function (LASA Functional Limitation Questionnaire (score) and LASA Physical Activity Questionnaire) (score) (3 months)	RCT 5

(Continues)

TABLE 2 (Continued)

Author (year), Country	Setting Participants IG, CG, (IG2)	Nutritional assessment[a]: Nutritional status at baseline IG, CG (IG2)	Intervention; Duration Control; Duration	Nutritional outcomes assessed by nurses (Time measurements)	Design Study quality[b]
Pedersen et al. (2016) Denmark	Community A (mean): 86.4, 86.3, 85.6 F (%): 78, 82, 90 C: Living alone, recently discharged from hospital, at risk of malnutrition or malnourished *n*[c]: 52, 54, 51	MNA[d]: Score 17–23.5:53, 55, 56 Score < 17:47, 45, 44	Standard care, during hospital stay; Individual nutritional counselling of patient and caregiver by a dietitian based on nutritional needs with: IG: three home consultations, each consultation: 45 min; 4 weeks after discharge IG2: three telephone consultations, each consultation: 15 min; 4 weeks after discharge CG: Standard care; during hospital stay	Nutritional status (MNA) (score), HGS (kg), ADL function (BI) (score) (8 weeks)	RCT 3
Rondanelli et al. (2016) Italy, USA	Hospital A (mean): 80.77, 80.21 F (%): 58, 61 C: Relative muscle mass < 7.26 kg/m^2 (men) and < 5.5 kg/m^2 (women), stable body weight *n*[c]: 69, 61	MNA[d]: 17.84 ± 3.07, 17.84 ± 3.57	IG: Powder of essential amino acid, whey protein, and vitamin D mixture (32 g), 1 portion per day, concurrent with controlled physical activity programme, 20 min, 5 times per week; 12 weeks CG: Placebo, concurrent with controlled physical activity programme, 20 min, 5 times per week; 12 weeks	Nutritional status (MNA) (score), body weight (kg), energy intake (kcal/day), protein intake (g/day), BMI (kg/m^2), WC (cm), HGS (kg), ADL function (Katz Index) (score) (12 weeks)	RCT 3
Salvà et al. (2011) Spain, France, Switzerland	Community A (mean): 79.4, 78.6 F (%): 67, 69.1 C: Mild or moderate dementia, living with caregiver *n*[c]: 448, 498	MNA[d]: At risk: 51.5, 34.5 Malnutrition: 7.8, 2.8	IG: Teaching and training intervention for patient, caregiver and professional with: (a) information about Alzheimer's disease, nutrition and nutritional problems, physical exercise, available aid and services; (b) support in weight monitoring; (c) action protocols and standardised help decision trees related to malnutrition risk for professionals; NR CG: Usual care	Nutritional status (MNA), (score), body weight (kg), BMI (kg/m^2), ADL function (activities of daily living scale) (6 and 12 months)	RCT 3
Sharma et al. (2017) Australia	Hospital A (mean): 82.0, 81.6 F (%): 60.3, 67.1 C: Malnourished *n*[c]: 57, 46	PG-SGA[d]: B: 90.5, 87 C: 9.5, 13	IG: Nutritional intervention to meet 100% of patients' energy and protein requirements (combination of strategies including ONS, mid-meal snacks and food fortification), individual dietetic counselling to patients and care providers to augment energy intake, during hospital admission; telephone counselling by a dietitian to collect information about recent weight, side effects of supplementation and compliance with the intervention, 2 times; until 2 months after discharge CG: Usual care; during hospitalisation	Nutritional status (PG-SGA) (score), body weight (kg), BMI (kg/m^2), MUAC (cm), TSF (mm), HGS (kg) (3 months)	RCT 2

(Continues)

TABLE 2 (Continued)

Author (year), Country	Setting Participants IG, CG, (IG2)	Nutritional assessment[a]: Nutritional status at baseline IG, CG (IG2)	Intervention; Duration Control; Duration	Nutritional outcomes assessed by nurses (Time measurements)	Design Study quality[b]
Stange et al. (2013) Germany	Nursing homes A (mean): 87, 86 F (%): 88.1, 94.3 C: At risk of malnutrition or malnourished *n*[c]: 22–42, 17–35	MNA-SF[d]: 9.0 (8.0–11.0), 9.0 (8.0–10.0)	IG: ONS, 125 ml with 300 kcal and 12 g protein, 2 bottles per day, supplementary to regular meals; 12 weeks CG: Usual care	Nutritional status (MNA-SF) (score), body weight (kg), energy intake (kcal/day), protein intake (g/day), BMI (kg/m^2), MUAC (cm), CC (cm), HGS (kPa), ADL function (BI) (score) (12 weeks)	RCT 3
Veronese et al. (2014) Italy	Community A (mean): 71.8, 71.3 F (%): 100, 100 C: Healthy, attending a fitness programme, 25(OH)D concentrations ≥ 50 nmol/L *n*[c]: 53, 71	HGS: 22.08 ± 5, 21.16 ± 5.81	IG: Oral magnesium supplementation, 300 mg, 1 tablet per day; 12 weeks CG: No placebo or intervention	Body weight (kg), BMI (kg/m^2), HGS (kg) (12 weeks)	RCT 2
Ziylan et al. (2016) The Netherlands	Community A (mean): 70.5 F (%): 54.3 C: Healthy, without dietary restrictions *n*[c]: 120	MNA-SF[d]: At risk: 1.7	Four different beef or chicken meals: (a) 25 g protein and 450 g portion size, (b) 30 g protein and 450 g size, (c) 25 g protein and 400 g size, (d) 30 g protein and 400 g size, one of these variants once a week at lunchtime; 4 weeks CG: Crossover	Energy intake (kJ), protein intake (g) (after each meal)	Randomised crossover 0

Abbreviations: A, age (years); ADL, activities of daily living; BI, Barthel Index; BMI, body mass index; C, condition (of older participants); CaHMB, calcium β-hydroxy β-methylbutyrate; CC, calf circumference; CG, control group; F, female; HGS, handgrip strength; HP-HMB, high-protein β-hydroxy-β-methylbutyrate; IG, intervention group; IG2, intervention group 2; LOS, length of stay; MNA, Mini Nutritional Assessment; MNA-SF, Mini Nutritional Assessment short-form; MUAC, mid-upper arm circumference; MUST, Malnutrition Universal Screening Tool; NR, not reported; NRS-2002, Nutritional Risk Screening-2002; ONS, oral nutritional supplement; PG-SGA, Patient Generated Subjective Global Assessment; SGA, Subjective Global Assessment; TSF, triceps skinfold; WC, waist circumference.

[a]Data are presented as %, mean ± SD, or median (first quartile–third quartile).

[b]Based on the revised Cochrane risk-of-bias tool for randomised trials, where no of items at low risk (out of 5) is shown (Higgins et al., 2016).

[c]Sample size during analysis.

[d]NRS-2002: score ≥3: at risk for malnutrition; MUST: score = 1: medium risk for malnutrition, score ≥2: high risk for malnutrition; MNA: score 17–23.5: at risk of malnutrition, score <17: malnutrition; (PG-)SGA: category B: mild-moderate malnutrition, category C: severe malnutrition; MNA-SF: score 8–11: at risk of malnutrition, score <7: malnutrition.

4.5 | Identified interventions

Four intervention types, which could be integrated in nursing care, were identified in the included studies. These are oral nutritional supplements, food/fluid fortification or enrichment, dietary counselling and educational interventions. In 19 studies, single-component interventions were described (Andersson et al., 2017; Beelen et al., 2018; Botella-Carretero et al., 2008; Cramer et al., 2016; Deutz et al., 2016; Ekinci et al., 2016; Fernández-Barrés et al., 2017; Gariballa et al., 2006; Hin et al., 2017; Kim & Lee, 2013; Luger, Dorner, et al., 2016; Munk et al., 2014; Myint et al., 2013; Pedersen et al., 2016; Rondanelli et al., 2016; Salvà et al., 2011; Stange et al., 2013; Veronese et al., 2014; Ziylan et al., 2016). In two studies, multicomponent interventions were described (Neelemaat et al., 2011; Sharma et al., 2017; Table 2). Duration of these interventions ranged from the period of hospitalisation until 12 months after discharge. Duration of the intervention was not clearly reported in two studies (Botella-Carretero et al., 2008; Salvà et al., 2011).

4.5.1 | Oral nutritional supplements

In 12 studies, the intervention or part of a multicomponent intervention consisted of provision of oral nutritional supplements. Nutritional drinks with high nutrient and energy density were given to older adults in 10 studies (Botella-Carretero et al., 2008; Cramer et al., 2016; Deutz et al., 2016; Ekinci et al., 2016; Gariballa et al., 2006; Kim & Lee, 2013; Myint et al., 2013; Neelemaat et al., 2011; Sharma et al., 2017; Stange et al., 2013). Older adults received oral supplements with vitamin D3 in one study (Hin et al., 2017), magnesium in another study (Veronese et al., 2014), and vitamin D3 and calcium in addition to nutritional drinks (Neelemaat et al., 2011). The oral nutritional supplements were given once or twice a day, or depending upon individual patients' needs in addition to the regular oral diet.

4.5.2 | Food/fluid fortification or enrichment

In seven studies, the intervention or part of the intervention was provision of food/fluid fortification or enrichment given to older adults. In two studies, fortification was provided, where a powder with amino acid, whey protein and vitamin D (Rondanelli et al., 2016), or a protein powder (Botella-Carretero et al., 2008) was dissolved in fluid. In the latter study with a three-arm RCT design, the protein powder was provided to a second intervention group, where oral nutritional supplements were given to a first intervention group (Botella-Carretero et al., 2008). Protein-enriched food and drink products replacing regular products or added to the menu were served in one study (Beelen et al., 2018). In another study with a crossover design, participants consumed four beef meals and other participants consumed four chicken meals on four different days, once per week. These meals were composed with a difference in protein amount (25 g vs. 30 g) and portion size (normal vs. reduced) according to a 2 × 2 factorial design (Ziylan et al., 2016). Small dishes enriched with natural energy-dense ingredients and fortified with protein powder were supplemented in one study (Munk et al., 2014). In two multicomponent interventions, an energy and protein-enriched diet (Neelemaat et al., 2011) and fortified meals and drinks (Sharma et al., 2017) were supplied.

4.5.3 | Dietary counselling

Four studies described dietary counselling. In the first study, individual tailor-made counselling was given to older adults and provided by telephone and home visits after discharge from a rehabilitation institution. The goal was how to achieve and maintain good nutritional status at home (Andersson et al., 2017). In the second study, nutritional counselling based on nutritional needs, tailored to individual preferences and circumstances was provided by a dietitian to older adults and informal caregivers after hospital discharge at home. Counselling was either given through home or telephone consultation (Pedersen et al., 2016). In the third study, dietary counselling, as part of a multicomponent intervention, consisted of advice and stimulation to comply with the proposed nutritional intake by a dietitian through telephone counselling sessions (Neelemaat et al., 2011). In the last study, dietary counselling, as part of an individualised nutrition plan, was provided by dietitians to older patients. Counselling consisted of sessions, where information about recent weight was collected, side effects of the supplementation and compliance with the dietetic plan were discussed (Sharma et al., 2017).

4.5.4 | Educational interventions

Three studies focussed on educational interventions. In one study, nutritional education sessions were conducted by nurses targeting informal caregivers about preventing the increasing risk of malnutrition in dependent patients and individual dietary monitoring of patients at home (Fernández-Barrés et al., 2017). One study examined a teaching and training intervention where patients and caregivers received information about Alzheimer's disease and nutrition, and support in weight monitoring. Also, caregivers followed education sessions administered by dietitians and professionals were provided with protocols related to malnutrition risk (Salvà et al., 2011). Patient education about fluid intake, animal and plant protein intake, and energy intake in combination with strength exercises within a circuit training given by nonprofessional volunteers was provided to older adults in another study (Luger, Dorner, et al., 2016).

4.6 | Nutritional outcomes assessed by nurses

Table 3 describes the effects of the four types of interventions on 11 nutritional outcomes, which can be assessed by nurses. Detailed information about all outcomes is displayed in Appendix S4.

TABLE 3 Effect of four types of interventions on 11 nutritional outcomes, which can be assessed by nurses

	Interventions:			
Outcomes	**Oral nutritional supplements (12 studies)**	**Fortification/enrichment (7 studies)**	**Dietary counselling (4 studies)**	**Education (3 studies)**
Nutritional status	Effect: Category A, SGA: IG: 45.5% CG: 30% Category B, SGA: IG: 52.1% CG: 66.3% Category C, SGA: IG: 2.4% CG: 3.8% (p = .009) (Deutz et al., 2016) No effect[a] (Sharma et al., 2017; Stange et al., 2013)	Effect: Change score MNA: IG: 1.76 ± 2.19 CG: 0.24 ± 3.4 (p = .003) (Rondanelli et al., 2016) No effect[a] (Sharma et al., 2017)	No effect[a] (Pedersen et al., 2016; Sharma et al., 2017)	Effect: *Score MNA:* IG: 21.4 ± 3.2 CG: 18.3 ± 3.8 (p < .001) (Fernández-Barrés et al., 2017) Change score MNA: IG: 0.46 ± 3.98 CG: −0.66 ± 3.35 (p = .028) (Salvà et al., 2011) No effect[a] (Luger, Dorner, et al., 2016)
Body weight	Effect: kg: IG: 55.8 ± 9.7 CG: 52.2 ± 8.4 (p = .002) (Stange et al., 2013) No effect[a] (Cramer et al., 2016; Deutz et al., 2016; Ekinci et al., 2016; Gariballa et al., 2006; Hin et al., 2017; Kim & Lee, 2013; Sharma et al., 2017; Veronese et al., 2014)	Effect: Change, kg: IG: 1.12 ± 3.12 CG: −0.89 ± 2.87 (p < .001) (Rondanelli et al., 2016) No effect[a] (Munk et al., 2014; Sharma et al., 2017)	No effect[a] (Andersson et al., 2017; Sharma et al., 2017)	No effect[a] (Fernández-Barrés et al., 2017; Salvà et al., 2011)
Energy intake	Effect: kcal/day: IG: 1,124 ± 315 CG: 896 ± 277 (p = .008) (Kim & Lee, 2013) IG: 1,480.5 ± 207.5 CG: 1,127.4 ± 211.2 (p < .000) (Myint et al., 2013) No effect[a] (Botella-Carretero et al., 2008; Cramer et al., 2016; Stange et al., 2013)	Effect: kcal/day: IG: 2,163 ± 570 CG: 2,061 ± 549 (p = .047) kcal/kg: IG: 31.1 ± 9.9 CG: 28.6 ± 10.2 (p = .02) (Beelen et al., 2018) IG: 24.6 ± 9.3 CG: 19.6 ± 7.9 (p = .013) (Munk et al., 2014) kJ: (p < .05)[a] (Ziylan et al., 2016) No effect[a] (Botella-Carretero et al., 2008; Munk et al., 2014; Rondanelli et al., 2016; Ziylan et al., 2016)	—	No effect[a] (Fernández-Barrés et al., 2017)
Protein intake	Effect: *g/day:* (p < .0001)[b] (Cramer et al., 2016) IG: 54.7 ± 21.2 CG: 32.7 ± 10.3 (p < .001) (Kim & Lee, 2013) IG: 73.6 ± 10.6 CG: 63.5 ± 12.3 (p < .000) (Myint et al., 2013) g/kg: IG2: 1.1 ± 0.2 CG: 0.79 ± 0.15 (p < .001) (Botella-Carretero et al., 2008) No effect[a] (Stange et al., 2013)	Effect: g/day: IG: 105.7 ± 34.2 CG: 88.2 ± 24.4 (p < .01) g/kg: IG: 1.51 ± 0.53 CG: 1.22 ± 0.43 (p < .01) (Beelen et al., 2018) IG: 1.03 ± 0.25 CG: 0.79 ± 0.15 (p < .001) (Botella-Carretero et al., 2008) g/day: IG: 53 ± 16 CG: 43 ± 17 (p = .011) g/kg: IG: 0.9 ± 0.4 CG: 0.7 ± 0.3 (p = .003) Reaching ≥ 75% protein requirement: IG: 66% CG: 30% (p = .001) (Munk et al., 2014) g: (p < .001; p < .05)[a] (Ziylan et al., 2016) No effect[a] (Rondanelli et al., 2016; Ziylan et al., 2016)	—	Effect: g/day: IG: 64.3 ± 17.8 CG: 58.7 ± 10.5 (p = .05) (Fernández-Barrés et al., 2017)

(Continues)

TABLE 3 (Continued)

Outcomes	Interventions: Oral nutritional supplements (12 studies)	Fortification/enrichment (7 studies)	Dietary counselling (4 studies)	Education (3 studies)
BMI	Effect: Change, kg/m^2: IG 0.03 ± 1.21 CG: −0.49 ± 1.01 (p = .012) (Myint et al., 2013) IG: 0.41 ± 1.87 CG: −0.36 ± 1.87 (p = .04) (Sharma et al., 2017) kg/m^2: IG: 23.5 ± 3.3 CG: 22.3 ± 3.1 (p = .002) (Stange et al., 2013) No effect[a] (Botella-Carretero et al., 2008; Cramer et al., 2016; Ekinci et al., 2016; Gariballa et al., 2006; Hin et al., 2017; Veronese et al., 2014)	Effect: Change, kg/m^2: IG: 0.42 ± 1.27 CG: −0.42 ± 1.09 (p < .001) (Rondanelli et al., 2016) IG: 0.41 ± 1.87 CG: −0.36 ± 1.87 (p = .04) (Sharma et al., 2017) No effect[a] (Botella-Carretero et al., 2008)	Effect: Change, kg/m^2: IG: 0.41 ± 1.87 CG: −0.36 ± 1.87 (p = .04) (Sharma et al., 2017)	No effect[a] (Fernández-Barrés et al., 2017; Salvà et al., 2011)
MUAC	Effect: cm: IG: 24.8 ± 3.53 CG: 24.9 ± 3.25 (p = .015) (Stange et al., 2013) No effect[a] (Botella-Carretero et al., 2008; Ekinci et al., 2016; Gariballa et al., 2006; Kim & Lee, 2013; Myint et al., 2013; Sharma et al., 2017)	No effect[a] (Botella-Carretero et al., 2008; Sharma et al., 2017)	No effect[a] (Sharma et al., 2017)	—
CC	Effect: cm: IG: 31 ± 4.4 CG: 30.3 ± 3.3 (p = .018) (Stange et al., 2013) No effect[a] (Ekinci et al., 2016)	—	—	—
WC	—	No effect[a] (Rondanelli et al., 2016)	—	—
TSF	No effect[a] (Botella-Carretero et al., 2008; Ekinci et al., 2016; Gariballa et al., 2006; Myint et al., 2013; Sharma et al., 2017)	No effect[a] (Botella-Carretero et al., 2008; Sharma et al., 2017)	No effect[a] (Sharma et al., 2017)	—
HGS	Effect: Kgf: IG: 8.63 ± 3.83 CG: 6.4 ± 3.86 (p = .026) (Ekinci et al., 2016) No effect[a] (Cramer et al., 2016; Hin et al., 2017; Kim & Lee, 2013; Neelemaat et al., 2011; Sharma et al., 2017; Stange et al., 2013; Veronese et al., 2014)	Effect: Change, kg: IG: 3.2 ± 4.06 CG: −0.47 ± 2.32 (p < .001) (Rondanelli et al., 2016) No effect[a] (Munk et al., 2014; Neelemaat et al., 2011; Sharma et al., 2017)	No effect[a] (Neelemaat et al., 2011; Pedersen et al., 2016; Sharma et al., 2017)	—
ADL function	No effect[a] (Deutz et al., 2016; Gariballa et al., 2006; Neelemaat et al., 2011; Stange et al., 2013)	Effect: Change score Katz Index: IG: 0.54 ± 0.6 CG: −0.61 ± 0.72 (p < .001) (Rondanelli et al., 2016) No effect[a] (Neelemaat et al., 2011)	Effect: Improved score BI: IG: 96% CG: 72% (p < .01) (Pedersen et al., 2016) No effect[a] (Neelemaat et al., 2011; Pedersen et al., 2016)	No effect[a] (Fernández-Barrés et al., 2017; Salvà et al., 2011)

Notes: Data are presented as mean ± *SD*, unless specified otherwise with %.

—, nutritional outcome not measured.

SGA: category A: well-nourished, category B: mild–moderate malnutrition, category C: severe malnutrition.

Abbreviations: ADL, activities of daily living; BI, Barthel Index; BMI, body mass index; CC, calf circumference; CG, control group; HGS, handgrip strength; IG, intervention group; IG2, intervention group 2; MNA, Mini Nutritional Assessment; MUAC, mid-upper arm circumference; SGA, Subjective Global Assessment; TSF, triceps skinfold; WC, waist circumference.

[a]See Appendix S4 for precise information about the mean ± *SD* or percentages.

[b]Precise information about the median change between baseline and 24 weeks is not reported in the study.

4.6.1 | Oral nutritional supplements

In 12 studies, the effect of oral nutritional supplements on 10 nutritional outcomes was evaluated. These outcomes included nutritional status, body weight, energy intake, protein intake, BMI, mid-upper arm circumference, calf circumference, triceps skinfold, handgrip strength and ADL function. No significant differences were found in triceps skinfold and ADL function. On the other eight nutritional

outcomes, there were significant as well as nonsignificant differences. Some studies described the effects on several nutritional outcomes, but were incomplete in reporting about the mean and/or standard deviation. These are (a) change in body weight from baseline to 90 days, where no effect was found (Deutz et al., 2016); (b) change in energy and protein intake from baseline to 24 weeks, where protein intake showed significant improvement ($p < .0001$; Cramer et al., 2016); (c) BMI, mid-upper arm circumference, and triceps skinfold (Botella-Carretero et al., 2008); and (d) body weight and BMI (Veronese et al., 2014) were not significantly different between intervention and control group.

4.6.2 | Food/fluid fortification or enrichment

The effect of flood/fluid fortification or enrichment on 10 nutritional outcomes, that is nutritional status, body weight, energy intake, protein intake, BMI, mid-upper arm circumference, waist circumference, triceps skinfold, handgrip strength and ADL function, was examined in seven studies. Nonsignificance in waist circumference was found in one study (Rondanelli et al., 2016), and in mid-upper arm circumference and triceps skinfold in two other studies (Botella-Carretero et al., 2008; Sharma et al., 2017). In one study, energy and protein intake was similar after each meal between the groups receiving a normal-sized and lower-protein beef meal and a reduced-size and lower-protein beef meal, a normal-sized and enriched beef meal and a reduced-sized enriched beef meal. For protein intake, this was also the case for the groups receiving a chicken meal. There was no difference in energy intake between groups receiving a normal-sized lower-protein chicken meal and a reduced-size lower-protein chicken meal. There were significant differences in energy intake ($p < .05$) and protein intake ($p < .001$ or $<.05$) between the other groups receiving a beef or chicken meal with different sizes and protein enrichment (Ziylan et al., 2016).

4.6.3 | Dietary counselling

Four studies assessed the effect of dietary counselling on seven nutritional outcomes containing nutritional status, body weight, BMI, mid-upper arm circumference, triceps skinfold, handgrip strength and ADL function. The intervention had no significant effect on nutritional status, body weight, mid-upper arm circumference, triceps skinfold and handgrip strength. BMI significantly increased in the intervention group ($p = .04$) over a three-month period in one study (Sharma et al., 2017). In a three-arm intervention study, the percentage of participants with maintenance or improvement of ADL function was significantly higher in the intervention group, which received dietary counselling at home, than the control group ($p < .01$). There was no effect between the intervention group, which received dietary counselling by telephone, and the control group. However, there was no significant difference in change in ADL function from baseline to the follow-up endpoint between both interventions and the control group (Pedersen et al., 2016).

4.6.4 | Educational interventions

In three studies where an educational intervention was evaluated, six nutritional outcomes were measured, including nutritional status, measured with the MNA, body weight, energy intake, protein intake, BMI and ADL function. Body weight, energy intake, BMI and ADL function were not statistically different between the intervention and control group in single or multiple studies. The intervention group showed a significant increase in protein intake over 12 months, while intake in the control group remained the same ($p = .05$; Fernández-Barrés et al., 2017). Significant and nonsignificant differences were found in nutritional status (Fernández-Barrés et al., 2017; Luger, Dorner, et al., 2016; Salvà et al., 2011).

4.7 | Certainty of evidence

We graded the certainty of evidence as very low to moderate for nutritional outcomes assessed by nurses within the four identified interventions, and as a consequence, the results should be interpreted with caution (Table 4). Certainty was decreased for several reasons. First, most studies were assessed to be at high risk of bias or had some concerns. Second, for most outcomes the sample size was smaller than 400, and according to GRADE, this is an indication for serious imprecision (Schünemann et al., 2013). Third, the standardised mean differences or odds ratio of most nutritional outcomes were small, indicating that there is barely an intervention effect. This means that for most nutritional outcomes certainty of evidence could not be upgraded. The GRADE evidence profile is given in Appendix S5.

5 | DISCUSSION

This is the first systematic review to highlight interventions on prevention and treatment of malnutrition in older adults, which can be integrated in nursing care. From 21 randomised clinical trials from which three studies were assessed to be at low risk of bias, we have identified four types of useful interventions that nurses can use in their care for older adults. These interventions are provision of oral nutritional supplements, provision of food/fluid fortification or enrichment, dietary counselling and education. Our findings also highlight the impact of these interventions on 11 nutritional outcomes, which were identified as being applicable for assessment by nurses. The overall certainty of evidence for these outcomes ranged from very low to moderate. The effects of provision of oral nutritional supplements and food/fluid fortification or enrichment were measured in 10 out of 11 nutritional outcomes. Both positive effects and no effects were found in nutritional status, body weight, energy and protein intake, BMI, mid-upper arm circumference, calf circumference, handgrip strength and ADL function. In both types of interventions, there were no effects in triceps skinfold. In the provision of food/fluid fortification or enrichment, no effects were found in waist circumference. Studies where dietary

counselling and educational interventions were reported, focussed on seven and six out of 11 nutritional outcomes, respectively. An educational intervention showed to have a slight effect on protein intake (Fernández-Barrés et al., 2017), and dietary counselling demonstrated to have a small effect on BMI (Sharma et al., 2017). Educational interventions showed no effects on BMI. In both types of interventions, both positive effects and no effects were found in nutritional status and ADL function. There were no effects in body weight, energy intake, mid-upper arm circumference, triceps skinfold and handgrip strength. Not all included studies reported adverse events, but in those that did, we found no reporting of adverse events due to the intervention under study (Botella-Carretero et al., 2008; Cramer et al., 2016; Deutz et al., 2016; Ekinci et al., 2016; Hin et al., 2017; Kim & Lee, 2013; Myint et al., 2013; Rondanelli et al., 2016; Stange et al., 2013; Veronese et al., 2014). It appears that the identified interventions provide a low risk for harm in older adults.

We identified four types of interventions, which had also been evaluated in previous systematic reviews and meta-analyses (Allen et al., 2013; Avenell et al., 2016; Bandayrell & Wong, 2011; Milne et al., 2009; Morilla-Herrera et al., 2016; Munk et al., 2016). Additionally, in one review trained volunteer mealtime assistants (Howson et al., 2017) and in one meta-analysis multidisciplinary support (Rasmussen et al., 2018) had been investigated. Given the inclusion criteria, these interventions were not assessed in our review, but could possibly add to nursing care to prevent and treat malnutrition in older adults.

Most of the studies described in previous reviews focussed on populations of older adults with rather specific ageing conditions or residing in a particular setting. We targeted heterogeneous older adult populations, which we considered an important goal of our review, because in daily care nurses work with different older adult populations in various nursing care settings. More important, many older adults receive care in different settings, continuity of care could add in prevention and treatment of malnutrition.

Several included studies focussed on older adults who stay in a hospital or rehabilitation, where the intervention started during inpatient admission. In some studies, these interventions continued after discharge at home. These studies showed that at admission, a significant proportion of study participants were malnourished or at risk for malnutrition. Because of the serious and adverse consequences of malnutrition in older adults, minimalising malnutrition or decreasing the risk for malnutrition is necessary, and hence, focus on prevention of malnutrition will be beneficial (Volkert et al., 2019). This means, there should already be attention for malnutrition in older adults living at home, and not just in the period during inpatient admission when older adults are more vulnerable, also for malnutrition.

To provide nurses with effective nutritional interventions, we focussed on identifying interventions that can be executed by registered nurses. We did not limit our search to the nursing domain, because there are effective interventions from other domains, which can be executed by nurses. As the interventions included in our systematic review were in only one case actually carried out by nurses (Fernández-Barrés et al., 2017), this opens up the discussion about what the results will be if the intervention would have been carried out by nurses. We expect a higher effect given that nurses play a key role in nutritional care, since nurses in general provide possibilities for more contact moments with older adults. Where dietitians in general play a key role in the composition of food (Cederholm et al., 2017; The Dutch Malnutrition Steering Group, 2017), nurses play a key role in eating.

In our systematic review, we identified dietary counselling and educational interventions. These are complex interventions, which are defined as interventions with several interacting components (Craig et al., 2008). We found no supporting information about the development of these interventions. Potentially, lack of a comprehensive development process can be an explanation for the lack of effect of complex interventions. The complex interventions from our review showed no effects on the majority of the 11 nutritional outcomes, and only a very slight effect on protein intake (Fernández-Barrés et al., 2017) and BMI (Sharma et al., 2017).

We established a comprehensive overview of 11 outcomes related to malnutrition, which can be assessed by nurses in nutritional care within nursing research and nursing practice. Consensus on standardised definition and operationalisation of malnutrition utilising standardised measurements and procedures is recommended for a consistent approach on assessing outcomes. However, a gold standard is still lacking and singular outcomes are not sufficiently validated when identifying malnutrition (Cederholm et al., 2017, 2015).

In identifying older adults who are malnourished or at risk for malnutrition, there are additional considerations. A negative influence of the normal ageing process should also be taken into account when measuring outcomes like body weight, BMI, mid-upper arm circumference and triceps skinfold (Allen et al., 2013). Consequently, these outcomes might not be accurate for measuring malnutrition in older adults.

The use of common screening tools like the MNA or Malnutrition Universal Screening Tool has been demonstrated to be valid in populations of older adults (Cederholm et al., 2017). However, since these tools are developed at population level, their sensitivity at individual patient level has not been proven. This implies that current screening tools might not detect a risk for malnutrition in individual older adults.

When interpreting significant associations on several nutritional outcomes derived from the studies, the clinical relevance of these results should be kept in mind. For instance, in the study of Salvà et al. (2011), a significant difference in nutritional status in favour of the intervention group compared with the control group was found. At the 12-month follow-up, the intervention and control group showed a mean score on the MNA of 23.4 and 23.5 points, respectively. This does not seem clinically relevant, because both scores are an indication of risk for malnutrition.

5.1 | Limitations

In this literature review study, we used an explicit and systematic method (Higgins & Green, 2011); however, some potential limitations need to be considered.

TABLE 4 Summary of certainty of evidence for nutritional outcomes assessed by nurses across identified interventions using GRADE[a]

Outcomes	Interventions: Oral nutritional supplements (12 studies)	Fortification/enrichment (7 studies)	Dietary counselling (4 studies)	Education (3 studies)
Nutritional status	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	⨁◯◯◯ Very low	⨁◯◯◯ Very low	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b] ⨁⨁⨁◯ Moderate[b]
Body weight	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	⨁◯◯◯ Very low	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	⨁◯◯◯ Very low
Energy intake	⨁◯◯◯ Very low	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	—	⨁◯◯◯ Very low
Protein intake	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	⨁◯◯◯ Very low[b] ⨁⨁◯◯ Low[b]	—	⨁◯◯◯ Very low
BMI	⨁◯◯◯ Very low [b] ⨁⨁◯◯ Low[b]	⨁◯◯◯ Very low	⨁◯◯◯ Very low	⨁◯◯◯ Very low
MUAC	⨁◯◯◯ Very low	—	⨁◯◯◯ Very low	—
CC	⨁◯◯◯ Very low	—	—	—
WC	—	⨁◯◯◯ Very low	—	—
TSF	⨁◯◯◯ Very low	—	⨁◯◯◯ Very low	—
HGS	⨁◯◯◯ Very low [b] ⨁⨁◯◯ Low[b]	⨁⨁◯◯ Low	⨁◯◯◯ Very low[b] ⨁⨁⨁◯ Moderate[b]	—
ADL function	⨁⨁◯◯ Low[b] ⨁⨁⨁◯ Moderate[b]	⨁⨁◯◯ Low[b] ⨁⨁⨁◯ Moderate[b]	⨁◯◯◯ Very low[b] ⨁⨁⨁◯ Moderate[b]	⨁◯◯◯ Very low

Abbreviations: ADL, activities of daily living; BMI, body mass index; CC, calf circumference; HGS, handgrip strength; MUAC, mid-upper arm circumference; TSF, triceps skinfold; WC, waist circumference.

[a]Grading of Recommendations Assessment, Development and Evaluation (GRADE) for rating for outcomes across included studies. Certainty of evidence can be graded as: high, moderate, low and very low (Schünemann et al., 2013).

[b]Within identified interventions, outcomes were graded at different levels due to use of different instruments to measure the outcomes, units to express the outcomes or reporting of outcomes between studies.

First, in order to be sensitive to finding interventions, which can be applied in nursing care for older adults, we did not limit our search to particular interventions, older populations and nutritional outcomes. This led to heterogeneity of the studies from which we retrieved our results, and hence, generalising should be done with caution. Subsequently, pooling of intervention effects carrying out a meta-analysis appeared not feasible (Schünemann et al., 2013). However, with the approach of this review, we were able to provide an overview of the available knowledge.

Second, we only included studies, which are characterised by sufficient sample size. Sample size was sometimes based on other defined nutritional outcomes (e.g. vitamin D level or fat-free mass) or non-nutritional outcomes (e.g. hospital readmission or mortality) also used in the studies. Therefore, it is possible that the sample size in some of the included studies was too small for finding an effect, and as such not provided evidence for the analysis of this systematic review. This could be an explanation why evident effects of the interventions on the 11 nutritional outcomes were not found. In addition, from three studies (Cramer et al., 2016; Gariballa et al., 2006; Neelemaat et al., 2011) we already concluded that sample size was sufficient for some of the nutritional outcomes, but not for all. To avoid study selection bias, and as a consequence not to miss information on relevant interventions, which can be integrated in nursing care, we chose to include these three studies in our review.

Finally, most studies had a moderate to high risk of bias and certainty of evidence was graded very low to moderate. This raises questions about the internal validity of these studies (Higgins & Green, 2011). This should be kept in mind when generalising the results.

5.2 | Future research

Well-designed and well-executed future studies are needed to find a realistic estimation of an intervention effect (Higgins & Green, 2011). In these studies, at least assessors and data analysts should be blinded to reduce performance bias. Moreover, intervention studies should be powered well with a power analysis based on outcomes, which are related to malnutrition, and with assumptions of expected change in the outcomes based on prior research. Also, we recommend adequate comparison between intervention studies and estimation of the true intervention effect. This is needed to equip clinical nursing practice with effective interventions to prevent and treat malnutrition in older adults. Therefore, until a gold standard is developed, we recommend to use the definition and operationalisation of malnutrition based on the latest consensus reports from

national and international guidelines (Cederholm et al., 2017; The Dutch Malnutrition Steering Group, 2017).

We found no interventions, which were comprehensively developed, that means in practical, logical and evidence-based ways, and where contextual factors co-construct the intervention (Craig et al., 2008). Moreover, no information about implementation of the interventions into nursing care could be derived from the studies. Future nursing studies about the prevention and treatment of malnutrition in older adults should focus on development as well as implementation of interventions. Here, involvement of users, that is older adults, and providers, that is nurses, might be of benefit. It results in a higher chance of successful development and implementation, and makes the intervention more likely to fit nursing practice (Craig et al., 2008). For this purpose, the framework of the Medical Research Council (MRC; Craig et al., 2008) could be used.

In our review, we included diverse populations of older adults. Within future nursing research, populations of older adults who are malnourished or at risk for malnutrition should be targeted. Especially, more attention is needed for interventions to prevent malnutrition to precede the severe outcomes of malnutrition.

6 | CONCLUSION

In 21 studies, we identified four types of interventions, which can be integrated in nursing nutritional care, to prevent and treat malnutrition in diverse populations of older adults residing in different healthcare settings. We evaluated the effects of these interventions on 11 nutritional outcomes, which can be assessed by nurses. In general, one or more of the four types of interventions showed contradictory effects on nutritional status, body weight, energy intake, protein intake, BMI, mid-upper arm circumference, calf circumference, handgrip strength and ADL function. We found no effects on waist circumference and triceps skinfold. In addition, an educational intervention showed a small positive effect on protein intake and dietary counselling on BMI. However, the studies had a considerable risk of bias and low certainty of evidence for the nutritional outcomes. As a result, some reservation about the effectiveness of these interventions is therefore called for. Certainly, nurses can provide oral nutritional supplements and food/fluid fortification or enrichment, and give dietary counselling and education, as they are well placed to lead the essential processes of nutritional care to older adults.

7 | RELEVANCE TO CLINICAL PRACTICE

Given the repeating direct contact, mostly on a daily basis with older adults receiving care, nurses have a key role in the coordination of nutritional care, where they are in the best position to deliver excellent nutritional care in preventing and treating malnutrition in older adults. As part of basic care for nutrition, nurses can execute, monitor and evaluate the four identified interventions and use the 11 outcomes, which are related to malnutrition, appropriately. Although we did not specifically focus on safety of the interventions, we did not find these interventions might cause harm when used in daily nursing care. Therefore, nurses could use the interventions and 11 outcomes related to malnutrition in their daily practice. Here, it should be kept in mind that body weight, BMI, mid-upper arm circumference and triceps skinfold might be less accurate due to the normal ageing process. In daily care, nurses can assist older adults to eat and drink oral nutritional supplements and fortified or enriched foods and fluids. By giving dietary counselling and education, nurses can support older adults or caregivers to improve nutritional status and ensure adequate intake by achieving behavioural change (Bandayrell & Wong, 2011; Pedersen et al., 2016). From the included studies, no instructions about implementation strategies were handed over. For implementation tailored to specific nursing practices, the MRC framework could be used.

Besides having direct contact with older adults receiving care, nurses provide care in cooperation with other disciplines like dietitians, medical doctors, housekeeping personnel and representatives from all other professions involved in the nutritional care process (Cederholm et al., 2017; The Dutch Malnutrition Steering Group, 2017; Volkert et al., 2019). In this process, nurses themselves appropriately provide different kinds of nursing care activities, but also refer to specialist care by other disciplines where indicated. Hence, the coordination and activities of nurses in collaboration with other disciplines within nutritional care should be part of evidence-based multimodal and multidisciplinary interventions (Rasmussen et al., 2018; Volkert et al., 2019). Moreover, nurses ensure there is a clinical handover across the continuum within and between different care settings. In this way, nurses are ideally placed to provide integrated patient care in collaboration with older adults receiving care and other professional groups in intramural and transmural care (The Dutch Malnutrition Steering Group, 2017). Relevant goals in multimodal and multidisciplinary nutritional care would not only be treatment of malnutrition. Maybe even more important would be prevention of malnutrition to avoid older adults experiencing deterioration of their nutritional status as well as their general health.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Study design: DtC, RE, MS; search strategy: DtC, RE; study selection, quality assessment, data extraction: DtC, RE, RV; data synthesis: DtC, RE, JB, LS, MS; manuscript preparation: DtC, RE, GHdW, JB, RV, LS, MS. All authors read and approved the final version for publication.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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