

Assessing the impact of nutrition interventions on health and nutrition outcomes of community-dwelling adults: a systematic review

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Background: Malnutrition is pervasive in hospitalized patients and older adults. Although evidence shows the benefits of nutrition interventions in hospitalized patients, less is known about the role these interventions play on outcomes in patients in the community.

Objective: The objective of this systematic review is to evaluate the current evidence on nutrition interventions' impact on health and nutrition outcomes among community-dwelling adults.

Methods: This systematic review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Original studies of previously published research were identified by using a predefined search strategy. Articles identified through electronic and manual searches were compared against predefined study selection criteria.

Results: Twenty articles were deemed eligible for inclusion. Most of the studies examined nutrition interventions through oral nutritional supplements, dietary advice, counseling, and home visits, and were conducted in subjects who either had or were at risk of malnutrition. Nutrition interventions were found to improve anthropometrics (body weight), nutritional and functional status, energy and protein intake, and muscle strength (handgrip strength). However, their impact was inconclusive for body composition, quality of life, readmissions, complications/morbidity, and mortality, mainly due to a limited number of studies.

Conclusion: Nutrition interventions were found to improve health and nutrition outcomes among community-dwelling adults. Future research is needed to examine the pervasiveness of malnutrition in the community, to evaluate the impact that nutrition interventions have on improving health outcomes in this population, and to inform the design of novel nutrition-focused intervention programs for adults living in different community settings to improve outcomes.

Keywords: community, malnutrition, nutritional status, functional status, muscle strength

Introduction

Malnutrition is a global public health concern across the continuum of care. Malnutrition and the risk of malnutrition are prevalent in the hospital setting, impacting 20%–50% of patients.^{1–4} Malnutrition is also prevalent in the community setting, and research has shown that 20%–30% of community-dwelling adults have malnutrition or are at risk for malnutrition.^{5–8}

Malnutrition is associated with multiple adverse health outcomes including loss of muscle mass, decreased muscle strength, and reduced quality of life (QoL).^{1,9–13} Malnutrition is also associated with higher healthcare costs, mainly due to higher use of healthcare resources, both in hospital patients and in community-dwelling

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older adults.¹⁴ A recent population-based study showed that nutritional risk is independently associated with acute care hospitalizations and mortality.⁸

Multiple nutrition interventions, such as oral nutritional supplements (ONS), dietary advice, and counseling, have shown positive outcomes in different patient populations. For example, in hospitalized malnourished patients, nutrition interventions have been shown to reduce length of stay and the rate of 30-day unplanned readmissions, while enhancing QoL and saving costs.¹⁵⁻²⁰ A recent study showed that a comprehensive nutrition-focused quality improvement program in malnourished hospital inpatients reduced healthcare costs by reducing 30-day readmissions and reduced length of stay.²¹ However, only a limited number of studies focus on health and economic outcomes of nutrition interventions after hospital discharge in at-risk, community-dwelling adults. Moreover, although several studies have evaluated the benefits of ONS, few have explored the effectiveness of other nutrition interventions, such as the impact of registered dietitian nutritionist (RDN) home visits, nutrition counseling, and education, in improving patient outcomes in the community setting.

For instance, Elia et al conducted a systematic review to assess the impact of ONS on health and economic outcomes among community-dwelling adults and found that ONS use is associated with overall cost advantages.²² Although the results of their systematic review revealed the importance of nutrition intervention in the community setting, their work included ONS as the sole intervention without considering nutrition counseling, education, and other interventions. Therefore, the impact of other nutrition interventions in addition to ONS was not examined. To fill this gap, our review critically examines the research evaluating the impact of multiple nutrition interventions on health and nutrition outcomes in community-dwelling adults (ie, adults living either alone or with care and are not institutionalized).

Methods

This systematic review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Search strategy

A comprehensive literature search was completed in October 2016 with a predefined search strategy. The databases that were searched included MEDLINE, EBSCO, Embase®, Foodline®, SCIENCE, and Google Scholar. Search terms included the following keywords: “nutritional supplement”,

“dietary supplement”, “outcomes”, “community”, “home”, “care home”, “community-dwelling”, and “sheltered.” Articles were excluded if they included the following terms: “pregnancy”, “lactation”, “breastfeeding”, “animal”, “parenteral nutrition”, “exercise”, and “sports”. Search results were limited to English-language articles. Relevant literature reviews were manually searched for original studies meeting the predefined eligibility criteria. Studies were first scanned through titles, then abstracts, and then full text.

Inclusion and exclusion criteria

Studies identified through electronic and manual searches were compared against the eligibility criteria, which followed the PICOT (Population, Intervention, Comparison, Outcome, Time) model, and are summarized in Table 1. The review focused on studies that investigated health and nutrition outcomes of various nutrition interventions in community-dwelling adults regardless of the presence of malnutrition or risk of malnutrition. Health and nutrition outcomes included anthropometrics, nutritional and functional status, protein and/or energy intake, muscle strength, QoL, readmission, complications/morbidity, and mortality.

Data extraction

Three reviewers (AS, JL, and SS) independently reviewed all studies that met the inclusion criteria. Data were extracted per the PICOT framework and documented in Table 2. If a discrepancy regarding whether a study should be included occurred during the review of a study, the primary reviewers discussed it to reach an agreement, and a fourth reviewer (JP) was consulted to assist in achieving a consensus, as necessary.

Results

Literature search

The PRISMA flow diagram (Figure 1) outlines the literature selection steps. The electronic literature search resulted in 398 articles. In addition, five studies were recommended for inclusion from clinical nutrition experts, resulting in a total of 403 articles. After removal of duplicative publications, articles not meeting inclusion criteria, reviews with no relevant original studies, and ongoing studies for which data have not yet been published, 401 articles were available for final assessment. Only 20 studies were eligible to be included in the final qualitative analysis.

Study characteristics

Characteristics of the 20 eligible studies are detailed in Table 2. Studies meeting inclusion criteria were published

Table 1 Summary of inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Population	Any setting in the community ≥18 years of age Any nutritional status (well nourished, malnourished, or at risk of malnutrition)	Animal studies <18 years of age Pregnant or lactating females
Intervention	Alone or in combination: Oral nutritional supplements Dietary counseling/dietary advice Formalized nutrition discharge education Nutrition, post-discharge phone calls Discharge with ONS coupons and literature on ONS-tailored nutritional care plan Home visits by registered dietitians nutritionists	Noncommercially available or home-prepared ONS Exercise/physical activity ONS in combination with drug therapy (eg, anabolic hormones) Parenteral nutrition Enteral tube feeding alone Vitamin and/or mineral supplementation only (single- or multi-nutrient) used without ONS
Comparison	Nutrition intervention(s) vs no nutrition intervention(s) Nutrition intervention(s) vs standard of care	
Duration (intervention period)	≥1 week	<1 week
Outcome	Anthropometrics Body weight Body composition BMI Nutritional status Functional status Energy intake Protein intake QoL Muscle strength Handgrip strength Physical activity Readmissions Morbidity Complications Mortality Falls	

Abbreviations: BMI, body mass index; ONS, oral nutritional supplements; QoL, quality of life.

between 1987 and 2016, with the majority (14/20; 70%) of studies being published in the year 2000 or later.^{23–37} Among the 20 included studies, 18 were randomized controlled trials (RCTs).^{23–33,35–43} In the majority of studies, 80% (16/20) nutrition interventions were implemented for 3 months or more.^{23–30,33–35,37–42,44} There were slightly more studies that implemented a single nutrition intervention (12/20) than those that used multiple nutrition interventions (8/20). ONS were used in almost all the studies (19/20).

Many of the studies (10/20) were conducted in older adults (age 60 years and older)^{23,26–28,30,31,33–35,38,44} and/or in subjects who were malnourished, undernourished, or at risk of malnutrition (14/20).^{23–31,33–36,43,44} Six (6/20) of the stud-

ies focused on surgical patients.^{32,36,37,39–41,43} The remaining 14 studies examined various populations including cancer, chest infection, Alzheimer's disease, gastrointestinal issues, or alcoholic liver disease. The sample sizes ranged between 51 and 652 subjects.

Outcomes

Anthropometrics

Fourteen studies (14/20) investigated the correlation between nutrition intervention and anthropometric measures, including body weight and/or body composition (lean body mass [LBM]).^{23,25,26,28,30–32,35–41,44} Only three studies measured anthropometrics beyond body weight^{32,35,38} and only Woo et al

Table 2 Data extraction table

Study	Study design	Country	Population	Nutritional status	Setting	Sample size	Intervention	Single or multiple interventions	Duration	Results (intervention group)
Deutz, 2016 ²³	RCT	US	Older, adult (≥65 years) hospital patients	Malnourished	Hospital and post-discharge/home	652	ONS + standard of care vs placebo supplement	Single	90 days	↑ Body weight ↑ Nutritional status ↓ Mortality No difference in QoL No difference in readmissions ↑ QoL ↑ Energy intake ↑ Protein intake ↑ Micronutrient intake No difference in body weight ↓ Falls ↑ Protein intake ↑ HRQoL
Parsons, 2016 ²⁴	RCT	UK	Care home residents	Malnourished	Home	104	ONS vs dietary advice	Single	12 weeks	↑ QoL ↑ Energy intake ↑ Protein intake ↑ Micronutrient intake No difference in body weight ↓ Falls ↑ Protein intake ↑ HRQoL
Suominen, 2015 ²⁵	RCT	Finland	Patients with Alzheimer's disease living with a spouse	Malnourished and well nourished	Home	78	Tailored nutrition guidance + RDN home visits + ONS as needed vs written guide	Multiple	1 year	No difference in body weight ↓ Falls ↑ Protein intake ↑ HRQoL
Beck, 2013 ²⁶	RCT	Denmark	Geriatric medical patients	At nutritional risk	Post-discharge/home	152	Nutrition counseling with a RDN + GP follow-up visits vs GP follow-up visits	Multiple	12 weeks	↑ Functional status/mobility ↑ Nutritional status/body weight ↓ Use of meals-on-wheels ↓ Functional limitations No difference in physical activity No difference in QoL
Neelemaat, 2012 ²⁷	RCT	The Netherlands	Hospitalized older adult patients (≥60 years)	Malnourished	Post-discharge/home	210	Energy and protein enriched diet, ONS, calcium-vitamin D supplement, RDN telephone counseling vs usual care	Multiple	3 months	↑ Functional status/mobility ↑ Nutritional status/body weight ↓ Use of meals-on-wheels ↓ Functional limitations No difference in physical activity No difference in QoL

(Continued)

Table 2 (Continued)

Study	Study design	Country	Population	Nutritional status	Setting	Sample size	Intervention	Single or multiple interventions	Duration	Results (intervention group)
Neelemaat, 2011 ²⁸	RCT	The Netherlands	Hospitalized older adult patients (≥ 60 years)	Malnourished	Post-discharge/home	210	Energy and protein enriched diet, ONS, calcium-vitamin D supplement, RDN telephone counseling vs usual care	Multiple	3 months	<ul style="list-style-type: none"> ↑ Body weight ↓ Functional limitations No difference in physical performance/physical activities No difference in HGS No difference in fat-free mass ↑ QoL
Norman, 2011 ²⁹	RCT	Germany	Patients with benign GI disease	Malnourished	Post-discharge/home	134	ONS + dietary counseling vs dietary counseling	Multiple	3 months	<ul style="list-style-type: none"> ↑ Body weight No difference in Barthel score No difference in sit-to-stand No difference in falls ↑ Handgrip strength ↑ Vector movement No difference in QoL ↑ Body weight ↑ HGS
McMurdo, 2009 ³⁰	RCT	Scotland	Hospitalized older adults	Undernourished	Post-discharge/home	253	ONS vs control supplement	Single	16 weeks	<ul style="list-style-type: none"> ↑ Body weight No difference in Barthel score No difference in sit-to-stand No difference in falls ↑ Handgrip strength ↑ Vector movement No difference in QoL ↑ Body weight ↑ HGS
Price, 2005 ³¹	RCT	UK	Elderly hospital patients (>75 years)	Undernourished	Post-discharge/home	136	ONS vs usual care	Single	8 weeks	<ul style="list-style-type: none"> ↑ Body weight ↑ HGS

(Continued)

Table 2 (Continued)

Study	Study design	Country	Population	Nutritional status	Setting	Sample size	Intervention	Single or multiple interventions	Duration	Results (intervention group)
Smedley, 2004 ³²	RCT	UK	GI surgery patients	Not specified	Pre-hospitalization, during hospitalization, and post-discharge/home	179	ONS pre- and post-surgery vs ONS pre-surgery vs ONS post-surgery	Single	1 month	Less weight loss in ONS pre- and post-surgery group No difference in anthropometrics No difference in energy or protein intake No difference in QoL ↓ Minor complications in the ONS pre- and post-surgery group No difference in major complications ↑ Nutritional status ↑ HGS No difference in QoL
Edington, 2004 ³³	RCT	UK	Elderly hospital patients	Malnourished	Post-hospital/home	100	ONS vs no ONS	Single	24 weeks	↑ Nutritional status ↑ HGS No difference in QoL
Arnaud-Battandier, 2004 ³⁴	Observational, prospective, longitudinal, cohort study	France	Elderly patients (≥70 years)	Malnourished	Community/home or in institution	378	Rare prescription of ONS vs frequent prescription of ONS	Single	1 year	↑ Nutritional status ↓ Cost per patient of hospital care
Payette, 2002 ³⁵	RCT	Canada	Elderly persons receiving community home care services	At high risk of undernutrition	Community/home	83	ONS + dietary advice vs no intervention	Single	16 weeks	↑ Energy intake ↑ Body weight No difference in anthropometrics No difference in muscle strength No difference in functional variables ↑ Emotional role functioning ↓ Number of days spent in bed

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Table 2 (Continued)

Study	Study design	Country	Population	Nutritional status	Setting	Sample size	Intervention	Single or multiple interventions	Duration	Results (intervention group)
Beattie, 2000 ³⁶	RCT	US	GI surgery patients	Malnourished	Hospital and post-discharge/home	101	ONS vs no ONS	Single	10 weeks	Less weight loss/ weight regain ↑ Anthropometrics ↑ HGS ↑ QoL ↓ Antibiotics prescriptions No difference in body weight No difference in activity levels No difference in energy or protein intake
MacFie, 2000 ³⁷	RCT	UK	GI surgery patients	Not specified	Hospital and post-discharge/home	100	ONS + normal diet pre- and post-surgery vs ONS pre-surgery vs ONS post-surgery vs no ONS	Single	6 months	↑ Energy intake ↑ Protein intake Less weight loss HGS maintenance ↓ Complications ↓ Levels of fatigue No difference in nutritional status No difference in well-being
Keele, 1997 ³⁹	RCT	UK	GI surgery patients	Not specified	Hospital and post-discharge/home	100	ONS vs no ONS	Single	4 months	↑ Protein intake ↑ Energy intake Less weight loss HGS maintenance ↓ Complications ↓ Levels of fatigue No difference in nutritional status No difference in well-being
Jensen, 1997 ⁴¹	RCT	Denmark	Colorectal surgery patients	Not specified	Post-discharge/home	87	Dietary advice + ONS vs standard of care	Multiple	4 months	↑ Protein intake ↑ Energy intake ↑ LBM ↑ Body weight

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Table 2 (Continued)

Study	Study design	Country	Population	Nutritional status	Setting	Sample size	Intervention	Single or multiple interventions	Duration	Results (intervention group)
Jensen, 1997 ⁴⁰	RCT	Denmark	Colorectal surgery patients	Not specified	Post-discharge/home	87	Dietary advice + ONS vs standard of care	Multiple	4 months	↑ Protein intake ↑ Energy intake ↑ LBM ↑ Body weight No difference in fatigue No difference in work capacity or hand grip strength or pinching strength No difference in QoL
Woo, 1994 ³⁸	RCT	Hong Kong	Hospitalized older adults with chest infection	Not specified	Post-discharge/home	81	ONS vs no ONS	Single	3 months	↑ Anthropometrics ↑ Functional ability No difference in well-being
Gray-Donald, 1994 ⁴⁴	Pilot	Canada	Patients >60 years of age receiving home care	At risk for malnutrition	Home	145 (14 got intervention)	ONS, RDN visits, and dietary counseling	Multiple	12 weeks	↑ Energy intake ↑ Body weight ↑ Functional status ↑ Hand grip strength ↑ General well-being
Hirsch, 1993 ⁴²	RCT	Chile	Ambulatory patients with decompensated alcoholic liver disease	Not specified	Home	51	ONS vs placebo capsule	Single	1 year	↑ Energy intake ↑ Protein intake ↓ Hospitalizations ↓ Infections ↓ Complication rates ↓ LOS
Flynn, 1987 ⁴³	RCT	US	Patients with cancer undergoing surgery	Malnourished and well nourished	Pre-hospitalization and during hospitalization	61	ONS + nutrition counseling vs nutrition counseling		2–4 weeks before surgery	

Abbreviations: BMI, body mass index; HGS, handgrip strength; HRQOL, health-related quality of life; MNA, mini-nutritional assessment; MSW, medical social worker; ONS, oral nutritional supplements; QoL, quality of life; RCT, randomized controlled trial; RDN, registered dietitian nutritionist; VAS, visual analog scale; LBM, lean body mass; GI, gastrointestinal; US, United States; UK, United Kingdom.

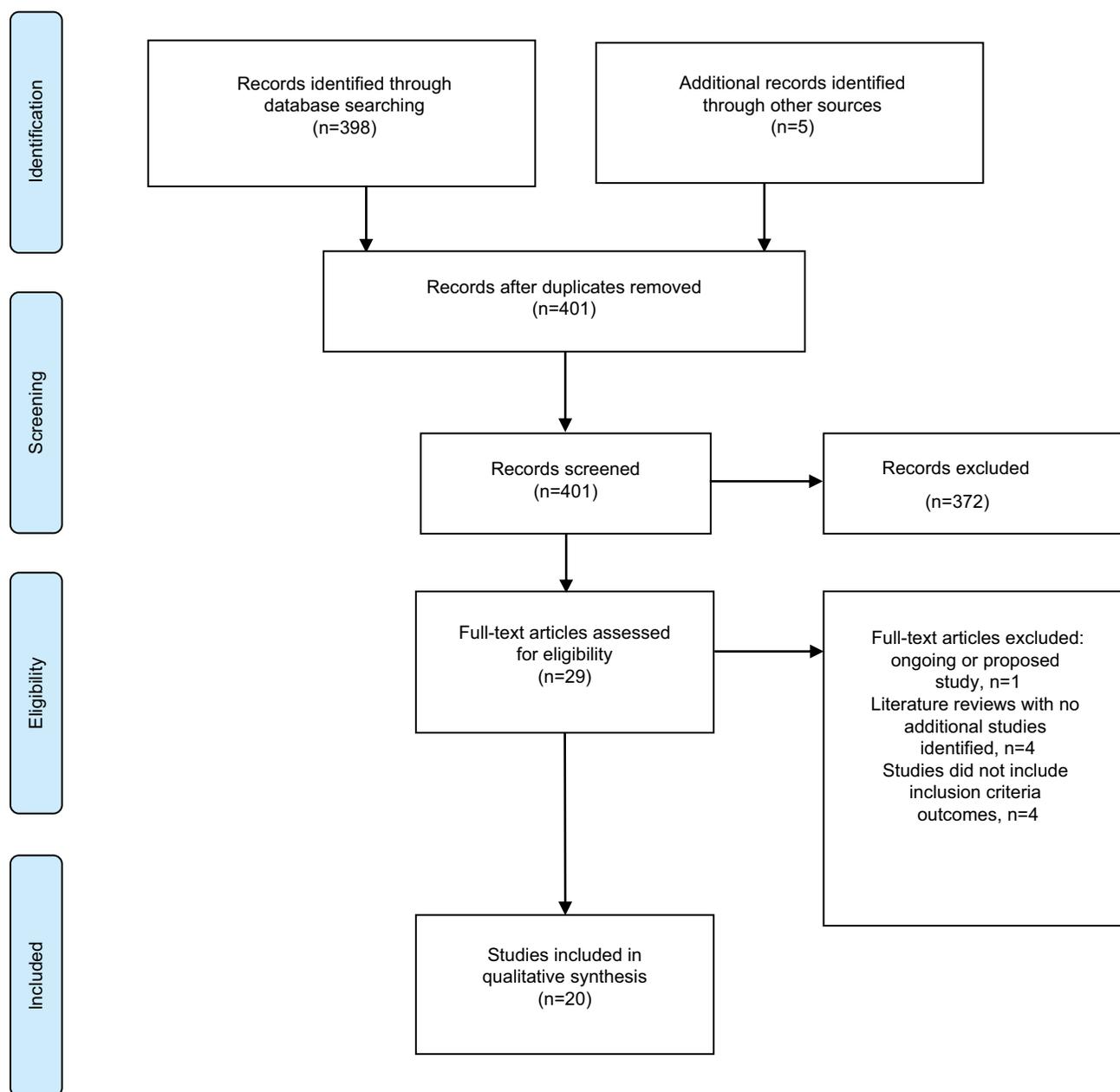


Figure 1 PRISMA flow diagram showing the selection of studies for this systematic review.

Abbreviation: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

found an improvement in further anthropometric measures (eg, mid-arm circumference, biceps, and triceps skinfold thickness) in the nutrition intervention group receiving ONS vs the control group receiving no ONS.³⁸ Twelve (12/14) studies demonstrated that nutrition interventions were associated with increased body weight and reduced weight loss, particularly in patients discharged from the hospital and in older adults.^{23,26,28,30–32,35,36,38–41,44} Payette et al showed that nutrition interventions (ie, provision of an ONS and dietary advice) resulted in significantly more weight gain (1.62 vs 0.04 kg) compared to the control group.³⁵ However, a few

studies found no statistically significant difference in weight change between the nutrition intervention group and the control group.^{25,37} Only one study by Jensen et al measured body composition as LBM and showed an increase in LBM in the group receiving ONS and dietary advice vs the standard of care group, but it did find an improvement in overall body weight with the nutrition intervention.^{40,41}

Nutritional and functional status

Thirteen (13/20) studies explored the effect of nutrition intervention on measures of nutritional status and/or func-

tional status.^{23,25–28,30,33–35,37–40,44} Most studies (9/13) found significant improvements in nutritional status, functional status, falls, and/or general measures of well-being, among the group receiving nutrition intervention.^{23,25–28,33,34,38,39,44} Deutz et al, Edington et al, and Arnaud-Battandier et al showed improved nutritional status in older adult patients with malnutrition receiving nutrition intervention.^{23,33,34} Further, three studies demonstrated increased functional status or decreased functional limitations in older adults with or at risk of malnutrition who received nutrition intervention.^{26–28,44} However, some studies have not shown improvements in nutritional or functional status with nutrition intervention in various patient populations including older adults and surgery patients.^{30,35,37,40} However, it is important to note that in these studies that evaluated nutritional and/or functional status, various tools were used to evaluate nutritional status (eg, serum albumin level, retinol binding protein level, and total lymphocyte count,⁴⁴ Mini Nutritional Assessment [MNA])³⁴ and health and functional status (eg, 36-Item Short Form Health Survey [SF-36],^{29,35} revised Barthel Index,³⁸ and General Well-Being Schedule).⁴⁴

Protein and/or energy intake

Ten studies (10/20) evaluated the impact of nutrition interventions on protein and/or energy intake,^{24–26,32,35,37,39–42,44} and most (8/10) studies found substantial increases in protein and/or energy intake in the nutrition intervention group compared with the control group.^{24–26,35,39–42,44} Additionally, one study found significant increases in micronutrient intake in the ONS group compared to the dietary advice group.²⁵ However, studies by Smedley et al and MacFie et al in surgical patients did not show differences in energy and/or protein intake between the nutrition intervention group and the control groups.^{32,37}

Muscle strength

Among the included studies, nine studies (9/20) evaluated the impact of nutrition intervention on muscle strength (mostly as a measure of handgrip strength) and/or physical activity level.^{27,28,30,31,33,35,36,39,40,44} Overall, six of nine studies found improvements in muscle strength and/or physical activities in the nutrition intervention groups.^{30,31,33,36,39,44} Studies found that handgrip strength was significantly improved among the group receiving nutrition intervention, mainly ONS.^{30,31,33,36,44} Specifically, six of eight studies showed improved or maintained handgrip strength in the nutrition intervention groups.^{30,31,33,36,39,44} Keele et al found that the ONS group maintained handgrip strength during

the supplementation period, whereas the non-ONS group had a significant decline in this outcome.³⁹ The outcome of general physical activities was explored in one study, which found no significant difference regarding the measurement of general physical activities among the nutrition intervention group compared with the control group receiving usual care.^{27,28}

QoL

Eleven (11/20) studies evaluated the effect of nutrition interventions on QoL,^{23–25,27,29,30,32,33,35,36,40} with only five studies showing improvements in QoL in the nutrition intervention groups compared to the control groups.^{24,25,29,35,36} Parsons et al showed that in care home residents, those receiving ONS had significantly higher QoL than those receiving dietary advice.²⁴ Additionally, one study by Payette et al found significant beneficial effects in emotional role functioning in older adults receiving home care services who received ONS and dietary advice compared to those receiving no intervention.³⁵ However, six other studies found no difference in QoL between the nutrition intervention and control groups.^{23,27,30,32,33,40}

Readmissions or postoperative morbidity/ complications

Seven studies evaluated the impact of nutrition interventions on readmission and/or postoperative morbidity/complications.^{23,26,32,36,39,42,43} Of these seven studies, four showed beneficial outcomes on readmissions and/or postoperative morbidity/complications,^{36,39,42,43} one study showed mixed results,³² and two studies showed no difference in readmissions between the intervention and control group.^{23,26} The studies showing positive outcomes, which include two RCTs, suggested that ONS and ONS plus nutrition counseling were associated with fewer complications.^{39,43} For readmissions, the RCT conducted by Deutz et al showed no difference in 90-day readmission rate between the ONS and placebo supplement groups.²³

Mortality

Only two studies explored the relationship between nutrition intervention and mortality among community-dwelling patients.^{23,26} One study found no statistically significant difference between patients receiving nutritional counseling by an RDN plus three follow-up visits by a general practitioner compared with patients receiving three follow-up visits only.²⁶ However, the largest RCT to date evaluating the effects of specialized nutrient-dense ONS on mortality rate and hospital

readmission rate among patients 65 years of age or older found a significant association between consumption of ONS and reduction in 90-day mortality rate.²³

Discussion

This systematic review found that nutrition interventions implemented independently or in combination had a significantly positive impact on anthropometrics (body weight), nutritional and functional status, protein and energy intake, and muscle strength (handgrip strength) in community-dwelling adults. These results highlight the importance of nutrition-focused interventions in positively affecting key health outcomes in a community setting.

Inconclusive results were reported regarding the impact of nutrition interventions on readmissions, postoperative morbidity or complications, QoL, and mortality. However, it is important to note that only a few studies focused on these measures and those that included small- to medium-sized samples and heterogeneous populations. In addition, the inconsistent and highly variable nutrition intervention periods (1 month–1 year) between studies should be taken into consideration. Before conclusions can be drawn about the effect of nutrition interventions on the studied outcomes in community-dwelling adults, future studies are needed with larger sample sizes of homogenous populations and consistent nutrition interventions of sufficient duration.

Overall, the results of this systematic review build upon the current body of evidence suggesting that nutrition interventions implemented alone or in combination can result in improved health outcomes for community-dwelling adults. Recent reviews of nutrition interventions in community settings have focused on single nutrition interventions such as ONS, nutrition education, or nutrition screening and have shown positive results.^{22,45,46} In this review, the majority of reviewed studies that implemented a combination of nutrition interventions reported significant and positive effects on outcomes of the targeted populations.^{25–29,35,40,41,43,44} These data support current comprehensive nutrition care practices which guide the healthcare professionals to use a variety of intervention strategies for patients to improve care and ultimately outcomes.

The importance of comprehensive nutrition programs is supported by studies in both home health and inpatient populations. A recent study of 1,269 malnourished inpatients showed that 30-day readmissions and length of stay were significantly lowered by use of a complete nutrition care and intervention strategy that included an electronic

medical record-cued malnutrition screening tool, prompt provision of ONS, patient/caregiver education, and sustained nutrition support during hospitalization and after hospital discharge.¹⁸ These findings highlight the need to develop, implement, and evaluate innovative and comprehensive nutrition programs to improve the outcomes of community-dwelling adults, as well as those at risk of or with malnutrition across the continuum of care.

This review is of interest given that although disease-associated malnutrition costs over \$15.5 billion in the US, malnutrition is usually overlooked and undertreated across healthcare settings and among community-dwelling adults in particular.^{47,48} Further, malnutrition leads to higher healthcare costs in hospital patients and community-dwelling adults and represents a significant percentage of the healthcare budget in various countries across the globe.¹⁴ These higher healthcare costs for hospital patients were shown by Sulo et al who assessed the impact of a nutrition-focused quality improvement program in which the authors found that due to significant reductions in readmission and length of stay for the treated patients, significant cost savings were observed, with total cost savings of over \$4.8 million and per-patient net savings of \$3,858 over the 6-month period of the program.²¹

This systematic review has several limitations. First, although strict inclusion criteria were applied to minimize the heterogeneity of the reviewed studies, different study designs and settings and inconsistent methods for assessing malnutrition/malnutrition risk and reported outcomes among the studies likely influenced the findings. Second, accuracy of the results reported from each study cannot be guaranteed since no original data were accessed. Third, this review does not report information regarding economic outcomes or cost savings resulting from the observed health outcomes. Regardless of these limitations, this is the first systematic review to our knowledge that assessed the impact of various nutrition interventions on different health and nutritional outcomes for community-dwelling adults. This review, along with new studies showing the benefits of comprehensive nutrition care in community-dwelling adults, should be utilized to determine the best intervention strategies for this population to develop nutrition care guidelines, optimize patient care, and subsequently improve patient outcomes.

Conclusion

Malnutrition has been and remains a key concern across the continuum of care. Patients in the community, especially those recently discharged from the hospital and those who

are older, are at high risk for malnutrition and often require nutrition intervention. Existing evidence shows that nutrition intervention strategies are beneficial in improving outcomes in patients, particularly those in the hospital setting. Overall, this systematic review showed that nutrition interventions were found to improve body weight, nutritional status, functional status, protein and energy intake, and muscle strength among community-based adults. However, the reported evidence is limited by the heterogeneity of study designs and settings, relatively small- to medium-sized samples, and lack of standardized measurements for assessing malnutrition/malnutrition risk and reported outcomes. Future research is needed to better understand the pervasiveness of malnutrition and the impact of nutrition interventions on health and nutritional outcomes in community-dwelling adults. This review can also help to inform the design of novel nutrition-focused intervention programs that can improve the outcomes for adults living in different community settings.

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Author contributions

All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work. AS, JL, SS, and JP designed the research; JL and SS performed the research; JL, AS, and SS analyzed the data and wrote the paper; AS, SS, and JP had primary responsibility for the final content. All authors read and approved the final manuscript.

Disclosure

AS, JL, SS, and JP are employees of Abbott. The authors report no conflicts of interest in this work.

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