Efficacy of Mealtime Interventions for Malnutrition and Oral Intake in Persons With Dementia

A Systematic Review

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Abstract: Malnutrition and weight loss are highly prevalent in persons with Alzheimer's disease and related dementias. Oral intake is an important interventional target for addressing these nutritional consequences. However, the efficacy of interventions remains poorly understood as prior syntheses have failed to examine the impact of intervention approaches on malnutrition and hypothesized mechanisms of action in persons with dementia. This review aimed to determine the efficacy of mealtime interventions to improve oral intake and nutritional outcomes in persons with dementia. Four databases yielded 1712 studies, resulting in 32 studies that met inclusion criteria. Studies included education, environmental modifications, feeding, oral supplementation, and other pharmacologic/ecopsychological interventions. While the majority of studies reported statistically significant improvements in at least 1 nutritional outcome, study design and outcome measures were heterogenous with many lacking adequate statistical power or blinding. Collectively, we found moderate evidence to suggest the efficacy of oral supplementation, and preliminary evidence to suggest that feeding interventions, education, and environmental modifications may confer improvements. Findings clarify the state of existing evidence regarding various interventional strategies for improving malnutrition in persons with dementia. While some approaches are promising, adequately powered and rigorously designed multidimensional intervention trials are needed to inform clinical decision-making in real-world contexts.

Key Words: dementia, malnutrition, mealtime, nutrition, treatment

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Weight loss and malnutrition are highly prevalent in both postacute and long-term care residents as well as persons with Alzheimer's disease and related dementias and are associated with poor functional outcomes, including an increased rate of hospitalizations, falls, cognitive impairment, and dependency with activities of daily living.[1–3] Oral intake is an important interventional target for addressing these more distal nutritional consequences, and feasible and efficacious interventions have been identified as a priority for patients, caregivers, and funding agencies.[4] Determinants of poor oral intake in persons with dementia are multifactorial, and integrated approaches to addressing contributing mechanistic and contextual factors have been proposed in a recent conceptual model that presents core modifiable domains of meal access, meal quality, and the mealtime experience.[5,6] In addition to these domains, staff, environmental, cultural, and societal characteristics are relevant contextual factors that shape care delivery and eating-related activities.[6]

Patients with dementia encounter many barriers to adequate nutritional intake within each mealtime domain. Cognitive impairments can negatively affect one's ability to participate and engage in physical and psychosocial aspects of the mealtime experience, often requiring feeding assistance and modifications.[7] For example, impairments in memory, executive functioning, and visual perception can negatively impact one's awareness of the mealtime situation, self-feeding abilities, and visual recognition of food.[8] In addition, impairments in cognitive flexibility, attention, and orientation can affect swallowing safety.[9,10] Furthermore, noncognitive behavioral symptoms such as verbal or physical aggression and agitation are common during mealtimes,[11] resulting in decreased consumption[12] and increased rates of aspiration.[13] Mealtime interventions targeting social interactions, food access, and the mealtime environment have shown promising results in improving these behavioral and psychosocial symptoms in postacute and long-term care residents.[14]

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Dysphagia, or swallowing impairment, is also a highly prevalent barrier to adequate and safe oral intake among older nursing home residents and persons with dementia.[15–17] Age-related swallowing dysfunction has been attributed to sarcopenia of pharyngeal musculature,[18,19] as well as oral and pharyngeal sensory deficits.[20–22] These difficulties are exacerbated in persons with dementia, worsening with disease progression.[23] Impairments in the efficiency of oral intake during meals commonly results in weight loss, dehydration, and malnutrition.[24] Aspiration is also a common adverse sequela, placing persons with dementia at a 2-fold increased risk of pneumonia-associated mortality.[25,26]

Mealtime interventions often address various determinants of poor nutritional status and have been successfully implemented among postacute and long-term care populations.[27] Readily available syntheses of the efficacy of various mealtime interventions in dementia populations are lacking. Furthermore, existing evidence summaries are outdated and have not attempted to delineate specific mechanistic and modifiable environmental and caregiving factors that are specific to dementia, limiting the evidence-base for informing clinical management of these patients in postacute and long-term care settings. Furthermore, prior syntheses of existing evidence have failed to provide conclusive evidence regarding the impact of intervention approaches on malnutrition, features of interventional strategies, intervention doses, or hypothesized mechanisms of action in persons with dementia.[14,27–31]

The efficacy of specific interventional strategies for improving oral intake and nutritional outcomes in individuals with dementia remains poorly understood due to heterogeneity in approaches and outcomes. To address this gap, the current paper reports findings from a systematic review designed to identify, synthesize, and critically appraise existing evidence surrounding the efficacy of mealtime interventions to improve nutritional outcomes in persons with dementia.

METHODS

Overview

The objective of this systematic review was to determine the efficacy of mealtime interventions in improving malnutrition and oral intake in persons with dementia. We initially attempted to identify articles for a homogenous dementia population to draw stronger inferences; however, upon reviewing the literature, it was clear that a broader approach was necessary due to multiple criteria for defining Alzheimer's disease and related dementias.[32] Thus, broad inclusion criteria was established regarding dementia subtypes, study setting, and types of nutritional outcomes to allow for a variety of study interventions and designs to comprehensively assess existing evidence and inform clinical practice. The goal of the review was to examine the efficacy of interventions specifically in persons with Alzheimer's disease and related dementias; thus, known studies that examined mealtime interventions in heterogenous postacute or long-term care cohorts without a specific emphasis on dementia were excluded.[33–35]

Search Strategy

Methodological standards established by the Cochrane Collaborative[36] were followed in determining a prior search strategy, study selection procedures, data extraction, and synthesis approach. Four databases were searched (PubMed, Scopus, CINAHL, and CENTRAL) from inception to March 2019 using terms developed by 2 authors (S.B. and N.R.-P.) and a librarian (S.J.) to capture all articles related to mealtime interventions, malnutrition, and dementia (For MeSH terms, see Supplementary Table 1, Supplemental Digital Content 1, http://links.lww.com/WAD/A269). The search strategy did not include dissertations or grey literature. A manual search of reference lists was performed on articles meeting inclusion.

Inclusion and Exclusion Criteria

Full-text articles were included if they reported on mealtime interventions and its effect on at least 1 nutritional outcome in persons with dementia. Dementia was broadly defined to include the following subtypes: Alzheimer's disease, Lewy body dementia, vascular dementia, Parkinson dementia, frontotemporal dementia, Huntington disease, mixed dementia, and Creutzfeldt-Jakob disease. Inclusion criteria for articles were the following: (1) persons with dementia; and (2) the outcome(s) for the study were objective measures of nutritional status and/or oral intake. No requirement was established regarding the methodology of diagnosing dementia, which could include a documented diagnosis in the medical chart. Exclusion criteria for articles were the following: (1) studies with a focus on end-of-life care; (2) qualitative methods/analyses; (3) geriatric populations without dementia; (4) enteral interventions; and (5) non-English articles.

Data Extraction

Results from each database search were imported into EndNote software, where duplicate papers were removed. Two authors (J.C.B. and S.B.) independently screened articles for potential inclusion based on titles and abstracts, assessed the eligibility of full-text articles, extracted relevant variables from articles meeting full-text inclusion, and performed quality assessments outlined below. A third author (N.R.-P.) resolved all disagreements that occurred in the screening, full-text review, extraction, or quality assessment process. The following information was extracted from articles meeting final inclusion: author, year, sample size, study design, study setting, type and severity of dementia, criteria to define dementia and cognition, age, sex, type of mealtime intervention, type of swallowing evaluation, nutritional outcome, and statistical and power analysis.

Assessment of Study Quality

All studies were reviewed through duplicate independent review using the Cochrane Risk of Bias Assessment Tool to appraise study quality.[37] Criteria for quality assessment as outlined by Cochrane includes sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete data, and selective outcome reporting. Studies were appraised as either high, low, or unclear risk of bias.

RESULTS

Study Characteristics

The database search yielded 1712 distinct articles. Thirty-two studies were determined to meet criteria. Thirty articles were retrieved directly from database searches[38–67] and 2 were identified through manual search of citations[68,69] (Fig. 1). Characteristics of study interventions, outcome measures, and results are detailed in Table 1. All but one

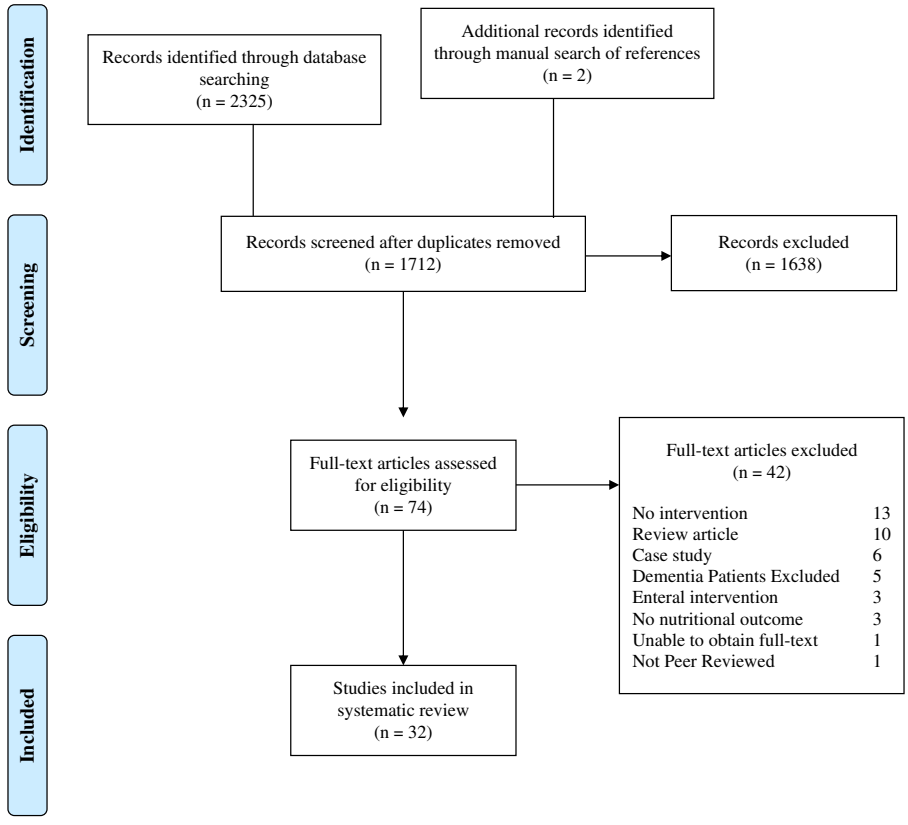

FIGURE 1. Study selection process. full color online

study employed a prospective design, including 14 randomized controlled trials (Table 2). Sample size ranged from 6 to 1912 patients, and power analyses were reported in 8 studies. Given broad variation in interventions and outcomes, as well as a small number of studies in certain categories, a meta-analysis was conceptually and statistically infeasible.

Patient Characteristics

The majority of studies examined persons with Alzheimer's disease.[44,46–48,52,54–58,60,62,63,65–68] Studies predominantly relied on the Mini-Mental State Examination[42,44,47,49,50,58,65,66] and the *Diagnostic and Statistical Manual of Mental Disorders*[43,53,57–59] for diagnosis of dementia. Additional diagnostic criteria, dementia diagnoses, and measures of cognition across studies are detailed in Table 3.

Assessment of Dysphagia

Twenty-three studies (66%) did not specify whether participants had clinical signs or a diagnosis of dysphagia.[41,42,44–51,53–56,60,61,64,66–69] One study included a subset of individuals with dysphagia, but did not report diagnostic criteria.[65] Seven studies excluded participants with dysphagia, defined as requiring modified food and liquids[38,52,62,63] or speech pathology services.[39] Two studies excluded persons with dysphagia but did not specify operational definitions.[40,59] Four studies excluded individuals with enteral or parental nutritional requirements.[43,57,58] Riley and Volicer[55] reported that a nutritional supplement reduced choking in 1 patient, whereas another patient did not exhibit improvements in the frequency of asphyxiation.

Nutritional Outcome Measurements

Twenty-nine studies (91%) considered oral intake or nutritional status as a primary study outcome,[38–40,42–48,50–57,59–69] as opposed to a secondary outcome.[41,49,58] In studies examining nutritional status as a secondary outcome, primary outcomes included knowledge and behaviors of nursing assistants,[41] feeding ability,[49] and the functional level of residents.[58] There was significant heterogeneity in nutritional outcomes across studies, as 23 studies (72%) included multiple nutritional outcomes. These included weight,[42–45,48,49,51,53,55–60,64,66,69] body mass index,[43,45–51,53,54,58–64,66] blood assays,[43,45,46,48,53–55,57,59,60] body composition assessments,[43,45,46,48,53,54] oral intake,[38–41,44,48,49,51,52,54,60,62,63,65,67,68] the Mini Nutritional Assessment,[43,46,48–50,56–61] and vitamin levels determined through blood assays.[43,45,46,54,57,59,60]

Mealtime Interventions

Mealtime interventions were classified into 1 of 5 categories: feeding interventions, environmental modifications, oral supplementation, education of patient, family, and staff, and other pharmacologic/ecopsychological interventions (Table 4). One study[53] separately assessed 2 intervention types (oral supplementation, education) and was included in both categories.

Patient, Caregiver, and Staff Education

Five studies examined the efficacy of patient,[53,58] caregiver,[53,56,58] and staff[39,41,58] education. The hypothesized mechanisms of action for these studies were related to increased knowledge and self-efficacy of patients, caregivers, or staff with education,[39,41,53,58] whereas one study targeted

TABLE 1. Study Characteristics and Results

References	Type of Intervention(s)	Comparator	Hypothesized Mechanism of Action	Duration	Setting	Nutritional Outcome	Statistical Significance
Education (n = 5)							
Batchelor-Murphy et al[39]	Web-based staff feeding skills training	Usual care	Increased knowledge and self-efficacy of staff feeding	45 min (follow-up: 8 wk)	Nursing home	Meal intake	Not reported
Chang and Lin[41]	Staff feeding skills training program	Usual care	Increased knowledge, attitudes, and quality of staff feeding	2 d	Nursing home	Food intake	No
Pivi et al[53]	Patient, caregiver, and staff education	Usual care; nutritional supplement	Increased knowledge of nutritional interventions with disease progression	Education: 10 classes; oral supplementation: 6 mo	Hospital	BMI	Yes
						Weight	No
						Arm circumference	Yes
						Arm muscle circumference	Yes
						Tricep skinfold thickness	No
						Serum albumin	No
						Total protein	Yes
						Total lymphocyte	Yes
Rivière et al[56]	Caregiver nutrition education program	Usual care	Caregiver stress reduction	9 sessions across 12 mo	Day center	Weight	Yes
						MNA	Yes
Salva et al[58]	Staff, caregiver, and patient nutrition education program	Usual care	Increased knowledge of nutritional interventions	4 sessions (follow-up: 12 mo)	Home	MNA	Yes
						BMI	No
						Weight	No
Environmental modifications (n = 4)							
Dunne et al[68]	High contrast (red) plates and cups	Low contrast (white) plates and cups	Enhanced mealtime visual discrimination	10 d (follow-up: 20 d)	Nursing home	Food intake	Yes
						Liquid intake	Yes
Edwards and Beck[44]	Aquarium during mealtime	Routine mealtime	Calming mealtime environment targeting agitation reduction	8 wk (follow-up: 3 mo)	Nursing home	Food intake	Yes
						Weight	Yes
Sulmont-Rosse et al[65]	Olfactory priming with a meat odor	NA	Increased food-related mental representations and appetite stimulation	4 consecutive meals	Nursing home	Food intake	Yes
Thomas and Smith[67]	Music during mealtimes	Usual care	Calming mealtime environment targeting agitation reduction	4 wk	Unclear	Total caloric intake	Not reported
Feeding (n = 6)							
Allen et al[38]	Glass without a straw	Glass with a straw	Increased compliance due to ease of consumption method	1 wk, 3 times per day on alternating days	Hospital	Liquid intake	Yes
						Energy and protein intake	No
Batchelor-Murphy et al[40]	Direct, under, or over handfeeding technique	NA	Patient autonomy and behavioral disturbance reduction	6 meals, changing technique every 2 d	Nursing home	Meal intake	No
Charras and Frémontier[42]	Shared mealtime between staff and residents	Usual care	Culturally traditional mealtime interactions	6 mo	Nursing home	Weight	Yes
Lin et al[49]	Montessori-based or spaced retrieval feeding intervention	Routine activities	Enhanced procedural memory, learning, and retention	8 wk (3 sessions/wk)	Nursing home	MNA	Yes
						BMI	No
						Weight	No
						Food intake	Yes
Lin et al[50]	Montessori feeding intervention	Routine activities	Enhanced procedural memory and learning	8 wk (3 sessions/wk)	Nursing home	MNA	No
						BMI	No
Wu and Lin[61]	Individualized or fixed spaced retrieval combined with Montessori activities	Routine activities	Enhanced procedural memory and learning	8 wk (follow-up: 6 mo)	Hospital	MNA	Yes
						BMI	Yes

Oral supplementation (n = 13)							
Gil Gregorio et al[46]	Nutritional supplement	Usual care	Supplementation for disease-related metabolic alterations and inadequate intake	12 mo	Nursing home	Albumin	No
						β Carotene	No
						Calcium	No
						Cholesterol	No
						Cryptoxanthine	No
						Iron	Yes
						Lutein	No
						Lycopene	Yes
						Lymphocytes	No
						Prealbumin	No
						Total protein	No
						Vitamin A	No
						Vitamin E	No
						Zinc	No
						BMI	No
						MNA	No
						Bicep circumference	No
						Brachial circumference	No
						Subscapular circumference	No
						Tricep circumference	Yes
						Calf circumference	No
Kamphuis et al[47]	Nutritional supplementation	Usual care	Neuroplasticity and reduction of amyloid-β production and toxicity	12 wk (follow-up: 6 mo)	Hospital	BMI	Yes
						Weight	Yes
						MNA	Yes
						Albumin	No
						C-reactive protein	No
						Appendicular fat-free mass	Yes
						Total fat-free mass	Yes
						Energy intake	Yes
						Protein intake	Yes
Keller et al[69]	Enhanced dietician time and menu	Usual care	Personalized attention to dietary needs with disease progression	21 mo	Nursing home	Weight	Yes
Lauque et al[48]	Nutritional supplement	Usual care	Supplementation targeting metabolic disturbances	3 mo (follow-up: 6 mo)	Day center	Weight	Yes
						BMI	Yes
						MNA	Yes
						Albumin	No
						C-reactive protein	No
						Total fat-free mass	Yes
						Appendicular fat-free mass	Yes
						Energy intake	Yes
						Protein intake	Yes
Navrátilová et al[51]	Nutritional supplement	Usual care	Supplementation targeting muscle mass and neuroplasticity	12 mo	Unclear	BMI	No
						Weight	No
						Energy intake	Yes
						Carbohydrate intake	Yes
						Food intake	Yes
						Protein intake	Yes

TABLE 1. (*continued*)

References	Type of Intervention(s)	Comparator	Hypothesized Mechanism of Action	Duration	Setting	Nutritional Outcome	Statistical Significance
Parrott et al[52]	Nutritional supplement	NA	Increased energy intake due to blunting of long-term appetite signals	3 wk	Nursing home	Energy intake	Yes
						BMI	Yes
Pivi et al[53]	Nutritional supplement	Usual care; Caregiver and staff education	Supplementation targeting biochemical parameters and immune status	Oral supplementation: 6 mo Nutrition education: 10 classes	Hospital	BMI	Yes
						Weight	Yes
						Arm circumference	Yes
						Arm muscle circumference	Yes
						Tricep skinfold thickness	No
						Serum albumin	No
						Total protein	Yes
						Total lymphocyte	Yes
Planas et al[54]	Nutritional supplement with micronutrients	Nutritional supplement without micronutrients	Reduction of inflammatory and oxidative stress processes, and cognitive decline	6 mo	Day center	Energy intake	No
						BMI	No
						Tricep skinfold thickness	No
						Mid-upper-arm circumference	No
						Albumin	No
						Cholesterol	No
						HDL-cholesterol	No
						LDL-cholesterol	No
						Magnesium	No
						Prealbumin	No
						Selenium	No
						Vitamin E	No
						Zinc	No
Riley and Volicer[55]	High-calorie nutritional supplement	Usual care nutritional supplement	Supplementation to maintain nutritional status	35 d	Nursing home	Weight	No
						Albumin	Yes
						Lymphocytes	No
						Transferrin	No
Salas-Salvado et al[57]	Whole formula diet	Usual care	Supplementation targeting energy intake	3 mo	Unclear	Weight	Yes
						MNA	No
						C-reactive protein	No
						Cholesterol	No
						Erythrocyte sedimentation rate	No
						Ferritin	Yes
						Folic acid	No
						Glucose	No
						Hemoglobin	Yes
						Lymphocytes	No
						Prealbumin	No
						Serum albumin	Yes
						Triglycerides	No
						Vitamin B_{12}	No

de Sousa and Amaral[43]	Nutritional supplement	Usual care	Supplementation targeting energy intake	21 d	Hospital	MNA	Yes
						BMI	Yes
						Weight	Yes
						Arm muscle circumference	Yes
						Tricep skinfold thickness	Yes
						Folic acid	No
						Serum albumin	Yes
						Total protein	Yes
						Total cholesterol	Yes
						Vitamin B_{12}	No
Young et al[62]	Nutritional supplement	NA	Supplementation targeting appetite regulation	21 d	Nursing home	BMI	No
						Carbohydrate intake	Yes
						Food intake	Yes
Young et al[63]	High carbohydrate dinner	Usual care with a mid-morning supplement	Supplementation targeting impaired olfaction, increased carbohydrate food preferences, behavioral disturbances, and changes in food intake patterns	21 d	Nursing home	BMI	No
						Food intake	Yes
Oral supplementation and education (n = 2)							
Faxén-Irving et al[45]	Staff feeding education and nutritional supplementation	Usual care	Supplementation and education targeting staff feeding skills, and cognitive function	5 mo (follow-up: 6 mo)	Nursing home	BMI	Yes
						Weight	Yes
						Arm muscle circumference	No
						Tricep skinfold thickness	Yes
						Hemoglobin	No
						Insulin-like growth factor	No
						Serum albumin	No
						Serum C-reactive protein	No
						Vitamin B_{12}	No
Suominen et al[60]	Patient and caregiver nutrition education and nutritional supplementation	Usual care	Personalized nutritional education and supplementation to improve patient/caregiver knowledge, oral intake, and quality of life	12 mo	Home	MNA	No
						BMI	No
						Weight	No
						Protein intake	Yes
						Calcium	Yes
						Fiber	No
						Folic acid	No
						Iron	No
						Total protein	No
						Vitamin C	No
						Vitamin E	No
						Vitamin B_{12}	No
						Vitamin B_1	No
						Vitamin B_2	No
						Vitamin D	No
						Zinc	No
Other pharmacologic/ecopsychological (n = 3)							
Johansson et al[64]	Preventative care program	NA	Interdisciplinary and individualized preventative care	Not reported	Home and nursing home	BMI	Yes
						Weight	Yes
McHugh et al[66]		Usual care				Food intake	

TABLE 1. (*continued*)

References	Type of Intervention(s)	Comparator	Hypothesized Mechanism of Action	Duration	Setting	Nutritional Outcome	Statistical Significance
	Premeal vocal recreative music therapy		Behavioral symptom reduction and increased mealtime engagement	3 wk (4 sessions/wk)	Nursing home		Not reported
Soysal and Isik[59]	Acetylcholinesterase inhibitor therapy	NA	Reduction in cognitive dysfunction with disease progression	6 mo	Hospital	BMI	No
						Weight	No
						MNA	No
						Albumin	No
						C-reactive protein	Yes
						Creatinine	Yes
						Folic acid	No
						Free T3	No
						Free T4	No
						HDL-cholesterol	Yes
						Hemoglobin	No
						LDL-cholesterol	No
						Thyroid-stimulating hormone	No
						Total cholesterol	No
						Vitamin B_{12}	No

BMI indicates body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MNA, Mini Nutritional Assessment; NA, not applicable.

caregiver stress reduction.[56] Improvements were evident in weight,[53,56] blood assays,[53] and self-report measures,[56,58] but not in body composition outcomes.[53] Batchelor-Murphy et al[39] documented beneficial trends in oral intake, but did not perform statistical analyses due to low sample size. Intervention duration ranged from a 45-minute session[39] to 9 sessions across 12 months.[56] Two studies included patients with Alzheimer's disease dementia,[56,58] whereas 3 studies did not specify dementia subtype.[39,41,53]

Environmental Modifications

Four studies examined the efficacy of environmental modifications, including the introduction of music[67] or an aquarium during mealtime[44] to reduce behavioral symptoms, manipulating the visual contrast of cups and plates to improve the perceptual salience and discrimination of tableware,[68] and olfactory priming targeting nonconscious memory processes to stimulate appetite.[65] Variability in hypothesized mechanisms of action was evident, including enhanced visual discrimination,[68] a calming environment targeting agitation reduction,[44,67] and increased food-related mental representations targeting appetite stimulation.[65] Three studies reported oral intake[44,67,68] and 2 examined weight.[44,65] Improvements in both outcomes were evident across all studies, though Thomas and Smith[67] only reported mean trends and did not perform statistical analyses. Intervention duration ranged from 4 consecutive meals[65] to 8 weeks with a 3-month follow-up.[44] All studies included patients with a diagnosis of Alzheimer's disease dementia.

Feeding Interventions

Six studies examined feeding interventions, including hand-over-hand feeding techniques,[40] altering consumption methods of liquids with either a glass or straw,[38] shared mealtime with staff and residents,[42] and Montessori-based feeding activities with[49,61] or without spaced retrieval.[50] Hypothesized mechanisms of action included increased compliance due to ease of consumption method,[38] increased patient autonomy during feeding,[40] increased mealtime interactions,[42] and targeting repetition priming and procedural memory during feeding.[49,50,61] Four studies examined weight,[42,49,50,61] and 3 studies reported oral intake[38,40,49] and/or self-report measures.[49,50,61] Improvements were evident in 2 studies reporting weight,[42,61] 2 studies examining self-report measures,[49,61] and 2 studies on oral intake.[38,49] Intervention duration ranged from 1 week[38] to 6 months,[42] and implementation of feeding strategies ranged from every meal[38] to 3 times per week.[49,50] Dementia subtype was unspecified across all studies.

Oral Supplementation

Fifteen studies examined oral nutritional supplementation, specifically oral supplementation with[45,60] or without[43,46–48,51–55,62,63,69] staff education, or a whole formula diet.[57] All studies examined weight as a primary outcome and improvements were reported in 8 studies.[43,45,47,48,52,53,57,69] Hypothesized mechanisms of action were largely multifactorial including disease-related metabolic alterations,[46,48] neuroplasticity,[47,51,54] and appetite regulation.[52,62] The majority of studies reported improvements in oral intake,[48,51,52,60,62,63] blood assays,[43,46,48,53,55,57,60] and body composition outcomes.[43,45,46,48,53] Six studies included self-report measures, 2 of which reported statistically significant improvements.[43,48] Average intervention duration lasted 174 days, ranging from 21[43,52,62,63] to 630 days.[69] The majority

TABLE 2. Quality Assessment

References	Sample Size	Sequence Generation	Allocation Concealment	Blinding of Participants	Blinding of Outcome	Incomplete Outcome Data	Selective Reporting	Power Analysis	Study Design	Mean Age (y)	Sex: Male (%)
Allen et al[38]	45	−	−	+	+	−	−	Yes	RCT	87	78
Batchelor-Murphy et al[39]	35	−	−	+	−	−	−	No	Prospective cohort, randomized sites	NR	NR
Batchelor-Murphy et al[40]	30	−	?	+	+	−	−	No	Prospective, randomized within-subject	89	10
Chang and Lin[41]	20	−	?	+	?	−	−	No	Prospective cohort, randomized sites	78	NR
Charras and Frémontier[42]	18	NA	NA	+	+	−	−	No	Prospective cohort	86	NR
Dunne et al[68]	9	NA	NA	+	+	−	−	No	Prospective, within-subject repeated measures	83	NR
Edwards and Beck[44]	70	NA	NA	+	+	−	−	No	Prospective, within-subject repeated measures	82	26
Faxén-Irving et al[45]	33	NA	NA	+	+	−	−	No	Prospective, nonrandomized, un-blinded	84	11
Gil Gregorio et al[46]	99	?	?	+	+	−	−	No	RCT	87	20
Johansson et al[64]	1912	NA	NA	−	−	+	+	No	Prospective within-subject longitudinal	83	38
Kamphuis et al[47]	225	−	−	−	−	−	−	No	RCT	74	50
Keller et al[69]	83	NA	NA	+	+	−	−	No	Prospective, cohort, nonrandomized	72	35
Lauque et al[48]	91	−	−	+	+	−	−	Yes	RCT	79	NR
Lin et al[49]	82	?	?	+	?	−	−	No	Prospective, sites randomized, single blinded	81	47
Lin et al[50]	29	?	?	+	−	−	−	No	Prospective, cross-over design	83	59
McHugh et al[66]	15	?	?	+	+	+	−	No	Prospective cohort randomized	81	20
Navrátilová et al[51]	100	?	?	+	+	−	−	No	Prospective, randomized	NR	NR
Parrott et al[52]	30	−	−	−	+	−	−	Yes	Prospective, randomized, cross-over, nonblinded	88	NR
Pivi et al[53]	78	?	?	−	+	−	−	No	Prospective cohort randomized	75	32
Planas et al[54]	44	?	?	−	−	−	−	No	Prospective, randomized, double-blind	75	45
Riley and Volicer[55]	13	?	?	−	+	−	−	No	Prospective, randomized	NR	NR
Riviere et al[56]	225	NA	NA	−	+	−	−	No	Prospective, nonrandomized convenience sample	77	23
Salas-Salvado et al[57]	53	?	−	−	+	−	−	No	Prospective, randomized cohort	85	17

TABLE 2. (continued)

References	Sample Size	Sequence Generation	Allocation Concealment	Blinding of Participants	Blinding of Outcome	Incomplete Outcome Data	Selective Reporting	Power Analysis	Study Design	Mean Age (y)	Sex: Male (%)
Salva et al[58]	946	?	?	–	+	–	–	Yes	Prospective cohort, nonrandomized	79	61
de Sousa and Amaral[43]	35	?	?	–	+	–	–	No	Prospective, randomized, nonblinded	79	26
Soysal and Isik[59]	116	NA	NA	+	+	–	–	No	Retrospective	78	44
Sulmont-Rosse et al[65]	32	+	?	–	–	–	–	No	Prospective, randomized within-subject	86	22
Suominen et al[60]	78	–	?	+	+	–	–	Yes	RCT	78	51
Thomas and Smith[67]	12	NA	NA	+	+	–	–	No	Prospective, time-series cross-over design	84	8
Wu and Lin[61]	90	NA	NA	+	–	–	–	Yes	Prospective, nonrandomized, single-blind, repeated measures	83	100
Young et al[62]	34	–	–	+	+	–	–	Yes	Prospective, randomized, cross-over, nonblinded	88	21
Young et al[63]	34	–	–	+	+	–	–	Yes	Prospective, randomized, cross-over, nonblinded	88	21

+ indicates high risk of bias; –, low risk of bias; ?, unable to determine risk of bias; NA, not applicable; NR, not reported; RCT, randomized controlled trial.

of studies included individuals with Alzheimer's disease dementia,[46–48,51,52,54,55,57,62,63] whereas 1 study also included Parkinson dementia, multi-infarct, and Korsakoff syndrome,[69] and 2 studies did not specify dementia subtype.[43,53]

Other Pharmacologic/Ecopsychological Interventions

Three studies described pharmacologic and ecopsychological interventions that did not fit into the aforementioned categories. Interventions included acetylcholinesterase inhibitor therapy,[59] music therapy,[66] and a comprehensive preventative care model involving various intervention components such as nutritional supplements, weight control, eating support, medication review, oral health care, patient education, parenteral and nutritional support, and end-of-life care.[64] Johansson et al[64] found improvements in body weight for patients who completed each step of an interdisciplinary and individualized preventative care process. McHugh et al[66] found no differences in oral intake between patients receiving vocal recreative music therapy 4 times a week for 3 weeks compared with control patients. After 6 months, Soysal and Isik[59] demonstrated improvements in some blood assay outcomes following acetylcholinesterase inhibitor therapy, but none were seen in weight, body mass index, or self-report.

Assessment of Study Quality

According to criteria outlined in the Cochrane handbook,[37] most studies demonstrated high risk of bias due to blinding of either the participant (n = 21, 66%) or outcome measure (n = 25, 78%). Detailed risk of bias ratings is provided in Table 2.

DISCUSSION

In this comprehensive systematic review, we identified 32 articles examining various mealtime interventions to improve oral intake and nutritional outcomes in persons with dementia. Results revealed 5 broad categories: education, environmental modifications, feeding, oral supplementation, and other pharmacologic/ecopsychological interventions which were commonly comprised of pharmacotherapy, music therapy, or multifactorial interventions involving several components of the aforementioned categories (eg, feeding, education, oral supplementation). Though heterogenous with regard to study design, nutritional outcomes, and length of intervention, there is some evidence to suggest that these mealtime interventions are efficacious in improving malnutrition or oral intake in persons with dementia. The majority (n = 27, 84%) of studies reported a statistically significant improvement with at least 1 nutritional outcome. Among studies examining 2 or more nutritional outcomes (n = 23), 17 (74%) reported improvements in at least 2 outcomes and 8 (35%) in 3 or more outcomes.

Studies included a wide range of nutritional outcomes to define and quantify changes in malnutrition, including weight loss, oral intake, blood assays, and body composition assessments. A recent consensus report by the Global Leadership Initiative on Malnutrition recommended at least 1 phenotypic (eg, weight loss, low body mass index, reduced muscle mass) and 1 etiologic criteria (eg, reduced food intake, inflammation or disease burden) to diagnose malnutrition.[70] Nineteen (59%) studies included outcomes that adhere to this recommendation. Dehydration, a common fluid and electrolyte disorder among postacute and long-term care residents,[71] was rarely examined across

TABLE 3. Study Characteristics of Dementia Subtype and Cognition

References	Dementia Assessment	Dementia Subtype	Cognitive Assessment	Cognitive Severity
Allen et al[38]	NR	Unspecified*	MMSE	Moderate
Batchelor-Murphy et al[39]	Medical record	Unspecified	MMSE	Mild to severe
Batchelor-Murphy et al[40]	BIMS	Unspecified	NR	Moderate to severe
Chang and Lin[41]	NR	Unspecified	NR	NR
Charras and Frémontier[42]	NR	Unspecified	MMSE	Severe
Dunne et al[68]	NR	Alzheimer	MMSE	Severe
Edwards and Beck[44]	MMSE	Alzheimer	NR	NR
Faxén-Irving et al[45]	NR	Varied†	MMSE	Severe
Gil Gregorio et al[46]	NINCDS-ADRDA FAST	Alzheimer	FAST	Moderate to severe
Johansson et al[64]	NR	Varied‡	MMSE	Mild
Kamphuis et al[47]	MMSE	Alzheimer	MMSE	Mild
Keller et al[69]	Physician	Varied§	MMSE	Severe
Lauque et al[48]	NINCDS-ADRDA	Alzheimer	MMSE	Moderate
Lin et al[49]	MMSE	Unspecified	MMSE	Mild to moderate
Lin et al[50]	MMSE	Unspecified	MMSE	Moderate
McHugh et al[66]	MMSE	Alzheimer	MMSE	Moderate
Navrátilová et al[51]	ICD-10	Alzheimer	MMSE	Not reported
Parrott et al[52]	NR	Alzheimer	GDS	Moderate
Pivi et al[53]	DSM-IV	Unspecified	MMSE	Moderate
			CDR	Mild to severe
Planas et al[54]	NINCDS-ADRDA	Alzheimer	GDS	Moderate
Riley and Volicer[55]	NR	Alzheimer	NR	NR
Riviere et al[56]	GDS	Alzheimer	GDS	Very mild to moderately severe
Salas-Salvado et al[57]	DSM-IV	Alzheimer	GDS	Moderately severe to severe
Salva et al[58]	DSM-IV MMSE	Alzheimer	MMSE	Normal to severe
de Sousa and Amaral[43]	DSM-IV	Unspecified	MMSE	Moderate
Soysal and Isik[59]	DSM-IV	Varied‖	MMSE	Mild
Sulmont-Rosse et al[65]	MRI	Alzheimer	MMSE	Severe
Suominen et al[60]	NINCDS-ADRDA	Alzheimer	MMSE	Mild
Thomas and Smith[67]	GDS	Alzheimer	GDS	Moderate to severe
Wu and Lin[61]	NR	Unspecified	MMSE	Mild to severe
Young et al[62]	NR	Alzheimer	GDS	Moderate
Young et al[63]	NR	Alzheimer	GDS	Moderate

*Included mild cognitive impairment.
†Alzheimer's disease, vascular, and unspecified.
‡Alzheimer's disease, vascular dementia, disease-related, alcohol-related, and unspecified.
§Alzheimer's disease, multi-infarct, Parkinson disease, and Korsakoff syndrome.
‖Alzheimer's disease, Lewy body dementia, vascular dementia, and corticobasal degeneration.
BIMS indicates brief interview for mental status; CDR, clinical dementia rating; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*; FAST, functional assessment staging; GDS, Global Deterioration Scale; MMSE, Mini-Mental State Examination; MRI, magnetic resonance imaging; NINCDS-ADRDA, National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's disease and Related Disorders Association; NR, not reported.

included studies and primarily included measures of liquid intake[38,68] and relevant blood assays, such as hemoglobin.[45,57,59] Our search terms did not include dehydration, which is a type of malnutrition that has been shown to affect persons with dementia. As a result, this may have excluded relevant studies.

There is moderate evidence to suggest that oral supplementation is efficacious in improving malnutrition in persons with dementia. This included 3 randomized controlled trials, though some degree of bias was evident in each study. All but one study showed improvements in at least 1 nutritional outcome. The effects of oral supplementation were most evident in weight and blood assay outcomes though the efficacy of oral supplementation likely varies as a function of many different factors including dementia subtype, disease severity, and psychosocial support. Despite these promising results, it is difficult to further assess related factors when prescribing oral supplementation given significant heterogeneity in the type and dosage of supplements, as well as the duration of supplementation. Future studies will be required to systematically examine the relative effects of these patient and intervention-related variables.

There appears to be preliminary evidence to suggest that some interventions targeting feeding, environmental modifications, and caregiver education demonstrate improvements in malnutrition and oral intake. Four of the 6 studies examining feeding interventions reported improvements in at least 1 nutritional outcome, most notably with oral intake. Feeding interventions such as shared mealtimes,[42] consumption of liquids in a glass,[38] and spaced retrieval combined with Montessori-based activities[49,61] demonstrated promising preliminary benefits on nutritional status. Improvements in weight and oral intake were evident across all 4 studies addressing environmental modifications during the mealtime; however, the small number of studies with heterogenous designs and small sample sizes warrants caution when interpreting and aggregating these results. Patient, family, or staff education alone appeared to improve self-report of nutritional status, whereas outcomes of weight and oral intake showed mixed results.

TABLE 4. Aggregated Study Results by Intervention Type

	Weight	Oral Intake	Blood Assays	Body Composition	Self-report
Education (n = 5)					
Batchelor-Murphy et al[39]	—	NR+	—	—	—
Chang and Lin[41]	—	→	—	—	—
Pivi et al[53]	↑	—	↑	→	—
Riviere et al[56]	↑	—	—	—	↑
Salva et al[58]	→	—	—	—	↑
Environmental modifications (n = 4)					
Dunne et al[68]	—	↑	—	—	—
Edwards and Beck[44]	↑	↑	—	—	—
Sulmont-Rosse et al[65]	↑	—	—	—	—
Thomas and Smith[67]	—	NR+	—	—	—
Feeding (n = 6)					
Allen et al[38]	—	↑	—	—	—
Batchelor-Murphy et al[40]	—	→	—	—	—
Charras and Frémontier[42]	↑	—	—	—	—
Lin et al[49]	→	↑	—	—	↑
Lin et al[50]	→	—	—	—	→
Wu and Lin[61]	↑	—	—	—	↑
Oral supplementation (n = 13)					
Gil Gregorio et al[46]	→	—	↑	↑	→
Kamphuis et al[47]	↑	—	—	—	—
Keller et al[69]	↑	—	—	—	—
Lauque et al[48]	↑	↑	↑	↑	↑
Navrátilová et al[51]	→	↑	—	—	—
Parrott et al[52]	↑	↑	—	—	—
Pivi et al[53]	↑	—	↑	↑	—
Planas et al[54]	→	→	→	→	→
Riley and Volicer[55]	→	—	↑	—	—
Salas-Salvado et al[57]	↑	—	↑	—	→
de Sousa and Amaral[43]	↑	—	↑	↑	↑
Young et al[62]	→	↑	—	—	—
Young et al[63]	→	↑	—	—	—
Oral supplementation and education (n = 2)					
Faxén-Irving et al[45]	↑	—	→	↑	—
Suominen et al[60]	→	↑	↑	→	→
Other pharmacologic/ ecopsychological (n = 3)					
Johansson et al[64]	↑	—	—	—	—
McHugh et al[66]	NR+	—	—	—	—
Soysal and Isik[59]	→	—	↑	—	→

↑: A statistically significant difference was reported for 1 or more outcomes in this category; the effect was beneficial.

↓: A statistically significant difference was reported for 1 or more outcomes in this category; the effect was not beneficial.

→: No statistically significant differences were reported for this study in this outcome category.

—: No outcomes in this category were reported for this study.

NR+: Statistical analyses were not performed, but beneficial trends were reported.

Interestingly, the only studies reporting improvements in objective nutritional outcomes provided education on both nutritional supplementation and management of behavioral symptoms during meals.[53,56]

Though the aforementioned intervention categories provide varying levels of evidence from diverse disciplines, such as nursing, nutrition, and speech-language pathology, a lack of interdisciplinary interventions addressing multiple mealtime domains was apparent. Only 3 studies included in this review examined interventions that integrated multiple domains of the mealtime experience.[45,60,64] A Swedish national preventative care program incorporated nutritional supplementation, weight control, eating support, medication review, oral health, nutritional education, and end-of-life care,[64] and 2 studies integrated both oral supplementation and nutrition education.[45,60] Though studies involving multiple domains are unable to elucidate the efficacy of domain-specific interventions, their ease of translation to clinical practice is greatly needed in this area of research.

This review identified several areas of improvement across studies that might inform future research. In order for findings to generalize to clinical practice, studies must diagnose and characterize dementia subtypes. Inadequate diagnostic methods were commonly employed, such as the Mini-Mental State Examination, *Diagnostic and Statistical Manual of Mental Disorders*, or medical charts, which alone are insufficient in diagnosing and characterizing dementia. For example, performing structural imaging, such as computed tomography or magnetic resonance imaging, and a comprehensive neuropsychological assessment is well supported by best-practice guidelines.[72,73] Thus, the external validity of included articles in this review is a limitation and prohibited examining the efficacy of interventions across different dementia subtypes or severities. To better elucidate the impact of interventions across the broad spectrum of Alzheimer's disease and related dementias and identify potential modifiers of effectiveness, comprehensive and valid diagnostic assessments are required. Future studies must also appropriately evaluate and characterize swallowing impairments in this patient population when assessing the efficacy of a nutritional intervention. Dysphagia, often characterized by tongue weakness in this population, is highly correlated with both malnutrition and longer mealtime durations in residents of long-term care facilities.[74] Furthermore, studies should incorporate instrumental swallowing evaluations, such as videofluoroscopic swallow studies or flexible endoscopic evaluations of swallowing, since bedside evaluations have not demonstrated adequate sensitivity for dysphagia detection.[75]

There are several limitations of this systematic review that should be acknowledged. Since our review focused solely on articles in English, we may have missed articles in other languages. In addition, improvements in study outcomes were based solely on statistical significance. Studies that were underpowered and reported nonsignificant results might have been susceptible to commit a type 2 error. Furthermore, direct comparisons between studies via meta-analysis was infeasible due to significant heterogeneity in study outcomes.

Malnutrition is prevalent among persons with dementia with known detrimental effects on health outcomes. Individual studies in this review contain varying levels of evidence to suggest that interventions targeting aspects of the mealtime experience can improve nutritional outcomes in this patient population. Patients, caregivers,

clinicians, and stakeholders can integrate this preliminary evidence into clinical practice. However, future large-scale, adequately powered interdisciplinary studies will be required to examine pragmatic interventions spanning multiple domains of the mealtime experience. These studies are needed to provide further guidance and evidence regarding the feasibility and efficacy of mealtime interventions across various disease stages and comorbid conditions, which are insufficiently characterized in the existing literature.

CONCLUSIONS

This review evaluated the efficacy of mealtime interventions to improve malnutrition or oral intake in persons with dementia. We found moderate evidence to suggest the efficacy of oral supplementation to improve nutritional outcomes, though future studies are required to better understand the optimal dosage, duration of supplementation, and effect modifiers on dementia subtypes and severities. There is preliminary evidence to suggest that some interventions targeting feeding, environmental modifications, and education might demonstrate improvements in malnutrition and oral intake. Findings from this review serve as a concise summary of the state of the literature for both clinicians and researchers. Future interdisciplinary studies are paramount to addressing the impact of malnutrition in persons with dementia and understanding the efficacy of pragmatic mealtime interventions.

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