Ageing Research Reviews 12 (2013) 967–981

Contents lists available at ScienceDirect

Ageing Research Reviews

journal homepage: www.elsevier.com/locate/arr

Review

Effectiveness of mealtime interventions on nutritional outcomes for the elderly living in residential care: A systematic review and meta-analysis

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ARTICLE INFO

Article history:
Received 22 March 2013
Received in revised form 14 June 2013
Accepted 17 June 2013
Available online 28 June 2013

Keywords:
Nutrition
Dining
Food
Residential care
Elderly
Dementia

ABSTRACT

The need to improve the nutrition of the elderly living in long term care has long been recognised, but how this can best be achieved, and whether (and which) intervention is successful in reducing morbidity is less well understood. The aim of this systematic review was to determine the effectiveness of mealtime interventions for the elderly living in residential care. Mealtime interventions were considered as those that aimed to change/improve the mealtime routine, practice, experience or environment. Following comprehensive searches, review and appraisal, 37 articles were included. Inadequate reporting in over half of the articles limited data quality appraisal. Mealtime interventions were categorised into five types: changes to food service, food improvement, dining environment alteration, staff training and feeding assistance. Meta-analysis found inconsistent evidence of effects on body weight of changes to food service (0.5 kg; 95% CI: −1.1 to 2.2; $p = 0.51$), food improvement interventions (0.4 kg; 95% CI: −0.8 to 1.7; $p = 0.50$) or alterations to dining environment (1.5 kg; 95% CI: −0.7 to 2.8; $p = 0.23$). Findings from observational studies within these intervention types were mixed, but generally positive. Observational studies also found positive effects on food/caloric intake across all intervention types, though meta-analyses of randomised studies showed little evidence of any effects on food/caloric intake in food improvement studies (−5 kcal; 95% CI: −36 to 26; $p = 0.74$). There was some evidence of an effect on daily energy intakes within dining environment studies (181 kcal/day, 95% CI: −5 to 367, $p = 0.06$). The need to improve the nutrition of the elderly living in residential long term care is well recognised. This review found some evidence that simple intervention around various aspects of mealtime practices and the mealtime environment can result in favourable nutritional outcomes. Further large scale pragmatic trials, however, are still required to establish full efficacy of such interventions.

1. Introduction

Malnutrition is one of the greatest threats to the health, well-being and autonomy of older adults (di Francesco et al., 2007), particularly those living in care homes. In 2010 in the UK, 37% of those admitted to a care home within the previous six months were found to be at risk of malnutrition (Russell and Elia, 2011). Studies across Europe have found the prevalence of under-nutrition within long term care units varies from 36% to 85% (Salva et al., 2009; Nieuwenhuizen et al., 2010). Elderly individuals identified as at risk of malnutrition have poorer quality of life, are more likely to be admitted to hospital, and are at increased risk of mortality (Leslie, 2011; Merrell et al., 2012; Rasheed and Woods, 2013).

Whilst the need to improve the nutrition of the elderly living in long term care has long been recognised (Department of Health, 2007; Arvanitakis et al., 2009; Nieuwenhuizen et al., 2010), how this can best be achieved, and whether (and which) intervention is successful in reducing morbidity is less well understood. Routine screening of malnutrition and appropriate and individualised nutritional care plans are mandated for every elderly resident in care (Care Commission, 2009; National Collaborating

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http://dx.doi.org/10.1016/j.arr.2013.06.002

Centre for Acute Care, 2006), but unfortunately it appears that it is often not undertaken and under-nutrition is overlooked (Leslie, 2011; Merrell et al., 2012; Leach et al., 2013). The question therefore remains as to whether there are more general interventions that can help improve their nutrition and overall health. A 2009 Cochrane review (Milne et al., 2009) examined the effects of providing extra protein and energy, usually in sip-feed form, in elderly people at risk from malnutrition in hospitals, care settings and the community. The review found that oral nutrition supplements produced a small weight gain in older people, and a possibility of reduction of complications, but did not result in functional improvement or reductions (for inpatients) in hospital stay. A more recent, non-systematic review of oral nutritional interventions in older nursing home residents found some evidence for a positive effect on functional status through improved weight gain (Beck et al., 2011), although conclusions were limited due to small sample sizes. However, neither of these reviews included research on the broader aspects of mealtimes such as feeding assistance, food choice and access, or the aesthetics of the eating environment, all of which are known to be important considerations for elderly people (Leslie, 2011). Age-related declines in taste and smell, along with increased satiation, also impact on practical considerations for mealtimes (Nieuwenhuizen et al., 2010). Indeed it is recognised that mealtimes are 'the highlight of the day' for many people in residential care (National Collaborating Centre for Acute Care, 2006) and both 'enjoying food and being able to eat food' are part of the UK Government's nutrition care plan (2007). Indeed, some studies have suggested that improved availability of food (Lorefalt and Wilhelmsson, 2012) and family style mealtimes (Charras and Fremontier, 2010) are able to improve food intake of residents in institutionalised care. To our knowledge however, there has been no systematic synthesis of research in this area.

The aim of this systematic review therefore was to determine the effectiveness of mealtime interventions for the elderly living in residential care, and where possible, determine which types of mealtime intervention were more effective. Mealtime interventions were considered as those that aimed to change/improve the mealtime routine, practice, experience or environment. Interventions that simply used oral nutritional supplements, such as commercial sip feeds, or those that fortified food, were not included in the review.

2. Methods

The systematic review was conducted following the general principles published by the NHS Centre for Reviews and Dissemination (Centre for Reviews and Dissemination, 2009). The protocol for this review was developed in consultation with an expert in geriatrics (see http://clahrc-peninsula.nihr.ac.uk/a-systematic-review-of-the-effectiveness-of-mealtime-interventions-in-elderly-people-living-in-resid.php) and is also registered with Prospero (registration number CRD42012002755).

2.1. Types of studies

Studies of the following design were included: (cluster) randomised controlled trials (RCTs), non-RCTs, studies with before and after designs, including time-series studies, and case-control studies. Case studies and those without enough information for replication or quality appraisal were excluded.

2.2. Types of participants

The intervention had to take place in residential nursing homes or care homes. Residents needed to be aged 65 years and older. Studies that were conducted in a hospital or palliative care setting or in an individual's home within the community were excluded. Studies that included residents with specific eating difficulties, such as dysphagia, were excluded.

2.3. Types of interventions

Mealtime interventions were considered as those which aimed to improve the mealtime routine, experience or environment. Interventions were included if they directly or indirectly provided: assistance and encouragement with eating, a more stimulating environment to eat, increased access to food, more choice of food or more appealing (visual, sensory) food. Nutrition education or training interventions that were specific to mealtime care for residential elderly were also included. Interventions that investigated the use of oral nutritional supplementation such as commercial sip feeds, or vitamin and mineral supplements were excluded. Interventions that assessed fortification of food with protein or energy were also excluded.

2.4. Types of outcome measures

There is no agreement on how best to measure nutrition status. Malnutrition develops as a continuum, starting with poor food intake, followed by biochemical, body composition and physiological changes (Woods et al., 2009). Thus in many studies, a combination of measures to assess nutrition status is often employed. For this review, studies had to report on at least one nutritional outcome. Nutritional outcomes were either those directly related to food intake (energy intake, macronutrient intake, percentage food intake) or those used in clinical practice to assess nutritional status: nutritional status assessment tool (e.g. Mini Nutritional Assessment [MNA] tool) weight, weight status (e.g. BMI), body composition (e.g. mid-upper arm circumference, lean body mass), biochemical indices (e.g. serum haemoglobin, albumin), and functional status (e.g. hand-grip). Data on dietary satisfaction and quality of life, where measured, were also outcomes of interest.

2.5. Search strategy

The search strategy was developed by an information specialist in consultation with topic and methods experts. The strategy used a combination of MeSH terms and free text terms. An illustration of the search strategy used on MEDLINE can be seen in Fig. 1. Fifteen databases were searched from inception to August 2012: MEDLINE, PsycINFO, Embase, HMIC, AMED (OvidSp); CDSR, CENTRAL, DARE (Cochrane Library); CINAHL (EBSCOhost); British Nursing Index (NHS Evidence); ASSIA (ProQuest); Social Science Citation Index (Web of Science); EThOS (British Library); Social Care Online and OpenGrey. No date or language restrictions were used. Forward and backward citation chasing of each included article was conducted as well as hand searching of key journals (Journal of Nutrition Health and Ageing 2008–2012, Journal of Clinical Nursing 1992–2012, Journal of the American Dietetic Association 1993–2012, Journal of Gerontological Nursing 2006–2012 and Journal of Gerontology 1996–2012). Two reviewers (RA and RW) independently screened titles, abstracts and full texts using the eligibility criteria. Discrepancies were discussed and resolved by a third reviewer (JTC) where necessary.

2.6. Data collection

Data on the study design, the setting, the population, the intervention, the outcomes and results, and risk of bias were collected

1 meal*.ti,ab. (46624)
2 (undernutrition or under nutrition).ti,ab. (4723)
3 nutrition education.ti,ab. (2717)
4 malnutrition.ti,ab. (24383)
5 food.ti,ab. (216612)
6 eating.ti,ab. (38661)
7 dining.ti,ab. (584)
8 feeding.ti,ab. (122004)
9 breakfast*.ti,ab. (5784)
10 dinner*.ti,ab. (2112)
11 lunch*.ti,ab. (3916)
12 (tea or teatime).ti,ab. (16948)
13 snack*.ti,ab. (3517)
14 home environment.ti,ab. (2348)
15 (ambience or ambiance).ti,ab. (285)
16 (diet or dietary).ti,ab. (280159)
17 or/1-16 (619034)
18 Aged/ (2107620)
19 geriatric*.ti,ab. (29134)
20 elderly.ti,ab. (152901)
21 (old* adj (people or resident*)).ti,ab. (15432)
22 old* adults.ti,ab. (27517)
23 old* men.ti,ab. (7393)
24 old* male*.ti,ab. (46226)
25 old* women.ti,ab. (11570)
26 old* female*.ti,ab. (36547)
27 later life.ti,ab. (5215)
28 (long stay adj2 patients).ti,ab. (590)
29 older patients.ti,ab. (20393)
30 old age patients.ti,ab. (54)
31 resident*.ti,ab. (98872)
32 or/18-31 (2308005)
33 care setting*.ti,ab. (18665)
34 care home*.ti,ab. (1533)
35 care residence.ti,ab. (15)
36 care unit*.ti,ab. (70277)
37 long term care.ti,ab. (12652)
38 elderly care.ti,ab. (618)
39 geriatric care.ti,ab. (1109)
40 communal care.ti,ab. (11)
41 institutional* care.ti,ab. (1408)
42 (residential adj (care or unit* or home*)).ti,ab. (2375)
43 nursing home*.ti,ab. (19995)
44 or/33-43 (121749)
45 17 and 32 and 44 (2498)

Fig. 1. Search strategy (example shown for Medline, searched 01.08.12).

using a standardised, piloted data extraction form. Data were extracted by one of two reviewers (RA, RW) and fully checked by one of three reviewers (RA, RW, JTC).

2.7. Risk of bias and study quality

Data on the risk of bias was collected by one of two reviewers (RA, RW) and checked by one of three reviewers (RA, RW, JTC). Any discrepancies were discussed and resolved. Risk of bias was assessed using a checklist based on the guidelines from the Centre for Reviews and Dissemination (Centre for Reviews and Dissemination, 2009). For RCTs, this included reporting adequacy of randomisation, which includes whether appropriate non-biased random sequence generation was used, and whether allocation was concealed. For all studies, including RCTs, blinded assessment of outcomes, reporting of specified eligibility criteria and outcome data, evidence of power calculations, non-selective reporting, compliance to intervention, validity and reliability of data collection tools, whether all participants were accounted for and whether appropriate analyses were undertaken, was assessed.

2.8. Data analysis and synthesis

Random effects meta-analyses were performed where possible; namely where we had data from RCTs within the same intervention type (see later in results for how interventions were classified into five types) assessing the same nutritional outcome (e.g. body weight, or food intake). As we used a random-effects model for the meta-analyses, the weightings for each study were determined not only by the size of each study included, but also by the between-study heterogeneity. Where there was more than one follow-up for a given study the estimated effect at the last wave was pooled. Synthesised results are presented by intervention type and outcome type. Where pooling was not appropriate or possible, the findings have been summarised in narrative form.

Summary data in the form of means and standard errors were used to estimate pooled effects reported as mean differences with 95% confidence intervals as all the outcomes were continuous. The results of studies that analysed outcome at follow-up were pooled with those that analysed change in outcome between baseline and follow-up. Similarly we did not differentiate between studies that did and did not adjust for potential prognostic factors. Where the mean, standard deviation and sample size for each trial arm were reported in the papers we used the *t*-test to calculate the mean difference between arms and standard error. For papers that used the cluster randomised design but had not allowed for clustering we inflated the standard error of the mean difference by the square root of the variance inflation factor calculated using the mean number of participants per cluster and assuming an intra-cluster correlation coefficient of 0.05. Sensitivity analyses in which the intra-cluster correlation was assumed to take the much higher value of 0.2 provided similar results and interpretation to those reported here. One paper (Essed et al., 2007) compared each of three intervention arms to a control arm. To deal with the fact that some study-specific estimates within the same meta-analysis would use the same control arm the sample size for the control arm was split across the three comparisons before estimating the intervention effect and standard error from the summary descriptive data. Heterogeneity across estimates was quantified using the I-squared statistic and the *p*-value for the *Q*-test was used test for evidence of heterogeneity (Higgins et al., 2003).

Data analysis was carried out using Stata [Stata Corporation. Stata Statistical Software. Release 12.1. College Station, TX, 2011] and Review Manager (RevMan) Version 5.1 software (http://ims.cochrane.org/revman).

3. Results

The electronic searches found a total of 6028 results, of these 95 full texts were retrieved for closer examination. A total of 37 articles (36 primary studies) were included in the final review with 12 identified from forward and backward citation chasing. Reasons for exclusion at the full text stage can be seen in Fig. 2.

3.1. Study characteristics

Studies that met the inclusion criteria were published between 1981 and 2012. Sixteen were from the United States, five from Sweden, five from Holland, four from Canada, two from the United Kingdom and one each from Finland, France and Taiwan. Study size varied from 7 to 1726 participants, with a skewed distribution towards the lower end (20 studies had less than 50 participants). Of the 36 primary studies, 16 included participants with dementia. A summary of the main study characteristics is provided in Table 1.

3.2. Intervention characteristics

The interventions were varied in length, ranging from a couple of days through to one year and could be broadly categorised into five types: food improvement ($n = 4$), food service ($n = 8$), staff training ($n = 6$), feeding assistance ($n = 4$), a combination of food service and staff training ($n = 2$), a combination of feeding assistance and food service ($n = 2$), and dining environment ($n = 11$). Whilst alterations to food service and staff assistance were sometimes components of improving the dining environment, if the intervention had a defined aim of making the dining room more home-like, 'dining environment' was chosen to categorise the intervention.

Food improvement interventions involved either the addition of sauce to meals or increasing the flavour of food by sprinkling flavourings directly onto food prior to serving (Mathey et al., 2001a; Essed et al., 2007; Appleton 2009) or adding mono-sodium glutamate (MSG) in the food preparation stage (Essed et al., 2009). Food service interventions involved changing the way the meal was presented to the care home residents; by switching from a pre-plated service to a bulk service (Shatenstein and Ferland, 2000; Desai et al., 2007), enhancing the colour contrast of the crockery that food was served on (Dunne et al., 2004), providing smaller portions, as a means of increasing appetite (Cluskey and Dunton, 1999), liberalising the diet (Black, 2010), providing real food snacks between meals (Simmons et al., 2010; Lorefalt et al., 2011), providing finger food instead of crockery dependent meals (Soltesz and Dayton, 1995) or serving a breakfast type meal as an evening meal (Young et al., 2011). Dining environment interventions were predominantly those that made the dining room more home-like, with table decorations, increased choice, the ability to self-serve, improved ambience and sometimes with staff joining the residents at the table (Mathey et al., 2001b; Nijs et al., 2006a,b; Kenkmann et al., 2010; Charras and Fremontier, 2010). Others assessed the effect of improved lighting (Koss and Gilmore, 1998; Brush, 2002), or the addition of music (Ragneskog et al., 1996; Thomas and Smith, 2009) in the dining room. Staff training interventions involved a focus on mealtimes after either specific nutrition education to care home staff (Kim and Holme, 1981; Wikby et al., 2009; Westergren and Hedin, 2010), a feeding skills training programme (Chang and Lin, 2005) or the incorporation of nutrition as part of integrity promoting care education (Mamhidir et al., 2007; Suominen et al., 2007). Finally feeding assistance studies assessed the effect of positive reinforcement and correct positioning (Coyne, 1988; Simmons et al., 2001, 2008; Simmons and Schnelle, 2004, 2006) or scripted reminiscence (Cleary, 2012).

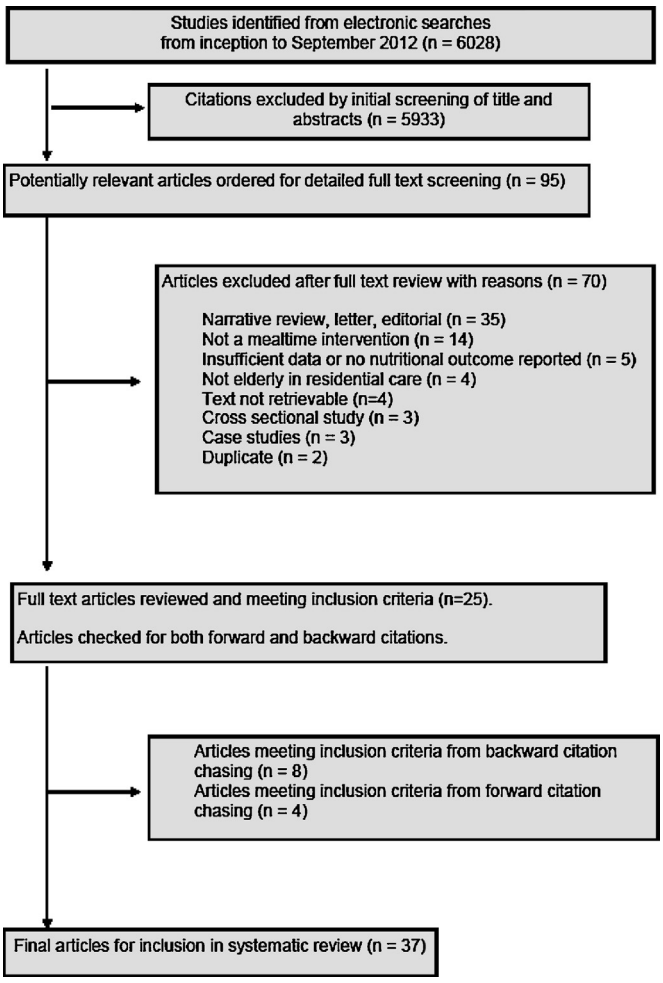

Fig. 2. Flowchart of search results and article retrieval.

3.3. Outcomes

Food intake, either as calories, or weight/percentage of food eaten, was the most common nutritional outcome assessed ($n = 30$), followed by body weight/weight status ($n = 22$), anthropometry ($n = 7$), biochemical indices ($n = 6$) or a composite malnutrition assessment tool ($n = 3$). Other nutritional outcomes reported were diet satisfaction, time spent eating and fluid intake. The majority of studies assessed more than one nutritional outcome (see Table 2).

3.4. Study quality (risk of bias)

Of the studies retrieved, 10 were RCTs, six were crossover studies, 13 were either pre–post or time series studies, three were non randomised controlled studies and three had a case-control design. The assessment of risk of bias for each individual study can be seen in Table 3.

None of the RCTs met all the criteria assessed by the study appraisal form, though inadequate reporting meant it was difficult to assess whether the study omitted these key elements in their design or whether it was simply not reported. Overall, in two thirds of the studies, eligibility criteria were clearly specified, there appeared to be non-selective reporting of primary outcome data and study participants were mostly accounted for. However there was a marked omission from the majority of studies of adequate power size calculations and it was not clear, in at least half of the studies, the degree to which there was compliance with the intervention or whether outcome assessments were blinded.

Table 1
Key study characteristics of mealtime interventions in elderly people living in residential care.

Source	Study design Follow-up length	Setting, country	Population	No.	Intervention type	Intervention/comparator *Study length*	Nutritional outcomes
Appleton, 2009	Pre–post *4 weeks*	Residential home, UK	>65 yrs	28	*Food Improvement*	Addition of sauce to meals compared to no sauce (as usual)	• Mealtime energy and macronutrient intake
Essed et al., 2007	Randomised controlled trial *16 weeks*	Nursing home, Holland	>65 yrs, mean age 84–85 yrs	83	*Food Improvement*	Flavour and/or MSG addition to protein component of cooked meal versus meals as usual	• Daily energy intake • Body weight • Body fat
Essed et al., 2009	Time series (A,B,A,B) *4 weeks*	Nursing home, Holland	>65 yrs, mean age 86 yrs	53	*Food Improvement*	MSG fortified beef, potatoes and spinach compared to usual	• Mealtime energy intake
Mathey et al., 2001b	Controlled trial *1 year*	Nursing home, Holland	>65 yrs, mean age 83–84 yrs	67	*Food Improvement*	Addition of flavour, sprinkled over whole meal, compared to usual meal	• Mealtime energy intake • Daily energy intake • Body weight • BMI
Black, 2010	Randomised controlled trial *18 weeks*	Long term care facility, USA	Mean age 79–81 yrs	22	*Food Service*	Liberalisation of diet compared to standard therapeutic diet	• Body weight •BMI • Nutritional biochemistry
Cluskey and Dunton, 1999	Pre–post *5 weeks*	Long term care facility, USA	Age not specified	31	*Food Service*	3 small meals throughout the day compared to 3 usual size meals per day	• Daily food intake (g)
Simmons et al., 2010	Randomised controlled trial *6 weeks*	Long term care facility, USA	Mean age 87 yrs	63	*Food service*	Participants randomised to receive usual care, or snacks (3rd arm – not analysed here)	• Body weight • Cost effectiveness
Desai et al., 2007	Case-control *3 weeks*	Nursing home, Canada	Mean age 86–89 yrs, with dementia	48	*Food service*	Bulk service versus tray service (as usual) – residents can choose 'what & how much'	• Mealtime energy intake • Daily energy intake • BMI
Dunne et al., 2004	Time series (A,B,A) *10 weeks*	Long term care facility, USA	Mean age 83 yrs with dementia	9	*Food service*	Introduction of high and low visual contrast crockery compared to usual crockery.	• Mealtime food intake (%) • Mealtime liquid intake (%)
Shatenstein and Ferland, 2000	Pre–post *10 weeks*	Nursing home dementia ward, Canada	Mean age 82 yrs mostly with dementia	22	*Food service*	Introduction of decentralised bulk food service – portioning occurring on word, as opposed to pre plated meals	• Daily energy intake • Body weight • BMI • Anthropometry • Nutritional biochemistry
Soltesz and Dayton, 1995	Pre–post *6 months*	Alzheimer's care facility, USA	>60 yrs, mean 78 yrs	54	*Food service*	Introduction of finger foods to usual menu	• Body weight • Daily food intake (%) • Mealtime food intake (%)
Young et al., 2005	Randomised cross-over trial *12 weeks*	Alzheimer's disease unit, Canada	Mean age 88 yrs	34	*Food service*	Served a breakfast-like meal instead of usual dinner	• Mealtime dietary intake • Daily dietary intake
Lorefalt et al., 2011	Controlled trial *3 months*	Nursing home, Sweden	Mean age 83–86 yrs	109	*Food service AND Staff training*	Multifaceted intervention of staff education and training support, with provision of snacks to supplement dietary intake	• Body weight • BMI • Nutritional status (MNA)
Lorefalt and Wilhelmsson, 2012	Pre–post *3 months*	Nursing home, Sweden	Mean age 84 yrs	67	*Food service AND Staff training*	Multifaceted intervention of staff education and training support, with provision of snacks to supplement dietary intake	• Body weight • BMI • Nutritional status (MNA) • Daily energy intake
Kim and Holme, 1981	Pre–post	Nursing home, USA	>51 yrs, mean age 75 yrs	28	*Staff Training*	Nutrition education to nursing home staff	• Daily energy intake and macronutrient intake
Wikby et al., 2009	Controlled trial *4 months*	Residential care home, Sweden	>65 yrs, mean age 85 yrs	115	*Staff Training*	Staff education in identifying nutritional needs and individualising nutritional care versus no additional education	• Body weight • Anthropometry • Nutritional biochemistry

Table 1 (*Continued*)

Source	Study design Follow-up length	Setting, country	Population	No.	Intervention type	Intervention/comparator *Study length*	Nutritional outcomes
Westergren and Hedin, 2010	Pre–post *2 year*	Long term care unit, Sweden	Mean age 85–86 yrs	1726	*Staff Training*	Effect or study circle and/or nutrition care policy	• Body weight • Nutritional status
Chang and Lin, 2005	Quasi-experimental *2 days*	Dementia long term care units, Taiwan	Mean age 72–84 yrs, with dementia	20	*Staff training*	Feeding skills training programmes versus no training	• Eating time • Mealtime food intake (%) • Feeding assistance
Mamhidir et al., 2007	Controlled trial *4 months*	Nursing Home, Sweden	Mean age 82 yrs, with dementia	33	*Staff training*	Staff training and support in integrity promoting care compared to no training	• Body weight
Suominen et al., 2007	Pre–post *6 months*	Nursing home dementia care ward, Finland	Mean age 85 yrs, with dementia	21F	*Staff training*	Incorporating nutrition as part of good care	• Daily energy intake and macronutrient intake • BMI • Nutrition status (MNA)
Simmons et al., 2001	Pre–post *2 days*	Nursing home, USA	Mean age 88 yrs	74	*Feeding Assistance*	Intervention of a 2day (6 meal) feeding assistance programme – positive reinforcement, correct position	• Mealtime food and fluid intake (%) • Eating time • Feeding assistance
Simmons and Schnelle, 2006	Pre–post *2 days*	Nursing home, USA	Mean age 88 yrs	91	*Feeding Assistance*	A 2day (6 meal) feeding assistance programme – positive reinforcement, correct position	• Mealtime food consumed (%) • Feeding assistance
Cleary, 2012	Pre–post *2 days*	Long term care, Canada	Age range (81–92 yrs), with dementia	7	*Feeding Assistance*	Scripted reminiscence conversation versus verbal clues versus control	• Mealtime food consumed (%)
Coyne, 1988	Randomised controlled trial *2 weeks*	Nursing home dementia unit, USA	>65 yrs, mean age 83–95 yrs, with dementia	24	*Feeding assistance*	Comparison of verbal prompts to eat/positive reinforcement with usual care	• Eating and drinking independence • Eating and drinking frequency
Simmons and Schnelle, 2004	Pre–post *2 days*	Nursing home, USA	Mean age 90 yrs	134	*Feeding Assistance, & Food Service*	Feeding assistance programme and for those who did not respond, a between meal snack intervention	• Mealtime food and fluid intake (%) • Eating time • Feeding assistance
Simmons et al., 2008	Randomised crossover intervention *6 months*	Nursing home, USA	Mean age 82–84 yrs	124	*Feeding Assistance & Food Service*	Staff provided feeding assistance twice per day, 5 days a week for 24 weeks and access to snacks between meals	• Daily energy intake • BMI
Kenkmann et al., 2010	Case-control study *1 year*	Care home, UK	Mean age 86–87 yrs	105	*Dining Environment*	Comparison of Increased choice of food at and between meals, improved dining room aesthetics, less rigid eating times compared to eating routines as usual	• Body weight • BMI • Food enjoyment
Mathey et al., 2001a	Cluster RCT *1 year*	Nursing home, Holland	>65 yrs, mean age 78–83 yrs	23	*Dining Environment*	Improved ambience of dining room, and presentation of food, increased availability of staff	• Body weight • Daily energy intake and macronutrient intake • Nutritional biochemistry • Quality of life
Nijs et al., 2006a	Cluster RCT *6 months*	Nursing home, Holland	Mean age 75–78 yrs	178	*Dining Environment*	Family-style mealtimes focussing on table dressing, non plated meals, staff joining residents to eat, compared to usual routine	• Body weight • Daily energy intake • Quality of life
Nijs et al., 2006b	Cluster RCT (same study as above) *6 months*	Nursing home, Holland	Mean age 75–78 yrs	178	*Dining Environment*	Family-style mealtimes focussing on table dressing, non plated meals, staff joining residents to eat, compared to usual routine	• Body weight • Daily energy intake and macronutrient intake • Nutritional status (MNA) • Anthropometry

Table 1 (*Continued*)

Source	Study design Follow-up length	Setting, country	Population	No.	Intervention type	Intervention/comparator *Study length*	Nutritional outcomes
Remsburg et al., 2001	Cluster RCT *3 months*	Long term care facility, USA	>65 yrs, mean age 80 yrs	40	*Dining Environment*	Comparison of buffet style dining room at supper times, increased choice and enhanced feeding assistance with usual tray service	• Body weight • Nutritional biochemistry
Brush, 2002	Pre–post *4 weeks*	Nursing home & assisted living facility, USA	>75 yrs, with dementia	25	*Dining Environment*	Improved lighting and table setting contrast	• Daily energy intake • Nutritional status (MAST)
Charras and Fremontier, 2010	Case-control *3 months*	Nursing homes special care units, France	Mean age 85 yrs, with dementia	18	*Dining environment*	Shared meals with staff, ability to serve own food (not-plated)	• Body weight
Koss and Gilmore, 1998	Pre–post *6 weeks*	Dementia Unit, USA	Age not specified, with dementia	13	*Dining environment*	Increased light intensity and enhanced visual stimulation during evening meals	• Mealtime food intake
McDaniel et al., 2001	Pre–post *2 weeks*	Alzheimers' Unit, USA	Age range: 61–81 yrs, with dementia	16	*Dining Environment*	Introduction to dining room that differed in light and noise	• Daily energy, protein and fluid intake • Mealtime energy, protein and fluid intake
Ragneskog et al., 1996	Time series crossover (A,B,A,B,A,B) *10 weeks*	Nursing home psychogeriatric ward, Sweden	Mean 80 yrs, with dementia	20	*Dining environment*	Introduction of music during dinner: 3 types (soothing, 20 s/30 s, pop)	• Mealtime food consumed (g)
Thomas and Smith, 2009	Time series crossover *8 weeks*	Alzheimer's Unit, USA	Mean age 83 yrs, with dementia	13	*Dining environment*	Mix of preferred music played over lunchtime	• Mealtime energy intake

Reporting of RCTs was better than reporting across the non RCT studies. Overall, in many studies, inadequate reporting made quality assessment difficult.

3.5. Synthesis by intervention type

3.5.1. Food improvement interventions

Two randomised studies that assessed the effects of flavour enhancement were entered into a meta-analysis, with 96 participants across the intervention groups and 54 in the control groups (Mathey et al., 2001a; Essed et al., 2007). The interventions comprised of enhancing food with either MSG based food flavours over the whole meal (Mathey et al., 2001a) or the addition of either MSG and/or food flavours over the protein part of the meal only (Essed et al., 2007) and both studies implemented the intervention over 16 weeks in populations very similar in age and health status. The pooled results (see forest plots in Fig. 3a and b) indicate no significant effect of food improvement on body weight, weighted mean difference 0.4 kg (95% CI: −0.8 to 1.7, $p = 0.50$), or on meal energy intake, weighted mean difference −5 kcal (95% CI: −36 to 26, $p = 0.74$), despite the findings of Mathey et al. (2001a) reaching individual significance. The addition of flavour to the whole meal in this study, as opposed to solely the protein component of the meal, may partly explain the differences observed here. It is also important to note the large range of mean differences observed in the Essed et al. (2007) study, which may be reflective of the food intake measure employed: meals and leftovers were weighed as a composite measure as opposed to individualised items, and no reliability data of this measure was provided. Essed et al. (2007) also assessed the effects of the flavour intervention on body fat, as measured by bio-electrical impedance, but in agreement with their findings on body weight above, found no effect of the intervention.

Findings from the two short term non-randomised studies of this intervention type were also discordant. Essed et al. (2009) found no increase in mealtime calorie intake across four meals when foods were flavoured by MSG compared to when cooked as usual. Whereas Appleton et al. (2009) found that despite reporting no increase in meal pleasantness, care home residents consumed significantly more energy (17 kcal (7%)/meal, $p = 0.04$) when sauce was added to their meals compared to when meals were served with no sauce.

3.5.2. Food service interventions

Three RCTs that assessed the effect of alterations to food service on body weight were entered into a meta-analysis with 96 participants in the intervention group and 91 in the control group (Simmons et al., 2008, 2010; Black, 2010). The interventions comprised of provision of snacks (Simmons et al., 2008, 2010) and liberalisation of the diet – that is taking the resident of a therapeutic diet to allow greater choice (Black, 2010). Intervention periods ranged from 6 to 24 weeks. The pooled results (Fig. 4a) indicate no evidence of any effect of food service interventions on body weight, pooled mean difference 0.5 kg (95% CI: −1.1 to 2.1; $p = 0.51$). Two of these studies provided data used in a meta-analysis of the effect of the intervention on BMI (Fig. 4b). There was weak evidence of a favourable effect of the intervention on BMI (pooled mean difference 0.7 kg/m^2, 95% CI: −0.1 to 1.5; $p = 0.07$). Findings from the non-randomised studies were mixed. A controlled six months intervention across three nursing homes in Sweden providing individualised real food snacks, in conjunction with staff training in nutrition care, reported increases in weight (2.3 kg, $p < 0.0001$) and BMI (0.7, $p < 0.05$) (Lorefalt and Wilhelmsson, 2012). In four smaller studies of residents with dementia, little evidence of changes in body weight were observed with either introduction of bulk food service (Desai et al., 2007) or with provision of more

Table 2
Summarised results: the effect of mealtime intervention studies on main nutritional outcomes by intervention type ($n = 37$).

Source	Study design	Weight/weight status	Food/caloric intake	Blood bio-chemistry	Body composition	Nutrition assessment tool	Diet satisfaction/appetite	Quality of life
Food improvement								
Appleton, 2009	Pre–post	–	↑+	–	–	–	→	–
Essed et al., 2007	RCT	→	→	–	→	–	→	–
Essed et al., 2009	Crossover	–	→	–	–	–	–	–
Mathey et al., 2001b	RCT	↑+	↑+	–	–	–	↑+	–
Food service								
Black, 2010	RCT	→	–	↑+/→	–	–	→	–
Cluskey and Dunton, 1999	Pre–post	–	↓+	–	–	–	–	–
Desai et al., 2007	Case-control	→*	↑+	–	–	–	–	–
Dunne et al., 2004	Crossover	–	↑+	–	–	–	–	–
Lorefalt et al., 2011	Controlled trial	↑+	–	–	–	↑+	–	–
Lorefalt and Wilhelmsson, 2012	Controlled trial	↑+	↑+	–	–	↑+	–	–
Shatenstein and Ferland, 2000	Pre–post	→	↑+	↓+/→	→	–	–	–
Simmons et al., 2010	RCT	→	↑+	–	–	–	–	–
Soltesz and Dayton, 1995	Pre–post	→	↑+	–	–	–	–	–
Young et al., 2005	Crossover	→	↑+	–	–	–	–	–
Dining environment								
Brush, 2002	Pre–post	–	↑+	–	–	–	–	–
Charras and Fremontier, 2010	Case-control	↑+	–	–	–	–	–	–
Kenkmann et al., 2010	Case-control	→	–	→	→	–	→	–
Koss and Gilmore, 1998	Pre–post	–	↑+	–	–	–	–	–
Mathey et al., 2001a	RCT	↑+	→	↑+	–	–	–	→/↑+[b]
McDaniel et al., 2001	Pre–post	→	→	–	–	–	–	–
Nijs et al., 2006a[a]	RCT	↑+	–	–	–		–	↑+
Nijs et al., 2006b[a]	RCT	↑+	↑+	–	→	↑+	–	–
Ragneskog et al., 1996	Crossover	–	↑+	–	–	–	–	–
Remsburg et al., 2001	RCT	→	–	→	–	–	–	–
Thomas and Smith, 2009	Crossover	–	→	–	–	–	–	–
Staff training								
Chang and Lin, 2005	RCT	–	→	–	–	–	–	–
Kim and Holme, 1981	Pre–post	–	↑+	–	–	–	–	–
Mamhidir et al., 2007	Controlled trial	↑+	–	–	–	–	–	–
Suominen et al., 2007	Pre–post	→	↑+	–	–	→	–	–
Westergren and Hedin, 2010	Pre–post	↑+	–	–	–	↑+	–	–
Wikby et al., 2009	Controlled trial	↑+	–	→	→	↑+	–	–
Feeding assistance								
Cleary, 2012	Crossover	–	→	–	–	–	–	–
Coyne, 1988	RCT	–	↑+	–	–	–	–	–
Simmons et al., 2001	Pre–post	–	↑+/→	–	–	–	–	–
Simmons and Schnelle, 2004	Pre–post	–	↑+	–	–	–	–	–
Simmons and Schnelle, 2006	Pre–post	–	↑+	–	–	–	–	–
Simmons et al., 2008	RCT	↑+	↑+	–	–	–	–	–

↑+ A statistically significant difference was reported for one or more outcomes included in this category; the direction of the effect was beneficial.
↓+ A statistically significant difference was reported for one or more outcomes included in this category; the direction of the effect was not beneficial.
→ One or more outcomes included in this category was measured in the study – no statistically significant differences were reported.
– No outcomes in this category were measured in the study.
* Significant interaction between food service and BMI.
[a] Same study, reporting different outcome.
[b] Morale-based QOL was comparable between intervention and control, whereas physical autonomy related QOL significantly dropped in control and remained stable for intervention.

accessible (Soltesz and Dayton, 1995) or more familiar foods (Young et al., 2005). However in both the bulk food service interventions (Shatenstein and Ferland, 2000; Desai et al., 2007) weight increased by 0.5–1.5 kg when compared to usual tray service, although the results were not significant at the 5% level.

Although the data prohibited formal meta-analysis, the reported effects on food intake were more uniform. All bar two studies found evidence of increased caloric intakes or higher percentages of meals consumed. In two RCTs, both assessing snack provision compared with usual care, there was weak evidence of increased daily caloric intakes; Simmons et al. (2010) observing increases of over 20% ($p < 0.000$) and Simmons et al. (2008) reporting increases of 132 kcal (~12%) ($p = 0.08$). Provision of real food snacks also resulted in 20–25% higher caloric intakes in both a short-term two day pilot intervention (Simmons and Schnelle, 2004) and a longer-term three month controlled trial (Lorefalt and Wilhelmsson, 2012). The only study to find a negative impact of changing food service was the study by Cluskey and Dunton (1999) who assessed the effects of reducing portion size to ascertain whether this might increase appetite. Predictably perhaps, when served smaller portions, residents consumed less food (approx. 15–20% less) and appetite was not improved as had been predicted. For the studies in residents with dementia, bulk food service resulted in approximately 20% increases in caloric intake (Desai et al., 2007; Shatenstein and Ferland, 2000), introduction of more familiar foods a 6% increase in caloric intake (Young et al., 2005), provision of more accessible foods a 3.5% increase in the percentage of the meal eaten (Soltesz and Dayton, 1995) and enhancements to visual contrast using brighter crockery, a 25% increase in percentage meal eaten (Dunne et al., 2004).

There was mixed findings relating to biochemical indices of nutritional status in the two studies that assessed them

Table 3
Indicators of study quality.

	Random sequence generation	Allocation concealment	Blinding of outcome assessment	Outcome data reported	Non-selective reporting	Eligibility criteria specified	Power calculations made	Baseline similar/imbalances adjusted	Compliance with intervention	Data collection tools valid and reliable	All participants accounted for	Appropriate analyses
RCTs												
Black, 2010	Y	?	?	Y	Y	N	N	Y	?	?	Y	?
Chang and Lin, 2005	Y	na	?	?	Y	Y	N	N	?	?	N	Y
Coyne, 1988	Y	Y	Y	Y	Y	Y	Y	N	?	?	Y	?
Essed et al., 2007	?	?	?	Y	Y	Y	Y	Y	Y	?	Y	Y
Mathey et al., 2001a	?	?	Y/?	N	N	Y	N	Y	?	Y/N	Y	?
Mathey et al., 2001b	?	?	?	?	Y	Y	Y	Y	Y	Y	N	Y
Nijs et al., 2006a	?	na	?	Y	Y	Y	Y	Y	?	Y	Y	Y
Nijs et al., 2006b	?	na	?	Y	Y	Y	Y	Y	?	Y	Y	Y
Remsburg et al., 2001	?	?	?	Y	Y	Y	Y	Y	?	Y	Y	Y
Simmons et al., 2008	Y	N	Y	?	?	Y	N	Y	?	Y	Y	?
Simmons et al., 2010	?	?	N	Y	Y	Y	N	Y	?	Y	Y	Y
Young et al., 2005	?	N	N	N	?	Y	Y	Y	?	?	Y	?
Non RCTs												
Appleton, 2009	na	na	N	Y	Y	Y	Y	na	?	?	Y	?
Brush, 2002	na	na	?	Y	Y	Y	N	na	?	?	Y	?
Charras and Fremontier, 2010	na	na	?	Y	Y	?	N	Y	?	Y	Y	?
Cleary, 2012	na	na	N	Y	?	Y	N	na	?	?	Y	na
Cluskey and Dunton, 1999	na	na	?	N	Y	N	N	na	?	N	N	?
Desai et al., 2007	na	na	?	Y	Y	Y	Y	Y	Y	?	Y	Y
Dunne et al., 2004	na	na	?	Y	?	Y	N	na	Y	?	Y	?
Essed et al., 2009	na	na	?	Y	Y	Y	N	na	Y	?	Y	?
Kenkmann et al., 2010	na	na	Y	?	Y	N	N	Y	Y	Y	?	Y
Kim and Holme, 1981	na	na	?	?	Y	N	N	na	?	N	Y	Y
Koss and Gilmore, 1998	na	na	N	Y	Y	N	N	na	?	N	Y	?
Lorefalt et al., 2011	na	na	N	?	N	Y	N	Y	?	Y	Y	?
Lorefalt and Wilhelmsson, 2012	na	na	?	?	Y	N	N	na	Y	?	Y	?
Mamhidir et al., 2007	na	na	N	?	?	N	N	?	?	Y	Y	?
McDaniel et al., 2001	na	na	?	Y	Y	Y	N	na	?	?	Y	Y
Ragneskog et al., 1996	na	na	?	Y	?	?	N	na	?	?	Y	?
Shatenstein and Ferland, 2000	na	na	N	?	?	Y	N	na	?	Y	Y	Y
Simmons et al., 2001	na	na	Y	Y	Y	Y	N	na	Y	Y	Y	Y
Simmons and Schnelle, 2004	na	na	N	Y	Y	Y	N	na	Y	Y	Y	?
Simmons and Schnelle, 2006	na	na	N	Y	Y	Y	N	na	Y	Y	Y	Y
Soltesz and Dayton, 1995	na	na	?	Y	Y	?	N	na	?	?	?	?
Suominen et al., 2007	na	na	N	?	N	N	N	na	?	?	Y	?
Thomas and Smith, 2009	na	na	?	N	N	Y	N	na	?	Y	?	na
Westergren and Hedin, 2010	na	na	?	N	Y	N	N	Y	?	Y	N	Y
Wikby et al., 2009	na	na	N	Y	Y	Y	N	?	?	Y	?	?

Y, described in paper; N, not described in paper; na, not applicable; ?, unclear.

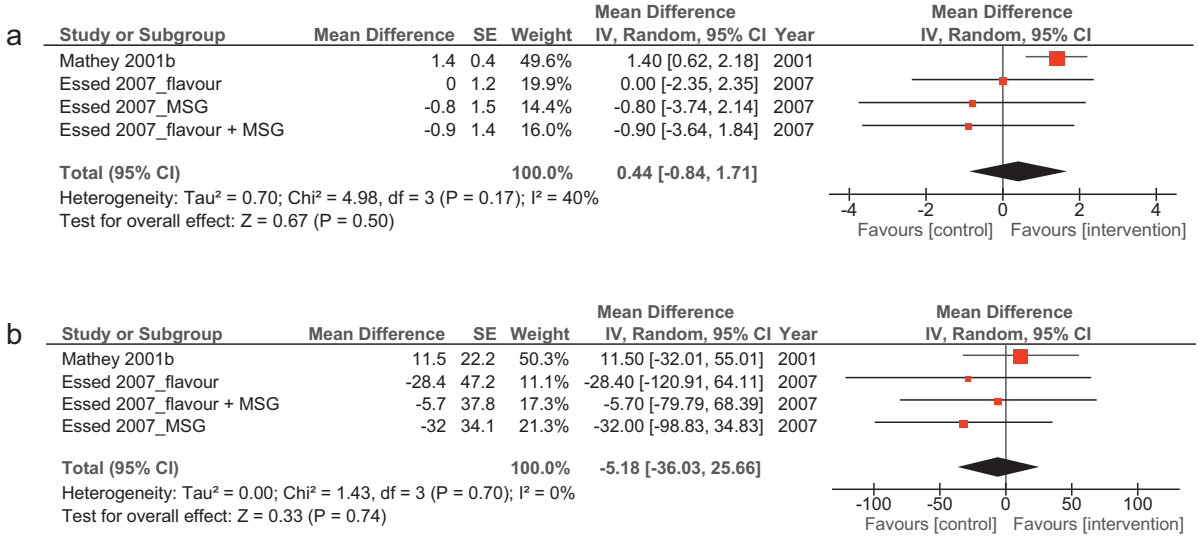

Fig. 3. (a) Meta-analysis of effect of food improvement interventions on body weight (kg). (b) Meta-analysis of effect of food improvement interventions on meal energy intake (kcal).

(Shatenstein and Ferland, 2000; Black, 2010). Black (2010) found significantly increased serum albumin but no effect on haemoglobin for elderly residents in long term care after a RCT assessing liberalisation of the diet, whereas Shatenstein and Ferland (2000) observed a significant decrease in serum albumin but no change in haemoglobin for residents after a 10 week trial of meals being portioned out at the ward level. Neither paper reported data on inflammation or underlying disease states of the residents which are known to impact to different degrees on serum protein levels. Furthermore, in this study, there was no observed effect on body composition, as measured by mid-upper arm circumference and triceps skinfold thickness.

3.5.3. *Dining environment*

Of the eleven studies of this intervention type, three employed a RCT design and assessed comparable nutritional outcomes, and were therefore deemed eligible for meta-analysis (Remsburg et al., 2001; Mathey et al., 2001b; Nijs et al., 2006b). All three assessed the effect of enhancing the ambience of the dining room environment along with the introduction of family style meals and greater staff assistance on resident body weight. The three interventions ranged from three months to one year in length, with the follow-up data point furthest from the commencement of the intervention used for each study. In total, 112 participants and 126 control participants were entered into the meta-analysis (see forest plot in Fig. 5a). Whilst no overall significant effect of intervention on body weight was observed (weighted mean difference 1.1 kg, 95% CI: −0.7 to 2.8, $p = 0.24$), these results favour the intervention with the study by Nijs et al. (2006a) reaching individual significance. Two of the above studies could also be pooled to assess the effect on daily energy intake (see Fig. 5b). Again, whilst no overall significant effect of intervention was observed (weighted mean difference 181 kcal/day, 95% CI: −5 to 327, $p = 0.06$), these results favour the intervention and approach significance with the study by Nijs et al. (2006a) reaching individual significance.

Findings from the non randomised studies were also mixed. Kenkmann et al. (2010) observed no effect on weight gain (1.05 kg, 95% CI: −0.97 to 3.06, $p = 0.31$) in a one year case-control study trialling more home-like conditions compared to usual conditions, in both general and dementia care homes. Whilst Charras and Fremontier (2010) reported increased body weight (3.4 kg) in dementia residents who experienced a three month

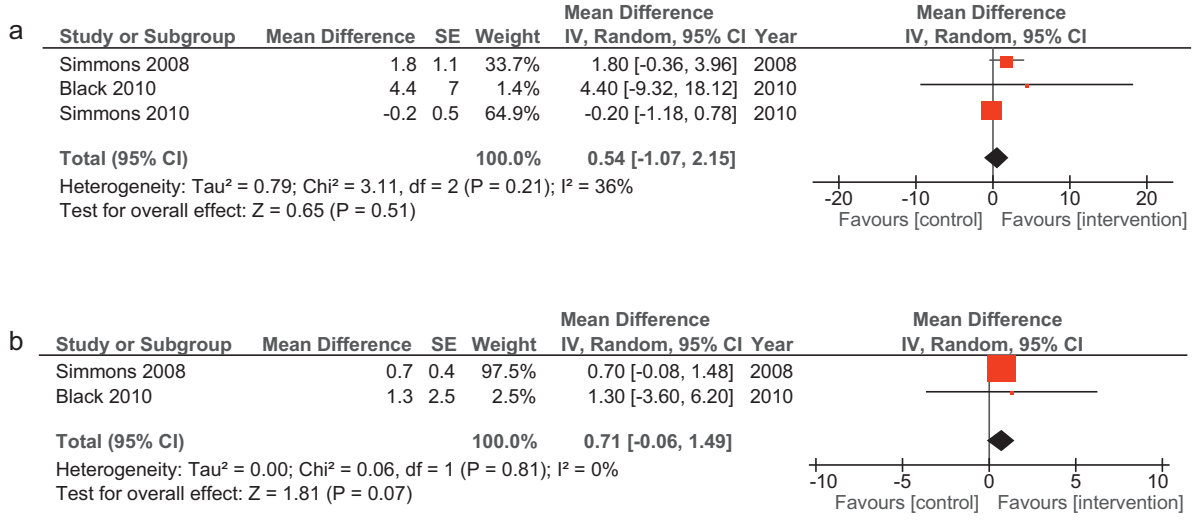

Fig. 4. (a) Meta-analysis of effect of food service interventions on body weight (kg). (b) Meta-analysis of effect of food service interventions on body mass index (kg/m^2).

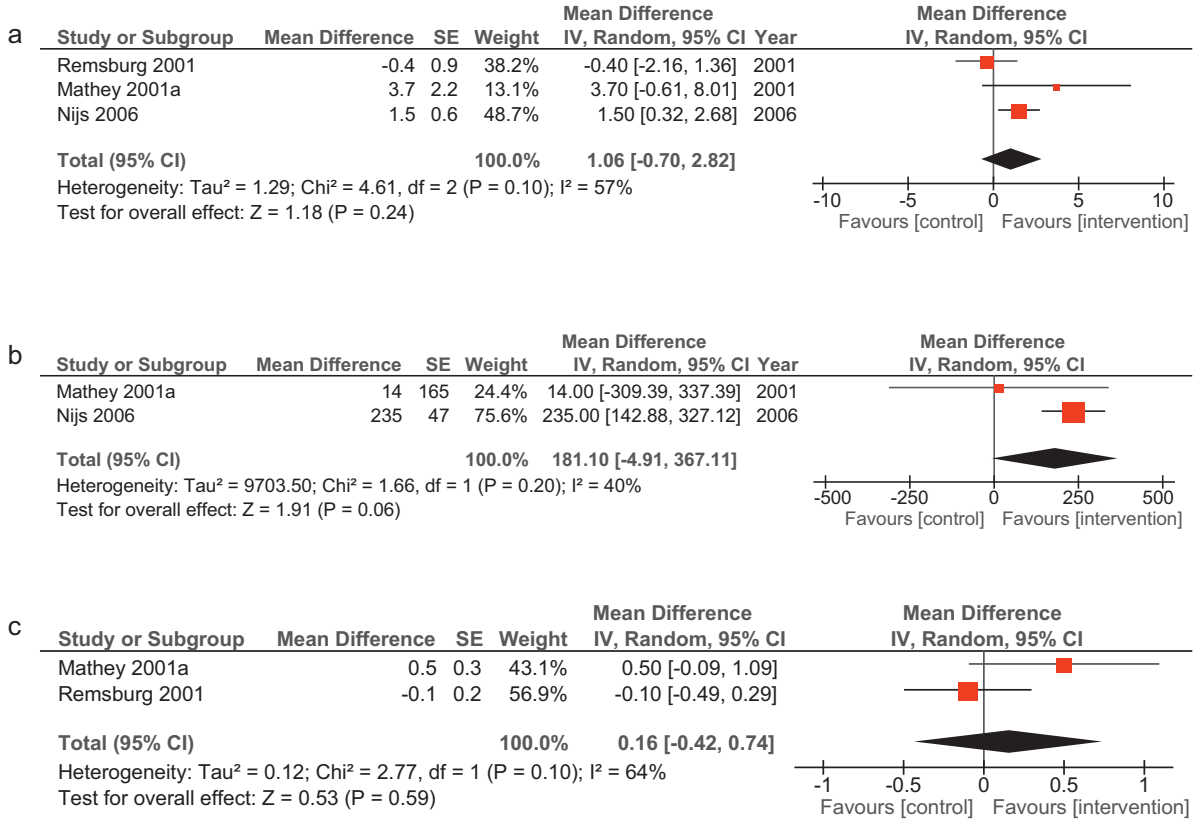

Fig. 5. (a) Effects of dining environment interventions on body weight (kg). (b) Effects of dining environment interventions on meal energy intake (kcal). (c) Effects of dining environment interventions on haemoglobin (mmol/l).

eating-meals-with-staff programme in a more home-like environment compared to weight loss (2.2 kg) in those experiencing usual dining rules and environment ($p < 0.024$). Further, in dementia residential care whilst some have observed no effect on body weight and/or food intake with improved lighting alone (McDaniel et al., 2001) or the playing of music during mealtimes (Thomas and Smith, 2009), others have found higher mealtime calorie intakes with some types of music, but not all (Ragneskog et al., 1996). Higher mealtime calorie intakes were also reported when improved lighting was provided in addition to visual enhancement of crockery (Koss and Gilmore, 1998; Brush, 2002).

Biochemical indices were used as outcome measures in three studies, all of which assessed changes to haemoglobin levels (Mathey et al., 2001b; Remsburg et al., 2001; Kenkmann et al., 2010). In accordance with the findings on body weight, a meta-analysis of the studies by Mathey et al. (2001b) and Remsburg et al. (2001) indicated no effect of flavour enhancement on haemoglobin, weighted mean difference 0.16 mmol/l (95% CI: −0.49 to 0.29, $p = 0.59$) – see Fig. 5c. The non-randomised study by Kenkmann et al. (2010) supported these findings, showing no effect of intervention on resident haemoglobin levels (comparative data not presented but reported in text). No significant effect on other biochemical indices of nutritional status, specifically haematocrit levels and pre-albumin, were observed (Mathey et al., 2001b; Remsburg et al., 2001).

Effects on body composition and/or physical function were assessed in two studies: the case-control study by Kenkmann et al. (2010) and the RCT by Nijs et al. (2006a), both described earlier in this section. Kenkmann et al. (2010) found no effect on mid-upper arm circumference or grip strength. Nijs et al. (2006a) found body fat free mass (measured by impedance) to fall across both control and intervention groups, though fell less in the group experiencing improved mealtime ambience (estimated difference between groups was 1.3 kg (95% 0.12–2.4). They also observed the intervention group to improve in the overall MNA score (95% CI: 1.5–03.4), whereas the control groups significantly worsened (95% CI: −01 to 3.1). Consequently those classified as malnourished fell from 17% to 4% in the intervention group, whereas this percentage increased from 11% to 23% in the control group.

The effect of the intervention on quality of life was also assessed in two of the RCTs (Mathey et al., 2001b; Nijs et al., 2006a). In both studies, eating in the enhanced dining environment was associated with maintenance of reported quality of life compared to a significant drop in reported quality of life in residents eating in their usual dining conditions.

3.5.4. *Staff training*

Education training frequency and length ranged, at the shortest, from 4 × 1 h over two days for a feeding skills programme (Chang and Lin, 2005), up to 6 × 2–3 h sessions over six months for broader nutrition education training interventions (Suominen et al., 2007; Westergren and Hedin, 2010) and a dementia-specific nutrition course which ran over 38 h (20 h of lectures, 18 h of group discussion) over three months (Mamhidir et al., 2007).

There were not sufficient robust data for meta-analyses amongst this intervention type. Resident body weight or weight status was the most common nutritional outcome assessed across the studies. In two pre–post studies from Sweden, one multifaceted (Lorefalt and Wilhelmsson, 2012) and one education only (Wikby et al., 2009), increases of 1–2 kg body weight across a 3–4 month period were observed amongst the residents in homes where staff had received education. However, Wikby et al. (2009) also observed a comparable increase amongst the residents in the control homes, which they attributed to possible 'contamination' by

nursing staff aware of what was happening in other homes, or simply being aware of being studied and improving their routine practice. Further, whilst there was no differences between intervention and control residents in biochemical measures of nutrition statues (albumin and transthyretin), nor in measures of body composition (arm muscle circumference and triceps skinfold thickness), a composite measure used to assess malnutrition did show a significant reduction in those assessed as malnourished over the 4 months in the intervention, which was not observed in the control group. Motor function also significantly improved in the intervention (education) arm compared to control.

Westergren and Hedin (2010) noted a significant decrease of malnourished residents (assessed as a composite measure of nutrition status outcomes) across a group of Swedish nursing homes implementing nutrition study circles compared to those following usual care over the course of two years. In the two studies devoted to residents with dementia, the controlled trial observed that residents managed by staff receiving the intervention maintained or gained weight compared to weight loss seen in the 'control' ward (Mamhidir et al., 2007), whilst the pre–post observation study of 21 residents, found little difference in resident weight status despite a six month education intervention (Suominen et al., 2007). The only RCT within this intervention type, also with residents with dementia, found no change in daily energy intakes, despite significant increases in nurses' nutrition knowledge and attitudes (Chang and Lin, 2005). This contrasts against two observational studies which found significant positive intervention effects on resident daily energy intakes (approx. 200–250 kcal/day) (Kim and Holme, 1981; Suominen et al., 2007).

3.5.5. Feeding assistance

There were not sufficient robust data for meta-analyses amongst this intervention type. The only study to report on body weight or weight status observed residents gaining just under 2 kg over six months when receiving feeding assistance either in the form of one to one mealtime assistance or between meal snacks when compared to controls (Simmons et al., 2008). The authors in this study did not present analyses on which part of the intervention was more successful, despite having data on those who received feeding assistance and those who received between meal snacks. Food intake, either as percentage of the meal eaten, or a more indirect measure of eating performance, was reported in five studies (Coyne, 1988; Simmons et al., 2001, 2008; Simmons and Schnelle, 2004, 2006). One to one feeding assistance was shown to improve the amount of a meal consumed by approximately 25% in three observational pre–post studies (Simmons et al., 2001; Simmons and Schnelle, 2004, 2006). In an RCT of 24 residents with dementia, those randomised to verbal prompts and positive reinforcement significantly improved their eating and drinking independence compared to those receiving usual care (Coyne, 1988). Marginal, though not significant, improvements in percentage food intake were also recorded in a pre–post trial of reminiscence therapy during mealtimes in seven residents with dementia (Cleary, 2012). Daily energy intake was also assessed in two studies (Simmons and Schnelle, 2004; Simmons et al., 2008). In a crossover cluster RCT across four nursing homes, feeding assistance and/or the provision of snacks between meals, resulted in a significant increase of daily calories (between 200 and 300 kcal/day) compared to usual care (Simmons et al., 2008), but as noted above, the authors in this study did not present analyses on which part of the intervention was more successful. An earlier study by the same lead author, also found a positive increase of approximately 250 kcal (~26% increase) in a pre–post design feeding assistance study of 134 nursing home residents (Simmons and Schnelle, 2004).

4. Discussion

This systematic review included 36 studies (37 articles) that examined whether mealtime interventions can improve nutritional outcomes for elderly people living in residential care. Examples of mealtime aspects that were studied included the mode in which food was presented to the resident, the ambience of the room in which the resident ate, the rules regarding food availability and choice, and the provision of mealtime assistance. Indeed there was considerable variety both in the type of intervention tested and nutritional outcomes assessed, but also in the study designs, sample sizes and quality of the study reporting. The overall quality of the included studies in the review was low. This is partly due to the range of study designs that were allowed for inclusion. The aim of the review was to ascertain whether mealtime practices in long term care improve nutritional outcomes for residents and had this been restricted to RCTs, we would not have gained the broad picture of interventions that have been studied. Thus, few of the studies included were randomised or blinded. That said, in studies involving food and mealtimes in institutional settings, there are considerable practical difficulties in ensuring blinding of intervention allocation (e.g. provision of snacks) and also too in outcome measurement, especially food intake.

4.1. Comparison with the literature

The two main nutritional outcomes assessed were changes to resident body weight/weight status and resident food/caloric intake. The review found some evidence to suggest that it is possible to maintain and or improve resident body weight through a variety of methods. Direct interventions of food assistance or food improvement, as well as more indirect interventions such as improving the ambience of the eating environment resulted in positive findings. Improving the nutritional knowledge of care home staff also resulted in positive effects of weight status in some studies. Clinically significant weight gains of 1–2 kg over the course of one to six months were observed in eight studies (Mathey et al., 2001a,b; Nijs et al., 2006a; Mamhidir et al., 2007; Simmons et al., 2008; Charras and Fremontier, 2010; Lorefalt et al., 2011; Lorefalt and Wilhelmsson, 2012; Westergren and Hedin, 2010), however few of them were RCTs and only one of the three meta-analyses pooling weight gain data was suggestive of finding a positive effect of the intervention. That said, in only one of the remaining twelve studies that showed no significant change in weight status with intervention compared to control (which in most cases was usual care), was there any suggestion of weight loss (Essed et al., 2007).

Maintenance of body weight is a critical issue in long term care. Unintentional weight loss is associated with higher risks of infection, muscle wasting, decreased immune-competence and increased risks of infection (Amaral et al., 2007; Salva et al., 2009). Whilst commercial oral supplements have been shown to have a small but consistent effect on weight gain in the elderly, of approximately 1.2 kg (for a 55 kg older person), they are not without cost and are prone to taste fatigue. Further sip-feeds do not allow for continuation of the socio-cultural enjoyment of eating that is important for the elderly, especially those in long term care who have been removed from their usual home and routine (Leslie, 2011). Whilst there were only isolated cases, comparable weight gains to those observed with oral supplements were observed by simple interventions such as sprinkling flavours on food prior to service (Mathey et al., 2001a), making small changes to the dining room and eating routines and practices (Mathey et al., 2001b; Nijs et al., 2006b) and provision of real food snacks (Lorefalt and Wilhelmsson, 2012). Moreover, in the

few studies that assessed it, there was some evidence to suggest that improving the overall dining environment was indeed associated with improved reported quality of life. Provision of an environment conducive to resident enjoying and being able to eat their food are indeed part of the Government's nutrition action plan (Department of Health, 2007). More research assessing how to maintain the important socio-cultural aspect of food and mealtimes for the elderly in the care home setting is required.

Whilst effects on body weight were inconsistent, there was more uniformity in the effects of mealtime interventions on food intake. Twenty-one studies found increases in either energy intake at the meal or daily level, or in the percentage of food eaten. Although the validity and reliability of outcome measurement was not reported in many of these studies, and thus these finding could be due to bias, these effects were observed across a range of intervention types, with only eight (out of 29) studies finding no effect on intakes. Interventions altering the food service and those aimed at providing feeding assistance produced the most consistent positive effects on food intakes, though increased intakes were observed across all intervention types. Improvements in food intake and weight status were observed in general care home residents as well as those specialising in dementia.

The fact that increased intakes did not always translate into weight gain (Soltesz and Dayton, 1995; Shatenstein and Ferland, 2000; McDaniel et al., 2001; Young et al., 2005; Suominen et al., 2007; Desai et al., 2007), should perhaps not be unexpected. The interventions may not have been substantial enough or long enough to elicit changes to body composition, and in many cases, underlying disease states or activity levels were either not measured or not reported, raising the possibility of confounding. Indeed, populations of care homes are likely to be suffering from a range of illnesses, many of which would affect the body's ability to gain weight. In six of the seven studies that observed this discordance, the residents had dementia. Raised metabolism and increased energy expenditures have been purported to explain why weight loss is more common in dementia, especially as dementia progresses (Keller et al., 2003). The mismatch between increased intakes and yet no effect on weight could be explained by raised energy demands, with the observed increases in food intake insufficient to surpass the already increased metabolic needs. Moreover, a sustained net energy balance is needed to gain weight and very few studies measured more than the 'pre' and 'post' intakes, which does not take account of changes in intakes throughout the full period of the intervention. Indeed compliance of intervention in many studies was lacking or not reported. This requires more detailed investigation. Nevertheless, maintenance of weight, as opposed to weight loss is a clinically important outcome for residents in long term care, especially those with dementia.

Few of the studies across the intervention types observed any effect on biochemical indicators of nutritional status (Shatenstein and Ferland, 2000; Remsburg et al., 2001; Wikby et al., 2009; Black, 2010; Kenkmann et al., 2010). Biochemical markers of nutritional status are very susceptible to underlying disease states, which were not commonly measured or reported. Indeed, serum proteins are neither specific, nor sensitive indicators of nutrition status (Parrish, 2006). Further, since there was limited evidence of improved energy balance (weight gain), it is not surprising that the intervention did not show any effect as measured by biochemical indices. Likewise there was limited success in the interventions resulting in positive changes to body composition. As has been stated, a sustained positive energy balance is required for this and the majority of studies did not measure or report on compliance to the intervention. Longer and more robust studies are needed to ascertain whether mealtime interventions can result in improvement in these longer term markers of nutritional status.

4.2. Strengths and limitations

This is the first systematic review of non-supplementation based mealtime interventions for residents of long term care. The review followed best practice guidelines for systematic reviews (Centre for Reviews and Dissemination, 2009) and did not restrict by date or language. Whilst we endeavoured to ascertain which types of nutrition intervention are more effective in the residential setting, we acknowledge that the categories we used may have not fully accounted for all components of the intervention. Further, whilst it was intended that we would be able to pool the data for meta-analysis, the limited number of randomised controlled trials, the availability of data, and the wide variation in intervention type meant that we were restricted to a few small meta-analyses within only three of the intervention types. In general, most of the studies were either too small in number or too short in time to be powered to detect any change in nutritional outcome. In addition, the reporting of the studies, especially with regards to compliance of the intervention and blinding and validity of outcome measurements was poor.

4.3. Implications for clinical practice

Provision of real-food snacks resulted in 20–25% higher caloric intakes (Simmons et al., 2010; Lorefalt and Wilhelmsson, 2012), and clinically significant weight gain. Real food snacks may be more appealing both in taste and familiarity to the elderly than commercial sip-feeds, and might be a simple practice for care homes to undertake with relatively little cost. Indeed, food snacks have been shown to be more cost effective and more appealing than oral supplements, to those in care homes (Simmons et al., 2010). Familiarity with more home-like conditions may help explain the comparable increases in caloric intake that were observed with the switching to a bulk food delivery. The studies that enhanced the dining room also included this aspect of the residents being able to help themselves and/or have more choice in what they ate. This aligns well with the UK government's eating plan (Department of Health, 2007) and published recommendations for nutrition care for residents in long term care (Salva et al., 2009; Leslie, 2011). This aspect of food service warrants exploring further in more controlled pragmatic studies that can consider implications for care home policies, staffing and expenses. Feeding assistance also resulted in increased food intakes in five of the six studies. This is in agreement with the review by Green and colleagues (Green et al., 2011), who found that feeding assistance by volunteers helped improve the mealtime care of institutionalised adults, though well designed studies were scarce and the authors recognised the need for more robust studies assessing effectiveness and cost implications. Again, prioritisation of training for staff in nutritional care and assistance with eating is part of the Government's nutrition care plan (Department of Health, 2007), and has been cited by some as critical step to ensuring adequate nutrition (Leach et al., 2013). However, the degree to which this is achieved in practice is unknown.

5. Conclusions

The need to improve the nutrition of the elderly living in long term care has long been recognised. Individual studies within this review have shown there are simple components of everyday practice within the care home setting that can be altered to improve nutritional care. Large scale multi-centre pragmatic trials

are however still required to establish the full efficacy of such interventions and cost implications.

Funding

This systematic review was funded by National Institute for Health Research through Peninsula CLAHRC. This review presents independent research commissioned by the National Institute for Health Research (NIHR). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the NIHR, or the Department of Health.

Competing interests

All authors declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; and no other relationships or activities that could appear to have influenced the submitted work.

Contribution of authors

RA, RW and JTC conceived the idea for the review and RA is the study guarantor. All authors contributed to the design of the review, interpreted the data, critically revised the manuscript for important intellectual content and approved the final versions. All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. RA and RW screened titles, abstracts and full texts and applied inclusion and exclusion criteria, with JTC acting as a third reviewer where necessary. RA and RW performed data extraction and quality appraisal and checked data extraction. RA and RW drafted the manuscript. AB and MR devised the search strategy and ran the literature searches. RA and RW carried out hand searches of the bibliographies of included papers and reviews identified during the process. OU conducted the analyses.

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