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REVIEW

Systematic review and meta-analyses of foodservice interventions and their effect on nutritional outcomes and satisfaction of adult oncology patients

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Abstract

Aim: An understanding of effective foodservice interventions on nutrition outcomes in adult patients with cancer is required to support clinical decision making. This systematic review aimed to determine the effect of foodservice interventions across a range of nutritional outcomes and satisfaction of hospitalised and ambulatory adult oncology patients.

Methods: The review protocol was registered with PROSPERO (CRD42016045772). Six databases were searched using search terms associated with the intervention and population. No date or language restrictions were applied. Authors applied the inclusion criteria to titles and abstracts and then full-text papers. The final library was assessed for risk of bias. Outcome data were combined narratively and, where possible, by meta-analysis.

Results: From the title and abstract review of 4414 studies, 12 studies testing the effect of foodservice interventions were included in this review. Meta-analyses demonstrated significantly greater energy (mean difference 1.54 MJ/day; 95% CI 0.85–2.23 MJ/day) and protein (mean difference 18.98 g/day; 95% CI 11.58–26.39 g/day) intake through the addition of oral nutrition supplements. Other positive effects on anthropometric outcomes were also recorded. Patient satisfaction was enhanced through other foodservice interventions.

Conclusions: Limited original research was found exploring the effect of foodservice interventions in oncology patients. Significant findings were found in favour of the intervention across a range of nutritional outcomes, suggesting that foodservice interventions may improve clinical outcomes and satisfaction in this population. Effective foodservice interventions for oncology patients remain under-researched, so we encourage dietitians and foodservice staff to implement rigorous study designs to evaluate and publish interventions in this clinical group.

Key words: adult, foodservice, oncology, oral nutrition supplement, systematic review.

Introduction

Malnutrition is common in patients receiving cancer treatment and is associated with poorer patient outcomes and increased health-care costs as a result of increased complications, longer length of stay and unplanned hospital admissions.[1,2] Early risk identification and timely intervention to address malnutrition ensures that these poorer outcomes and costs are limited.[2]

The provision of safe and nutritious food and fluids within health services is an essential element of patient care. Hospitalised patients represent a diverse group with varied clinical and cultural needs, and many are either malnourished on admission or become so during their admission. Oncology patients face unique challenges that put them at an increased risk of malnutrition. Some are already malnourished at presentation because of eating and drinking difficulties caused by the tumour location.[3] Nutritional status can deteriorate further secondary to the side-effects of radiotherapy or chemotherapy treatment or surgical intervention. Side-effects such as mucositis, odynophagia, dysphagia, xerostomia, trismus and changes in taste and appetite are common.[3] An important step towards reducing malnutrition prevalence is through appropriate interventions including those in the area of hospital foodservices. Providing timely and appropriate nutrition care will also assist with treatment and recovery and can improve a patient's experience of their care and quality of life.[4,5]

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Findings from the Malnutrition in Victorian Cancer Services point prevalence study[6] concluded that malnutrition was present in patients with all types of cancers, although it was more prevalent in patients with a cancer directly affecting the digestive tract, including head and neck, gastrointestinal and colorectal cancer, and also in patients with lung and haematological cancer. Malnourished patients had higher 30-day mortality, and a greater number required admission or readmission within 30 days. The majority of patients were reliant on food and oral nutrition supplements (ONS) to meet their needs, with only a small proportion (2.5%) of patients receiving tube or intravenous feeding. The high proportion of oncology patients reliant on food and oral ONS highlighted the importance of the quality and nutritional content of hospital meals and snacks as well as appropriate foodservice models to deliver the right food and beverages to the right patients at the right time.

Variable hospital foodservice systems exist across all health services, usually implemented to meet broad patient and operational needs. It is unclear what the most appropriate hospital foodservice models are to best support oncology patients.[6] This systematic review aimed to determine the effect of foodservice interventions on nutritional outcomes and satisfaction of hospitalised and ambulatory adults with cancer. This review supports the work of the Malnutrition in Victorian Cancer Services Foodservice Model project, a Victorian Department of Health and Human Services-funded project.

Methods

The protocol for this review was registered on the PROSPERO international prospective register of systematic reviews: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID = CRD42016045772

Eligibility criteria for this review were developed using the PICOS (Participant–Intervention–Comparator–Outcomes–Study design) format of Liberati *et al*.[7] Studies conducted with hospitalised and ambulatory adult oncology patients (aged ≥18 years) were considered. Studies that tested a foodservice intervention (e.g. menu and service modification, addition of ONS or enhanced eating environments) and compared this with standard/usual care were eligible for inclusion. Trials of micronutrient interventions or studies investigating standard versus specialised ONS products were ineligible, as were enteral or parenteral nutrition studies. The primary outcome measures were nutritional outcome, including energy and protein intake, weight change and other anthropometric measurements, as well as patient satisfaction with the intervention. Food waste was a secondary outcome. Full-text papers of prospective research were eligible for inclusion, whilst conference abstracts, narratives and commentaries, reviews and retrospective audits were ineligible.

Studies were identified by searching six databases and scanning the reference lists of included studies. The databases searched were: Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to present; PsycINFO (Ovid); CINAHL Plus with full text (EBSCOhost); EMBASE (Embase.com); Informit Health Collection & Informit Humanities & Social Sciences Collection; and the Cochrane Library. No restrictions on language or date were applied.

Search terms were developed through the exploration of the relevant literature and refined through consultation with a specialist medical librarian who subsequently ran the database searches. Searches were run between 7 and 13 July 2016. A combination of subject headings relevant to each database and textword phrases were used. Figure 1 sets out the initial search strategy run in Ovid Medline. This strategy was then adapted as appropriate for the other databases.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[7] guided the process of study identification, screening and eligibility assessment. After the removal of duplicates, two authors independently screened titles and abstracts and then independently reviewed the full texts of the remaining papers to identify publications for inclusion. Conflicting opinions were resolved through discussion. Reference lists of included publications were hand searched, but no additional studies were identified for inclusion.

A standard template was developed and piloted to extract data. This related to the study method, intervention and outcomes. Because of the extended time interval since many studies were undertaken, it was not considered feasible to contact authors for additional data. Data were determined from graphs when not presented in text.

Methodological quality of the final library was evaluated independently by two authors using the Cochrane risk of bias tool.[8] This tool addressed six domains: the level of selection bias, performance bias, detection bias, attrition bias, reporting bias and other forms of bias. Each domain was rated for each study as high risk of bias, low risk of bias or unclear risk of bias according to the Cochrane guidelines.

Meta-analyses were undertaken on outcomes where there was homogeneity in study design, and all required data were published. Results for energy and protein intake of randomised control trials of ONS interventions compared with a control were considered appropriate for meta-analysis. The mean difference (MD) and 95% confidence interval (95% CI) between groups was calculated using a random effects model in Review Manager (Version 5.3). A mean difference effect measure was selected because of the similar study design and outcome measures used across the included studies. Heterogeneity between studies was determined using the I^2 statistic. Subgroup analysis where studies at a high risk of bias were removed to determine their effect on the overall results was not undertaken because of the unclear measure of bias generally across all studies.

Results

The total yield from all databases was 6215 results, reduced to 4414 after the removal of duplicates. Following

1. *neoplasms/ or exp *neoplasms by histologic type/ or exp *neoplasms by site/ or exp *neoplasms, hormone-dependent/ or exp *neoplasms, multiple primary/ or *neoplasms, post-traumatic/ or exp *neoplasms, radiation-induced/ or *neoplasms, second primary/ or Cancer Care Facilities/ or Oncology Service, Hospital/
2. (neoplasm* or cancer* or oncolog* or tumor* or tumour* or glioma* or glioblastoma* or neoplastic* or leukaemia* or leukemia* or lymphoma* or malignant or malignancy or melanoma* or carcinoma* or chemotherapy or radiotherapy or radiation therapy).ti.
3. 1 or 2
4. nutrition therapy/ or exp diet therapy/ or nutritional support/ or enteral nutrition/ or food services/ or food service, hospital/ or menu planning/ or Nutritionists/ or Feeding Behavior/ or exp dietary supplements/ or food, fortified/ or Dietary Services/
5. (food* or menu* or meal* or nutrition* or malnutrition or diet* or snack* or cook* or feed or feeding or eat* or cater* or red tray* or dining or supplements or calory or calories or kilojoule* or energy intake or enteral).ti.
6. (food service* or food provision or food fortification or menu plan* or meal order* or meal distribution or fortified meal* or mealtime or meal time or nutritionist or nutritional support* or dietitian* or dietician* or diet therapist* or diet service* or hospital cater*).ti,ab.
7. diet therapy.fs.
8. 4 or 5 or 6 or 7
9. Cancer Care Facilities/ or Oncology Service, Hospital/ or exp Hospitalization/ or inpatients/ or outpatients/ or exp Hospitals/ or exp Hospital Units/ or Food Service, Hospital/ or Ambulatory Care/ or ambulatory care facilities/ or exp outpatient clinics, hospital/ or Hospices/
10. (hospital* or inpatient* or outpatient* or cancer cent* or cancer treatment cent* or cancer service* or ward* or oncology department* or oncology service* or ambulatory care or hospice*).ti,ab.
11. 9 or 10
12. 3 and 8 and 11
13. (child* or pediatric* or paediatric* or infant*).ti.
14. 12 not 13

[1] Search strategy used in Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to present and adjusted as necessary for other databases.

Figure 1 Medline search strategy for systematic review of foodservice interventions in adult cancer patients.

the full-text review, 12 studies fulfilled the eligibility criteria (Figure 2). Many papers that explored the effect of nutrition counselling versus usual care and clinical trials comparing specialised ONS products against standard ONS products were ineligible for inclusion. Several papers explored different hospital foodservice approaches in a paediatric population; these too were beyond the scope of this review. No previous reviews that explored foodservice interventions in the management of adult oncology patients were identified. Table 1 highlights the diversity of the included studies, with a broad range of geographical locations and cancer populations included in the final library.

Included studies were conducted across the time period 1981–2014, indicating that this area of research has been of clinical interest for some time. Ten studies examined the effect of ONS products on a range of clinical outcomes; nine of these were randomised controlled trials[9–18] (Table 2), whilst two other studies tested other foodservice interventions. These were training kitchen staff as food caregivers[19] and a comparison of point-of-service meal selection from an electronic food cart compared with a traditional tray service.[20]

The meta-analysis of the energy intake of four studies where mean and standard deviations were reported showed the beneficial effect of ONS products compared with a non-supplement control. Meta-analyses demonstrated significantly greater energy (mean difference: 1.54 MJ/day; 95% CI 0.85–2.23 MJ/day) and protein (mean difference: 18.98 g/day; 95% CI 11.58–26.39 g/day) intake through the addition of ONS. There was a significant overall effect in favour of the intervention on energy intake ($P < 0.0001$) and protein intake ($P < 0.00001$). Heterogeneity across the studies included in the meta-analyses was high for energy intake (Figure 3) and low for protein intake (Figure 4). Other included studies of ONS unable to be included in the meta-analysis generally yielded findings in favour of the intervention. None of the studies of ONS reported on patient satisfaction.

Other outcomes were also considered by authors. Body weight was preserved more consistently in studies of ONS. Lean body mass increased[17] as did BMI in one[11] of two studies.[11,15] Nutritional status, measured by patient generated—subjective global assessment (PG-SGA), in the two studies of Ravasco[15,16] was enhanced through the ONS intervention. Patient satisfaction was measured in the two non-ONS studies[19,20] included in this review; satisfaction was improved after the interventions were implemented. No studies reported on measures of food waste, the secondary outcome for this review. Across these outcomes of interest, the limited research in this area of practice is highlighted. As a result, limited conclusions can be drawn from the outcomes summarised in Table 2.

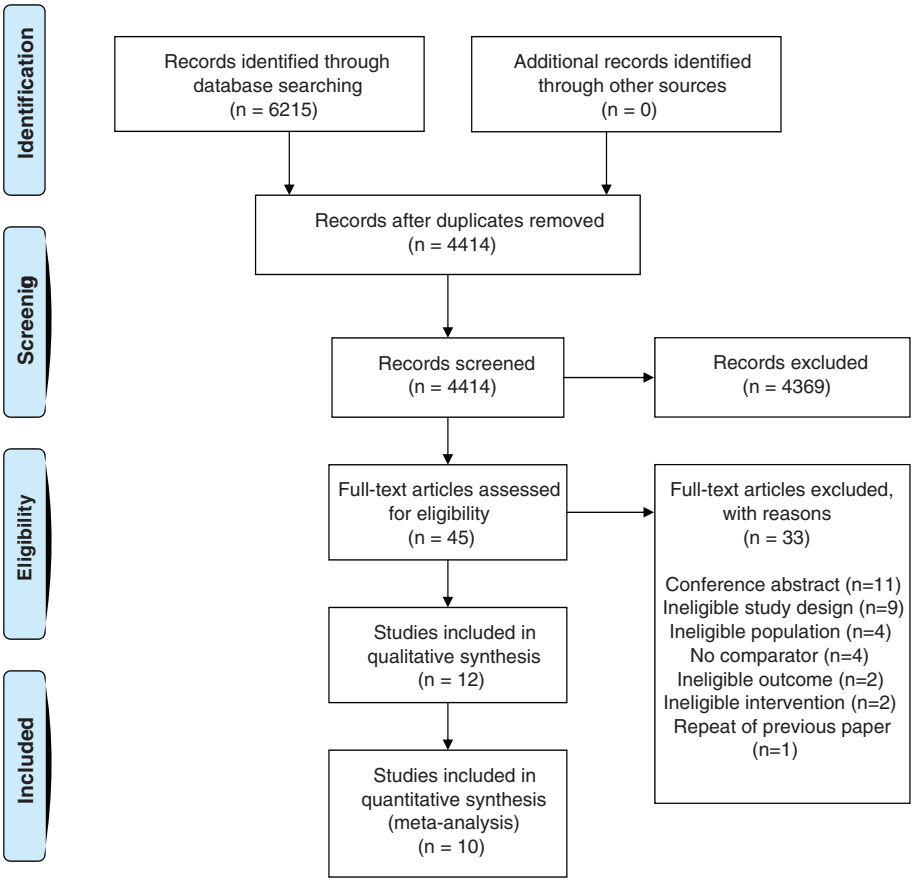

Figure 2 Flow diagram of study selection.

Methodological detail was not clearly reported in many studies, with the extent of bias unable to be assessed for the majority of studies. Some of the randomised controlled trials clearly reported high-quality randomisation and allocation procedures; others reported that they were 'randomised' but did not provide details of the techniques used. Not all studies were randomised controlled trials; therefore, selection bias was not considered across all included studies. Judgements regarding the bias of blinding of participants and personnel (performance bias) and outcome assessment (detection) were difficult to make because of a lack of clarity as to who made these assessments in many studies and if they were part of the research team (e.g. dietitian taking measures of dietary intake). In some instances, lack of blinding to outcome measures was indicated by authors, but it was difficult to evaluate the effect of this on outcome measurement.

Attrition bias was low across most studies as missing outcome data and reporting of patients who did not complete the study was generally reported clearly. Published study protocols were not reported in relation to any of the included studies, although in some cases, interventional studies may have been registered. Nevertheless, convincing text regarding the reporting of prespecified outcomes was not identified in any of the included studies. Issues of compliance, the method of obtaining dietary intake measurement and self-reported dietary intake provided other opportunities for the introduction of bias.

Discussion

This review aimed to determine the effect of foodservice interventions on nutritional outcomes and satisfaction of hospitalised and ambulatory adults with cancer. Oncology patients face unique challenges that put them at increased risk of malnutrition. An important step towards reducing malnutrition prevalence is through appropriate interventions, including those in the area of hospital foodservices.

The origins of foodservice interventions for this patient group appeared in the 1968 paper of Gauvin *et al.*[21] This work compared oncology patients' attitudes and outcomes of eating in a dining room versus the bedside in a medical centre in Minnesota, USA. Regrettably, this research did not investigate the defined outcomes for this review, making it ineligible for inclusion.

The positive effect on outcomes of the addition of ONS to usual diet in this review is similar to broader reviews of ONS in clinical practice. An overall positive effect on a range of clinical outcomes in favour of ONS has

Table 1 Characteristics and outcomes of studies investigating foodservice interventions in adult oncology patients

Author, country	*Study design*	*Population*	*Sample size (% retained)*	*Intervention*	*Comparator*	*Duration of Intervention*	*Outcomes of interest*
Oral nutrition support products							
Arnold, 1989, USA[9]	Randomised controlled trial	Ambulatory patients with cancer of the head and neck treated with radiotherapy	50 (94% retained—three intervention group patients were dead at three months post-treatment)	ONS providing 4017 or 4518 kJ/day plus usual diet plus intensive dietary counselling (n = 23)	No ONS, usual diet plus intensive dietary counselling (n = 27)	10 weeks	Body weight, energy intake, protein intake
Baldwin, 2011, UK[10]	Randomised controlled trial	Ambulatory patients with cancer of the GI track, non-small cell lung cancer or mesothelioma with weight loss receiving palliative chemotherapy	358 (90% retained at six weeks—4 withdrew, 31 died) (43% retained at 12 months—7 withdrew, 198 died)	Group 2 given dietary advice to increase food intake by an additional 2510 kJ/day. Group 3 given one ONS/day providing 2460 kJ. Group 4 given both dietary advice to increase food intake by an additional 2510 kJ/day and one ONS/day providing 2460 kJ	Group 1 received no dietary intervention (n = 96)	Six weeks	Weight change
Breitkreutz, 2005, Germany[11]	Randomised controlled trial	Ambulatory, moderately malnourished patients with GI adenocarcinomas, receiving chemotherapy	23 (assume 100% retention)	ONS with nutritional target of 35 non-protein kcal/kg/day and 1.1 g of protein/kg/day; plus nutritional counselling every 14 days	Diet composing 35 non-protein kcal/kg/day and 1.1 g of protein/kg/day without ONS; plus nutritional counselling every 14 days	Eight weeks	Energy intake, body weight, BMI
McCarthy, 1999, USA[12]	Experimental prospective study	Ambulatory, newly diagnosed patients with cancer beginning radiotherapy (excluding head and neck cancer patients)	40 enrolled (80% retained—8 dropped out)	Participants trained to complete a food record daily, three days per week for four weeks; education provided on recommended intake of calories and protein. Participants instructed to drink 237 mL ONS (containing 920–1050 kJ and 8–12 g	Participants trained to complete a food record daily, three days a week for four weeks, education provided on recommended intake of calories and protein. No supplements provided.	Four weeks	Energy intake, protein intake

Table 1 Continued

Author, country	*Study design*	*Population*	*Sample size (% retained)*	*Intervention*	*Comparator*	*Duration of Intervention*	*Outcomes of interest*
				protein) between meals and at bedtime			
Moriarty, 1981, Ireland[13]	Randomised controlled trial	Ambulatory patients with malignant disease undergoing radiotherapy	51 (80% retained—10 died during the study period)	Participants recorded intake each week for 3 days on 24-hour recall record forms; received dietitian counselling including addition of ONS (quantity not stated), twice weekly dietitian review	Participants recorded intake each week for 3 days on 24 hour recall record forms. No dietary advice provided	Not stated, intervention was for duration of course of radiation treatment	Energy intake, protein intake, body weight
Nayel, 1992, Egypt[14]	Randomised controlled trial	Ambulatory patients with head and neck cancer receiving radiotherapy	23 (100% retention)	Radiotherapy plus ONS increase estimated energy intake to estimated energy requirement. Malnourished patients commenced ONS for 10–15 days before therapy, all other patients after receiving first dose of radiotherapy.	Radiotherapy plus usual diet	Six weeks	Body weight
Ravasco, 2005, Portugal[15]	Randomised controlled trial	Ambulatory colorectal cancer patients referred for preoperative radiotherapy combined with chemotherapy	111 (100% retention)	Group 1 received individualised dietary counselling based on regular foods, given a specific energy and protein level to attain. Group 2 asked to consume 400 mL ONS (40 g protein, 400 kcals) per day in addition to usual diet	Group 3 instructed to maintain their ad libitum intake	Three months	Energy intake, protein intake, BMI, PG-SGA
Ravasco, 2005, Portugal[16]	Randomised controlled trial	Ambulatory patients with head and neck cancer referred for radiotherapy	75 (100% retention)	Group 1 received individualised dietary counselling based on regular foods, given a specific energy and protein level to attain. Group 2 asked to consume 400 mL ONS (40 g pro, 400 kcals) per day in addition to usual diet.	Group 3 instructed to maintain their ad libitum intake	Three months	Energy intake, protein intake, PG-SGA

Table 1 Continued

Author, country	*Study design*	*Population*	*Sample size (% retained)*	*Intervention*	*Comparator*	*Duration of Intervention*	*Outcomes of interest*
Sanchez-Lara, 2014, Mexico[17]	Randomised controlled trail	Ambulatory patients with non-small cell lung cancer eligible to receive chemotherapy	92 (91% retained—eight lost to follow up)	Advised to consume two serves ONS per day. Advised to follow a diet based on standardised menus (energy provided by ONS subtracted from menu so no extra energy was provided)	Advised to follow a diet based on standardised menus	Two cycles of chemotherapy	Energy intake, protein intake body weight, % loss usual weight, lean body mass
Uster, 2013, Switzerland[18]	Randomised controlled trial	Ambulatory patients classified as undernourished or at high risk of under-nutrition	67 (57% retained—16 died, 12 withdrew because of exhaustion, 1 had incomplete data)	Individual dietitian counselling at three time points (baseline, six weeks, three months), provision of an individual diet plan, and possible ONS prescription	Standard medical therapy without specific nutritional intervention or prescription of ONS	Six months	Energy intake, protein intake, body weight
Other foodservice interventions							
Lindman, 2013, Denmark[19]	Quasi-experimental comparison of data from two cross sectional studies	Hospital inpatients above 18 years diagnosed with haematological cancer receiving chemotherapy	99 in food intake study (87% retained—9 refused, 3 missing data, 1 acute impairment); 152 separate patients completed the questionnaire	Kitchen assistants trained as food caregivers. Extra tasks: address the patients and their relatives directly once a day; serve snacks; guide patients and relatives; tempt, compel, inspire and motivate patients to eat	Kitchen assistants working in the kitchen on the wards performing usual tasks	Patient food intake recorded for three days. Questionnaires conducted thrice before and after the intervention	Energy intake, protein intake, patient satisfaction
Pietersma, 2003, Canada[20]	Case series	Hospital inpatients admitted to an acute oncology/palliative care unit	27 (23 of whom had cancer) (82% retained—only 22 provided full survey responses)	Lunch delivered on an electric food cart. Same food as provided by tray service, but food cart enables patients to choose meal at point of service	Breakfast and supper provided by tray service	10 days	Patient satisfaction

BMI, body mass index; ONS, oral nutrition supplements; PG-SGA, patient generated—subjective global assessment.

Table 2 Outcome data of studies investigating foodservice interventions in adult oncology patients

Outcome of interest	*Study*	*Intervention results*	*Control results*	*P value*
Energy intake (kJ/day)	Arnold, 1989[9]	Mean energy intake during weeks 3, 5, 7 and 10 = 8074 ± 2533 kJ	Mean energy intake during weeks 3, 5, 7 and 10 = 6796 ± 2212 kJ	0.035
	Breitkreutz, 2005[11]	Mean daily intake of 7803 ± 1326 kJ	Mean daily intake 6510 ± 2080 kJ	NS
	Lindman, 2013[19]	Met an average of 93.3% of their EER (CI 95% 82.3–104.3)	Met an average of 76.2% of their EER (CI 95% 64.6–87.9)	0.03
	McCarthy, 1999[12]	Baseline intake = 7530 kJ Week 4 intake = 8577 kJ	Baseline intake = 7113 kJ Week 4 intake = 7530 kJ	0.01
	Moriarty, 1981[13]	Males at baseline = 8234 kJ Males at end of treatment/six-month review = 7833 kJ Females at baseline = 6435 kJ Females at end of treatment/six-month review = 6188 kJ	Males at baseline = 7180 kJ Males at end of treatment/six-month review = 6171 kJ Females at baseline = 6071 kJ Females at end of treatment/six-month review = 4648 kJ	NR
	Ravasco, 2005[15]	At end of RT: Group 1 (n = 37) Median intake extra 2322 kJ/d Group 2 (n = 37) Median intake extra 1239 kJ/d After three months: Group 1 maintained E intake Group 2 decreased E intake to baseline or below	At end of RT: Group 3 (n = 37) Median intake less 1192 kJ/d After three months: Group 3 decreased E intake to baseline or below	Group 1: $P = 0.002$ Group 2: $P = 0.04$ Group 3: $P < 0.01$ Group 2: $P = 0.05$ Group 3: $P = 0.05$
	Ravasco, 2005[16]	At end of RT: Group 1 Median intake extra 2180 kJ/d Group 2 Median intake extra 1347 kJ/d After three months: Group 1 maintained energy intake Group 2 decreased energy intake to baseline or below	At end of RT: Group 3 Median intake less 1674 kJ/d (range –841 to -2100 kJ/d) After three months: Group 3 decreased energy intake to baseline or below	Group 1: $P = 0.002$ Group 2: $P = 0.05$ Group 3: $P < 0.01$ Group 2: $P = 0.005$ Group 3: $P = 0.005$
	Sanchez-Lara, 2014[17]	Intake at second cycle of chemotherapy = 9184 ± 2766 kJ	Intake at second cycle of chemotherapy = 6920 ± 2540 kJ	<0.001
	Uster, 2013[18]	Baseline: 9388 ± 2300 kJ Six months: 9030 ± 2900 kJ	Baseline: 8460 ± 2700 kJ Six months: 8500 ± 2900 kJ	0.007
Protein intake (g/day)	Arnold, 1989[9]	Mean protein intake during weeks 3, 5, 7 and 10 = 88.4 ± 31.9 g	Mean protein intake during weeks 3, 5, 7 and 10 = 66.9 ± 26.1 g	0.005
	Lindman, 2013[19]	Met an average of 69.1% of their EPR (CI 95% 59.6–78.5)	Met an average of 64.3% of their EPR (CI 95% 53.7–75.0)	0.51
	McCarthy, 1999[12]	Baseline intake = 63 g Week 4 intake = 73 g	Baseline intake = 72 g Week 4 intake = 69 g	0.03
	Moriarty, 1981[13]	Males (baseline) = 81 g Males (end of treatment/six-month review) = 79 g	Male at baseline = 60 g Male at end of treatment/six-month review = 56 g	NR

Table 2 Continued

Outcome of interest	*Study*	*Intervention results*	*Control results*	*P value*
		Females (baseline) = 80 g Females (end of treatment/six-month review) = 60 g	Female at baseline = 61 g Female at end of treatment/six-month review = 44 g	
	Ravasco, 2005[15]	At end of treatment: Group 1 Median intake increased 27 g/d Group 2 Median intake increased 30 g/d After three months: Group 1 maintained protein intake Group 2 decreased protein intake to baseline or below	At end of treatment: Group 3 Median intake less 10 g/d After three months: Group 3 decreased protein intake to baseline or below	Group 1 $P = 0.007$ Group 2 $P = 0.001$ Group 3 $P < 0.01$ Group 2 $P = 0.06$ Group 3 $P = 0.06$
	Ravasco, 2005[16]	At end of treatment: Group 1 (n = 25) Median intake increased 26 g/d; Group 2 (n = 25) Median intake increased 35 g/d After three months: Group 1 maintained protein intake; Group 2 decreased protein intake to baseline or below	At end of treatment: Group 3 (n = 25) Median intake decreased 15 g/d After three months: Group 3 decreased protein intake to baseline or below	Group 1 $P = 0.006$ Group 2 $P = 0.001$ Group 3 $P < 0.01$ Group 2 $P < 0.05$ Group 3 $P < 0.05$
	Sanchez-Lara, 2014[17]	Intake at second cycle of chemotherapy = 87.8 ± 24 g	Intake at second cycle of chemotherapy = 57.5 ± 29 g	<0.001
	Uster, 2013[18]	Baseline 75 ± 17 g/day Six months 70 ± 18 g/day	Baseline 66 ± 20 g/day Six months 65 ± 20 g/day	0.016
Body weight (kg)	Arnold, 1989[9]	During treatment, no results provided. Both groups lost weight; there was no significant difference.		NS
	Arnold, 1989[9]	After treatment (between weeks 10 and 26) 3.9 kg	After treatment (between weeks 10 and 26) 2.8 kg	NR
	Baldwin, 2011[10]	Baseline to 52 weeks for Dietary Advice groups (n = 31) = 4.78 kg ± 5.0	Baseline to 52 weeks for No Dietary Advice groups (n = 37) = 1.36 kg ± 7.5	0.04
	Breitkreutz, 2005[11]	Baseline to day 28 (n = 12) 1.1 kg ± 0.5 Baseline to day 56 (n = 12) 1.4 kg ± 0.5	Baseline to day 28 (n = 11) 0.8 kg ± 0.5 Baseline to day 56 (n = 11) 2.1 kg ± 1.0	<0.01 <0.05
	Nayel, 1992[14]	0% experienced weight loss Median increase in body weight = 5%	58% experienced weight loss Median increase in body weight = –2%	0.001 0.001
	Sanchez-Lara, 2014[17]	Change in body weight second cycle of chemotherapy = –0.33 ± 3 kg	Change in body weight by second cycle of chemotherapy = –2.2 ± 3 kg	0.01
	Uster, 2013[18]	Change in mean body weight at three months = 0.2 kg; at six months = 1.2 kg	Change in mean body weight at three months = 2.1 kg; at six months = 3.7 kg	NS

Table 2 Continued

Outcome of interest	*Study*	*Intervention results*	*Control results*	*P value*
Percentage loss of usual weight	Sanchez-Lara, 2014[17]	Change in % loss of usual weight by second cycle of chemotherapy = 0.54 ± 4%	Change in % loss of usual weight by second cycle of chemotherapy = 2.8 ± 5%	0.733
Lean body mass (kg)	Sanchez-Lara, 2014[17]	Change in lean body mass by second round of chemotherapy = 1.6 ± 5 kg	Change in lean body mass by second round of chemotherapy = −2.0 ± 6 kg	0.01
Body Mass Index (wt/ht^2)	Breitkreutz, 2005[11]	Day 28 Change in BMI = 0.40 ± 0.10 Day 56 Change in BMI = 0.60 ± 0.20	Day 28 Change in BMI = −0.30 ± 0.20 Day 56 Change in BMI = −0.70 ± 0.40	<0.01 <0.01
	Ravasco, 2005[15]	At end of RT: Group 1 (n = 37) 1 declined, 36 maintained or improved Group 2 (n = 37) 3 declined, 34 maintained or improved After three months: Group 1 (n = 37) 2 declined, 35 maintained or improved Group 2 (n = 37) 6 declined, 31 maintained or improved	At end of RT: Group 3 (n = 37) 5 declined, 32 maintained or improved After three months: Group 3 (n = 37) 8 declined, 29 maintained or improved	NS
Other measures of nutritional status				
PG-SGA	Ravasco, 2005[15]	At end of RT: Group 1 (n = 37) 3 declined, 34 maintained or improved Group 2 (n = 37) 19 declined, 18 maintained or improved After three months: Group 1 (n = 37) 10 declined, 27 maintained or improved Group 2 (n = 37) 24 declined, 13 maintained or improved	At end of RT: Group 3 (n = 37) 34 declined, 3 maintained or improved After three months: Group 3 (n = 37) 36 declined, 1 maintained or improved	<0.002 favouring nutritional decline both at the end of RT and at three months <0.001 favouring maintenance or improvement of nutritional status at the end of RT and at three months
PG-SGA	Ravasco, 2005[16]	At end of RT: Group 1 (n = 25) 5 declined, 20 maintained or improved Group 2 (n = 25) 19 declined, 6 maintained or improved After three months: Group 1(n = 25) 3 declined, 22 maintained or improved Group 2 (n = 25) 24 declined, 1 maintained or improved	At end of RT: Group 3 (n = 25) 24 declined, 1 maintained or improved After three months: Group 3 (n = 25) 25 declined, 0 maintained or improved	<0.002 differences between intervention groups regarding nutritional decline both at the end of RT and at three months. <0.001 differences between intervention groups regarding maintenance/improvement of nutritional status at the end of RT and at three months.

Table 2 Continued

Outcome of interest	*Study*	*Intervention results*	*Control results*	*P value*
Patient satisfaction	Lindman, 2013[19]	67% stated they were informed about their nutritional needs	41% stated they were informed about their nutritional needs	0.001
	Pietersma, 2003[20]	95% preferred food cart service		<0.05
	Pietersma, 2003[20]	90% preferred to choose food portions themselves		
	Pietersma, 2003[20]	94% preferred to choose foods themselves		

[a]Includes data extracted from published tables.
BMI, body mass index; EER, estimated energy requirement; EPR, estimated protein requirement; NR, not reported; NS, not significant at $P < 0.05$; PG-SGA, patient generated—subjective global assessment; QoL, quality of life.

consistently been demonstrated in previous systematic reviews in other settings.[22–25] It reinforces that ONS have a role in the nutritional management of oncology patients. What is not as clear is the extent to which other foodservice innovations have an impact on clinical outcomes for this patient group. Both of the foodservice interventions included in this review tested approaches with a sound rationale: enhancing the patient focus of foodservice staff[19] and point-of-service meal selection via an electronic cart.[20] Both of these approaches reported an increase in patient satisfaction compared to usual care; however, no direct clinical outcomes were measured.

Although not eligible for this review, original foodservice research conducted in the paediatric setting may also inform future developments for adult oncology patients. Williams *et al*.[26] investigated a hotel-style 'room service' model in a hospitalised paediatric population and found positive impacts on patient energy and protein intake compared to the traditional meal tray foodservice model. While patients were ordering fewer times per day with room service, they were ordering more food each time and were eating a greater percentage of that food with an overall reduction in food waste. Patient satisfaction surveys indicated that both patients and parents were much more satisfied with room service than with the traditional tray line foodservice model. Wadden *et al*.[6] found similar results on patient satisfaction in a Canadian paediatric hospital when comparing a room service-style menu to a traditional menu. Statistically significant improvements in overall satisfaction, quality, temperature and variety of foods were noted after implementation of this room service model. 'Room service' models, whereby patients order and receive meals on demand, within dietary restrictions, from a fixed restaurant-style menu offers promise as an effective nutrition intervention for oncology patients and are being implemented and evaluated in a number of Australian hospital settings.

While not eligible for inclusion in this study, Williams *et al*.[27] conducted a prospective randomised clinical trial to determine if hospitalised paediatric oncology patients consumed more when eating with a family member or when eating alone in their room at meal time. While there was no significant difference in energy or protein intake in the two arms of the study, patients who ate with their caregivers expressed significantly greater satisfaction with foodservices.

The size of the title and abstract review that we undertook indicates that considerable work has been conducted in this domain, often presented at professional conferences and published as conference abstracts, not as full-text manuscripts. This problem in itself is challenging to resolve as foodservice interventions are often led by dietitians and foodservice staff who may not have the time or expertise to prepare scientific papers for peer review and publication. Various foodservice innovations, including breakfast buffet carts,[28] 'supersnack' mid-meal trolleys (Venn *et al*., 2015, unpublished data) and implementation of decentralised local kitchens,[29] have been tested often with favourable

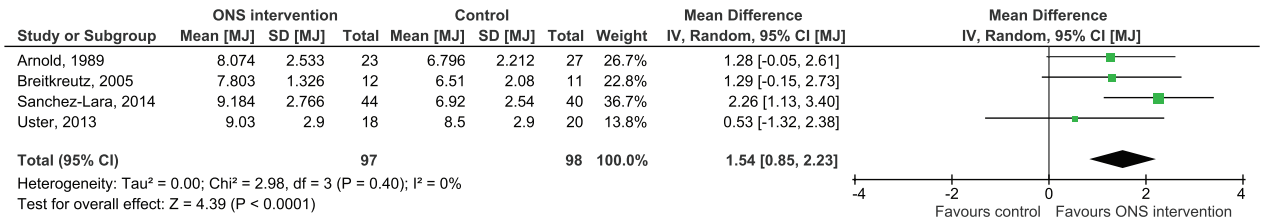

Figure 3 Meta-analysis of the effect of oral nutrition support products on energy intake (MJ/day) in the management of adults with cancer.

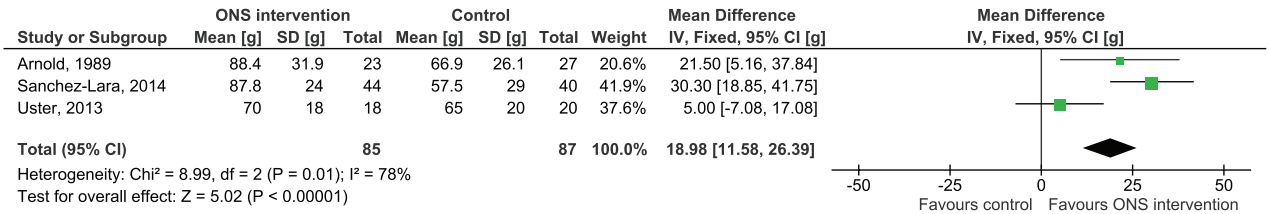

Figure 4 Meta-analysis of the effect of oral nutrition support products on protein intake (g/day) in the management of adults with cancer.

outcomes but did not meet the criteria for inclusion in this review because of the wrong population,[29] written in a narrative style[28] and wrong study design (conference abstract only) (Venn *et al.*, 2015, unpublished data). Clearly, opportunities exist to extend these quality improvement projects into published research through the utilisation of more rigorous study designs, thus informing international practice for cancer management. The inclusion of clinical and cost-effectiveness outcomes into the design of these studies will improve the translation of research in this setting.

Bias was assessed by the Cochrane risk of bias tool in this review. The restriction to full-text papers in this review, many of which were randomised controlled trials, did not limit bias across the entire library. Instead, we identified that methods were often unclear, including the randomisation process and the extent of blinding, both of the treating team and outcome assessors. The use of this tool has highlighted some areas for methodological improvement of study design for researchers into the future.

There were some notable strengths to this review, including the search strategy and absence of restrictions by date and language. A broad scoping search strategy was applied across six databases, ensuring that all studies across the field of study were included. Hand searching of reference lists and two authors independently conducting title and abstract screens, eligibility and quality assessments further increased confidence that relevant studies were identified and interpreted accurately. However, publication bias may exist, resulting in studies of negative findings not being published.

In conclusion, this review found that limited foodservice research has been conducted on the adult oncology patient population. Significant findings were found in favour of the intervention across a range of nutritional outcomes, suggesting that foodservice interventions can improve clinical outcomes and satisfaction of oncology patients, both in inpatient and ambulatory settings. There was clear evidence for the beneficial effect of ONS, whereby supplementing usual intake can significantly improve nutritional intake. We are unable to make specific recommendations for clinical practice for other foodservice approaches because of the small number of studies and quality of the evidence. We encourage researchers implementing foodservice interventions for oncology patients to consider more rigorous study designs, including evaluation of clinical and cost-effectiveness outcomes, enabling full-text papers to be published in the future.

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Conflict of interest

Authors have no conflicts of interest to declare regarding the contents of the manuscript nor has it been submitted for consideration elsewhere.

Authorship

ED and HW conducted the literature search. ED and JP collated, analysed and interpreted the data, and wrote the manuscript with NS. JP prepared the meta-analyses. All authors contributed to the conception of this review, and

have read and approved the version submitted for publication.

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