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REVIEW ARTICLE

Effectiveness and reporting of nutrition interventions in cardiac rehabilitation programmes: a systematic review

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Aims Dietary modification is essential for the secondary prevention of cardiovascular disease. However, there are limited published evidence syntheses to guide practice in the cardiac rehabilitation (CR) setting. This systematic review's objective was to assess effectiveness and reporting of nutrition interventions to optimize dietary intake in adults attending CR.

Methods and results Randomized controlled trials (RCTs) of nutrition interventions within CR were eligible for inclusion and had to have measured change in dietary intake. MEDLINE, Embase, Emcare, PsycINFO, CINAHL, Scopus, and The Cochrane Library were searched from 2000 to June 2020, limited to publications in English. Evidence from included RCTs was synthesized descriptively. The risk of bias was assessed using the Cochrane Risk of Bias 2 tool. This review is registered on PROSPERO; CRD42020188723. Of 13 048 unique articles identified, 11 were eligible. Randomized controlled trials were conducted in 10 different countries, included 1542 participants, and evaluated 29 distinct dietary intake outcomes. Five studies reported statistically significant changes in diet across 13 outcomes. Most nutrition interventions were not reported in a manner that allowed replication in clinical practice or future research.

Conclusion There is a gap in research testing high-quality nutrition interventions in CR settings. Findings should be interpreted in the light of limitations, given the overall body of evidence was heterogenous across outcomes and study quality; 6 of 11 studies were conducted more than 10 years old. Future research should investigate strategies to optimize and maintain nutrition improvements for patients attending CR.

Registration PROSPERO; CRD42020188723.

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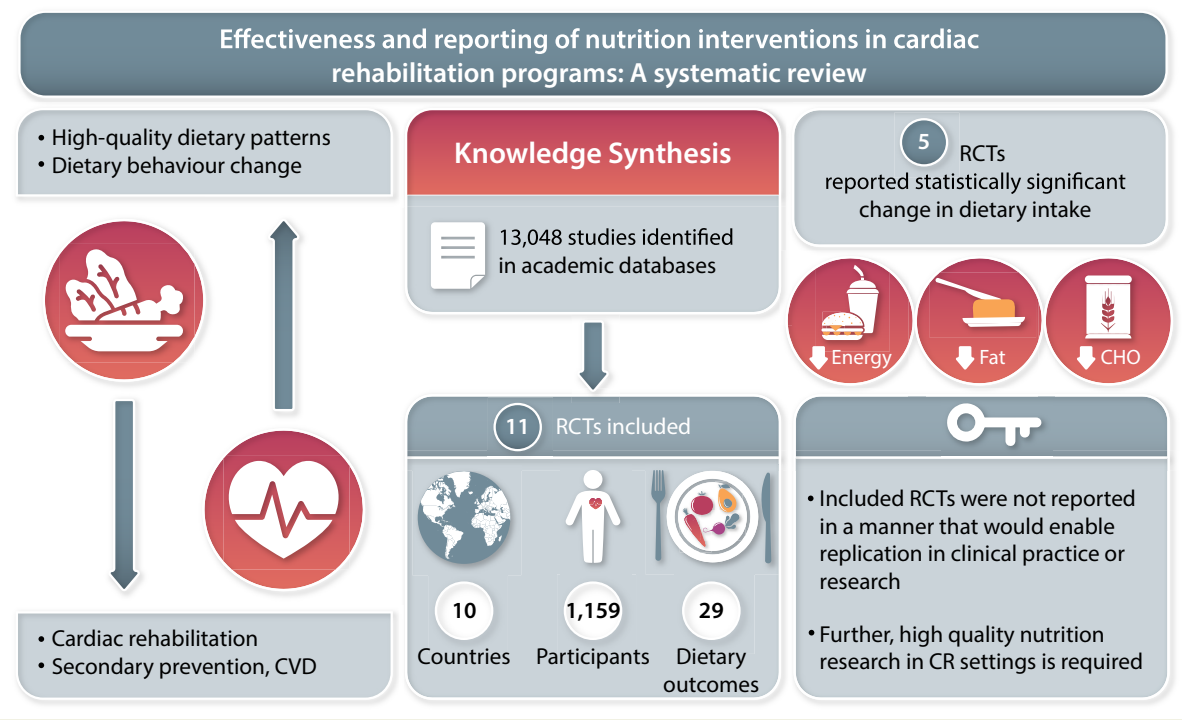
Graphical Abstract



Effectiveness and reporting of nutrition interventions in cardiac rehabilitation programs: A systematic review graphical abstract.

Keywords Cardiac rehabilitation • Nutrition • Diet • Behaviour change • Systematic review

Novelty

- This review provides a novel synthesis of knowledge regarding nutrition and the secondary prevention of cardiovascular disease, within the specific context of cardiac rehabilitation (CR).
- This work is the first to highlight a lack of high-quality nutrition interventions within the unique and important setting of CR, drawing attention to the need for additional work in this space.

Introduction

Cardiovascular diseases (CVDs) represent a significant health issue; despite ongoing declines in mortality, CVD is the leading cause of death in Europe.[1] Secondary prevention programmes such as cardiac rehabilitation (CR) are an essential component in reducing the burden of CVD.[2] Furthermore, CR is widely recognized as beneficial and cost-effective, improving cardiovascular mortality, risk of hospital admission and quality of life for people living with CVD.[2,3] Cardiac rehabilitation is a complex model of care consisting typically of an initial assessment, risk factor management, exercise training, and patient education, delivered by multidisciplinary teams.[3,4] Education is primarily focused on lifestyle factors that strongly influence future CVD risk,[5] such as smoking cessation, physical activity, and optimization of dietary patterns.[6–8]

Sub-optimal diet is a major lifestyle risk factor, responsible for more deaths globally than tobacco smoking.[9] In terms of nutrition and cardiovascular health, the field of research is extensive; multiple literature reviews report the evaluation of nutrition interventions,[10,11] and the evolution of nutrition recommendations for cardiovascular health.[12–14] Over the last 20 years, dietary recommendations have shifted from those focused on individual nutrients such as fat, to guidelines that acknowledge the synergistic effect of nutrients within food and dietary patterns.[12–14] Dietary patterns of higher nutritional quality have been associated with lower risk of recurrent cardiovascular events in populations with existing CVD or Type II diabetes.[15] For patients after myocardial infarction (MI), consuming a higher quality diet has also been associated with lower risk of CVD specific and all-cause mortality.[16] Therefore, nutrition behaviour change and the modification of dietary patterns are core components of CR programmes internationally.[3,4,6–8]

Current guidelines for dietary intervention in CR are variable.[3,7,8,17–19] Common target components include increasing fruit, vegetable, wholegrain, and fish intake; limiting saturated fats, red meat, sodium, highly processed foods, and alcohol; and including nuts and lean proteins regularly.[3,7,8,17–19] Despite guidelines

reflecting these dietary recommendations, patients with CVD do not typically consume diets that align with best evidence.[20,21] Globally, only 40% of patients with coronary heart disease consume a high-quality, 'healthy' eating pattern, as measured by the Alternative Healthy Eating Index.[21]

Recent data suggest most CR programmes include nutrition interventions, and 80% include a dietitian as part of programme staff.[4] However, these statistics do not provide information on the delivery means, quality, or outcomes of the dietary interventions. In addition, qualitative studies highlight the challenges CR patients face in sustaining dietary changes, including difficulties with overwhelming, contradictory, and a lack of individualized information.[22,23] Synthesis of information regarding effective nutrition interventions in a CR setting is required, to allow clinicians and other healthcare decision makers to translate research evidence into real-world practice and enable programme attendees to achieve optimal dietary and health outcomes.

A review article published in 2021 explored nutrition interventions within CR, highlighting a lack of standardization in practice.[24] However, this review was not systematic in method, excluded studies with non-validated nutrition assessment tools, and only recognized dietary patterns as per the American Heart Association or American College of Cardiology. The objective of this present study is to systematically assess the effectiveness and reporting of nutrition interventions to optimize dietary intake in adults attending CR. Key differences from the previously published review[24] include adherence to systematic review methodology; no exclusion according to dietary pattern or nutrition assessment tool; a focus on intervention reporting using an established checklist.[25]

Methods

This systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO); registration ID CRD42020188723. The review has been reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.[26]

Search strategy and information sources

A search strategy consisting of subject headings, key words, and synonyms related to nutrition and CR was developed. The included databases were MEDLINE, Embase, Emcare, PsycINFO, CINAHL, Scopus, and The Cochrane Library. Databases were searched from 1 January 2000 to June 2020; a focus on research from the last 20 years was chosen due to increased understanding of the complex health effects of dietary patterns, rather than individual nutrients, within this time frame.[27] Searches were also limited to the English language. The search strategy for each database is included in Supplementary material online, *File S1*. Reference lists of relevant systematic reviews and primary articles included in this review were hand searched to identify additional articles that met inclusion criteria.

Study selection

The results of database searches were imported into reference management software Endnote (X9.2, Clarivate Analytics, Philadelphia, PA, USA), where duplicates were removed. References were then uploaded to Covidence (online software that facilitates the management of systematic reviews; v1521, Melbourne, Australia), where additional duplicates were identified and removed.

Title and abstracts were independently screened by two review authors (L.K., A.J., M.F., or M.C.W.), for adherence to pre-determined eligibility criteria (see *Table 1*). Full-text publications were obtained for articles meeting eligibility criteria and reviewed by two independent authors (L.K. and M.F. or M.C.W.). For full-text publications, articles were excluded according to the following hierarchy: (i) not in the English language; (ii) incorrect study design (a) conference abstract and (b) other; (iii) population; (iv) comparator; (v) outcome; and (vi) intervention. At both title–abstract and full-text review stages, disagreements were resolved by discussion until consensus, or by a third author (T.L.S.) if consensus could not be reached.

Table 1 Study characteristics used as criteria for eligibility

Inclusion criteria	Exclusion criteria
Participants	
Adults, aged 18 years or older, attending cardiac rehabilitation	Children
Intervention	
Interventions to optimize dietary intake. Nutrition interventions could be implemented alone or in combination with other lifestyle factors (for example, physical activity)	No intervention component related to optimizing dietary intake
Comparator	
Usual care, alternative intervention, control, and/or pre-/post-intervention measures	Studies with no comparison group
Outcomes	
Must include at least one measure of change in dietary intake. This may be change in food, beverage, and/or supplement consumed and includes nutrient modification and/or dietary intake pattern or diet quality	Studies that did not measure change in dietary intake, or measured dietary knowledge, skills, or intention only
Study characteristics	
Published in the English language and either; RCT, pseudo-RCT,[a] non-randomized trial, cohort, case–control or retrospective analytical study	Conference abstracts, theses, review articles, and articles reporting the results of qualitative studies

RCT, randomized controlled trial.
[a]Defined as an experimental study in which subjects are allocated to groups in a non-random manner (for example, alternate allocation).[28]

It was hypothesized at the outset of this systematic review that there would be limited RCTs of nutrition interventions in a CR setting. Therefore, a broad range of study types were eligible for inclusion (see *Table 1*), with the caveat that if three or more RCTs were identified, only RCTs would proceed to the data extraction stage of the review.

Data extraction and quality assessment

Data extraction was completed by one author (M.C.W.) using Research Electronic Data Capture (REDCap; an electronic data capture tool hosted at Hunter Medical Research Institute)[29,30] and checked by a second (L.K.) for consistency. The pre-determined extraction template included information regarding study and participant characteristics, reporting of the nutrition intervention and nutrition-related outcomes. Data specific to the nutrition intervention component of included studies were extracted based on the Template for Intervention Description and Replication (TIDieR) checklist.[25] The TIDieR checklist provides guidance for the appropriate reporting of evaluative study designs across 12 items, in an attempt to improve intervention reporting and research translation.[25] Briefly, the TIDieR checklist covers all aspects of the intervention, including why, what, who, how, where, and when, as well as tailoring, modifications and fidelity.[25]

The risk of bias in individual randomized controlled trials (RCTs) was assessed using ROB 2: The revised risk of bias tool for randomized trials.[31] The tool assesses biases that may arise over different time points in a trial, across five domains: the randomization process, deviation from the intended intervention, missing outcome data, outcome measurement and selection of the reported result.[31] These domains were combined to form an overall risk of bias judgement. Risk of bias assessment was completed by one review author (M.W.) and checked by a second (L.K.) for consistency.

Reporting and synthesis

Due to heterogeneity of dietary intake outcomes and findings in included RCTs, a meta-analysis was not feasible; findings are summarized descriptively. Data from included RCTs were reported as per the primary research; no data conversions or calculations for missing summary statistics were performed. Primary research authors were not contacted to obtain missing data. Data retrieved throughout the review process are available in this article and its Supplementary material online.

Results

Study selection

Database searches identified 13 084 unique articles, 11 of which reported the results of RCTs and were included in the current review.[32–42] The study selection process is detailed in *Figure 1*. Twenty-six articles met the pre-specified inclusion criteria for population, intervention, comparator, and outcome characteristics, but were not RCTs.[43–68] The basic characteristics of these studies have been summarized in Supplementary material online, *Table S2*.

Study and participant characteristics

The 11 RCTs included in this systematic review were conducted across 10 different countries, with six published prior to 2010.[32,34–36,38,41] Four studies focused on nutrition interventions only,[32,36,38,39] whereas seven reported outcomes of combined lifestyle interventions (i.e. physical activity and nutrition).[33–35,37,40–42] Characteristics of the included studies are summarized in *Table 2*.

Collectively, the studies included a total of 1542 participants (range: 7–525), with participant characteristics summarized in Supplementary material online, *Table S3*. The reasons for referral to CR were variable, however commonly included MI, coronary artery bypass grafting, or angina pectoris. The average age of participants was >57 years in all studies, except one which did not report participant age.[32] In the majority of studies, females accounted for less than one-third of the study population. Exceptions included three studies that had no female participants,[33,36,41] one with only female participants,[40] and one study which did not report participant sex.[32]

Nutrition outcomes

The included studies reported 29 distinct dietary intake outcomes (see *Figure 2* and Supplementary material online, *Table S4*). Total energy intake ($n = 4$),[32,33,36,39] proportion of energy from total fat ($n = 4$),[32,36,38,42] and daily intakes of total fruit and vegetables ($n = 3$),[35,37,38] and fish ($n = 3$)[35,37,38] were the variables most commonly reported. Three studies reported intakes of saturated fat intake,[38,39,42] two as a proportion of total dietary energy[38,42] and one as an amount in grams.[39] Only one study reported daily dietary fibre intake,[42] and no included RCTs reported dietary sodium intakes as an outcome. Three studies reported results as a dietary score, rather than intakes of specific individual nutrients or food groups.[34,40,41] The diet score used by Jiang *et al.*[34] was based on saturated fat and cholesterol intakes, whereas the other two studies used scores of dietary variety with a focus on total fat.[40,41] Intervention periods ranged from 6 weeks to 12 months, and follow-up periods ranged from 10 weeks to 12 months, with just over half ($n = 7$) of the included studies assessing dietary intake at multiple follow-up time points.[32–35,37,38,42]

Dietary intake assessment methods were variable across the included studies (see Supplementary material online, *Table S4*). The most common methods used were estimated food records ($n = 3$)[34,41,42] and 'validated' food frequency questionnaires (FFQs).[33,39,40] Validation studies for two of the FFQs were conducted before 2000,[69,70] and each was validated in a different population, one each in Italy,[70] Portugal,[71] and USA.[69] None were validated in a population attending CR.[69–71]

Five studies reported statistically significant results, across 13 different dietary intake outcome variables,[34,36,38,39,41] eight of which were from the same study[39] (see Supplementary material online, *Table S4*). The only dietary intake outcome to be effectively modified across more than one study was total energy intake;[36,39] however, King *et al.*[36] did not assess between-group differences in the change in energy intake. Two studies did not report statistical significance data for the dietary intake outcomes reported.[37,42]

Reporting of nutrition interventions

In general, reporting of the nutrition intervention component in included studies was unclear (see *Figure 3* and Supplementary material online, *Table S5*). Three elements of the TIDieR checklist were not reported by any of the included studies. These were modifications to the intervention throughout the study, planned assessment of intervention fidelity and/or adherence, and actual assessment of fidelity and/or adherence.

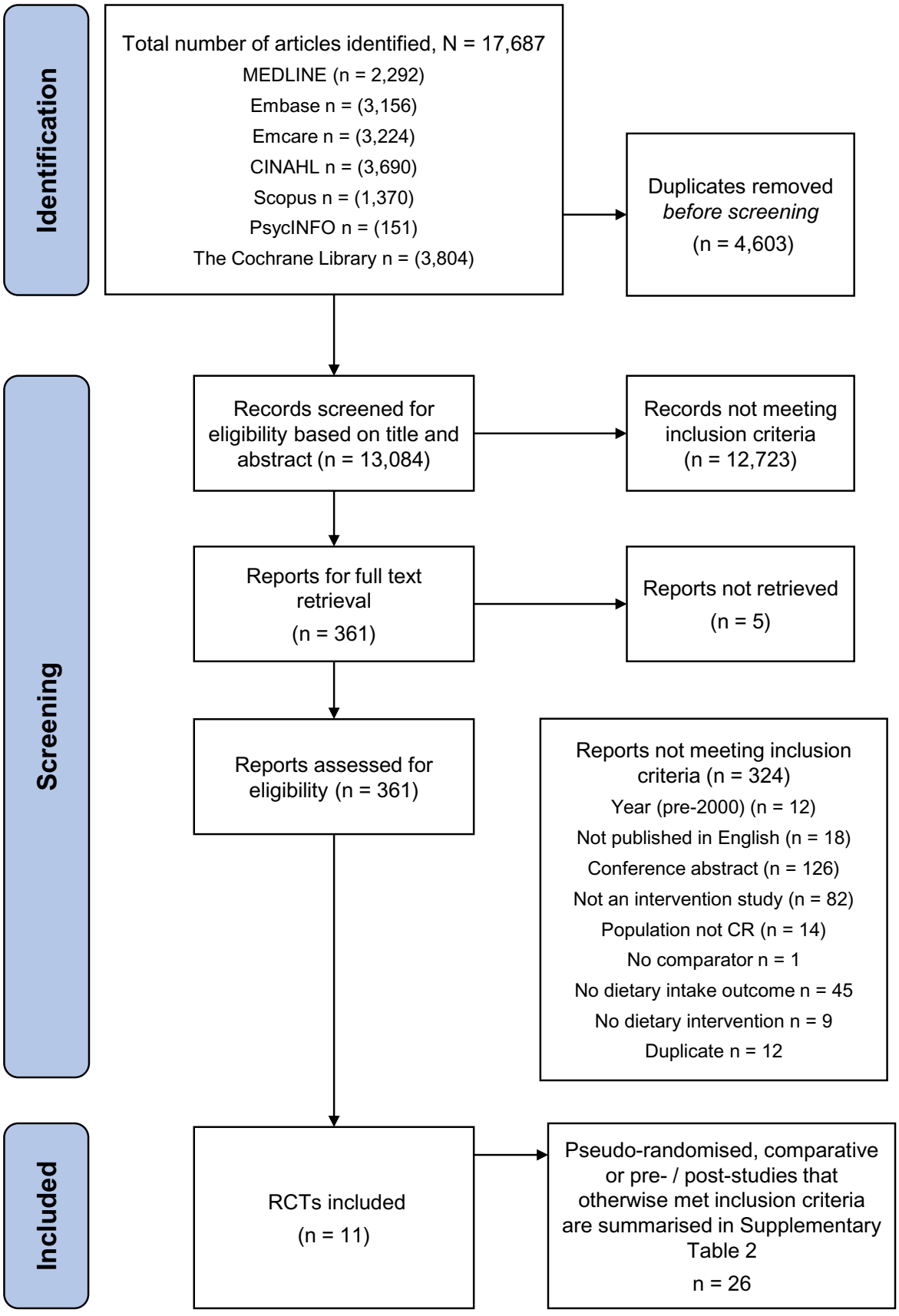


Figure 1 PRISMA flow diagram of articles in a systematic review of nutrition interventions in cardiac rehabilitation.

Table 2 Overview of included randomized controlled trials in a systematic review of nutrition interventions in cardiac rehabilitation, in alphabetical order of author surname

Reference (year of publication)	Country	Study design	Sample size	Intervention focus	Behavioural outcomes reported				
					Nutrition	Physical activity	Alcohol intake	Smoking	Medication adherence
Conrad *et al.*[32] (2000)	Canada	Two-arm RCT	7	Nutrition only	✓				
da Silva Vieira *et al.*[33] (2017)	Portugal	Three-arm RCT	46	Multiple behaviours	✓				
Jiang *et al.*[34] (2007)	China	Two-arm RCT	167	Multiple behaviours	✓	✓		✓	✓
Jolly *et al.*[35] (2007)	UK (England)	Two-arm RCT	525	Multiple behaviours	✓	✓		✓	
King *et al.*[36] (2000)	Ireland	Three-arm RCT	33	Nutrition only	✓		✓		
Kubilius *et al.*[37] (2012)	Lithuania	Two-arm RCT	140	Multiple behaviours	✓	✓		✓	
Leslie *et al.*[38] (2004)	UK (Scotland)	Two-arm RCT	98	Nutrition only	✓				
Luisi *et al.*[39] (2015)	Italy	Two-arm RCT	160	Nutrition only	✓		✓		
Midence *et al.*[40] (2016)	Canada	Three-arm RCT	169	Multiple behaviours	✓	✓		✓	✓
Sundin *et al.*[41] (2003)	Sweden	Four-arm RCT	144	Multiple behaviours	✓	✓		✓	
Yates *et al.*[42] (2015)	USA	Two-arm RCT	70	Multiple behaviours	✓	✓			

RCT, randomized controlled trial.

Common nutrition goals of included RCTs were to modify fat intake[32,34,36,38,42], specifically to reduce total dietary fat intake,[32] reduce saturated fat,[38] or reach specific percentage intake ranges of fat (20–35% energy from total fat,[36,42] <7% saturated fat[42]). Increasing fruit and/or vegetable intakes was also a common goal.[37,38] However, 4 of 11 included RCTs did not report any specific nutrition goals for the intervention.[33,35,40,41] Furthermore, most of the included articles (9 of 11) did not clearly report the 'dose' of the nutrition intervention, and it was unclear how much, how often, and for how long nutrition interventions and support were provided.[33–37,39–42]

Studies that reported an aim specific to a nutrition intervention,[32,36,38,39] rather than a general CR programme evaluation aim, were more clearly reported according to the TIDieR checklist.[25] Six of the included articles involved a dietitian in some aspect of the intervention.[32,36,38,39,41,42] However, the extent of dietitian involvement was often unclear. Two studies reported the use of health behaviour change theories in the intervention, the health belief model,[35] social cognitive theory,[42] and social support theory.[42] Other commonly reported nutrition intervention components included the provision of written patient resources and/or a workbook,[33–36,38] goal setting,[32,34,39,42] and encouraging social support, for example, encouraging partners to attend rehabilitation sessions.[38,42]

Risk of bias assessment

Based on ROB-2,[31] five studies were assessed to be at low risk of bias,[33,35,38–40] while there was moderate risk of bias for six studies.[32,34,36,37,41,42] No studies included in the current systematic review were evaluated as being at high risk of bias. See Supplementary material online, *Table S6* contains further details regarding risk of bias assessments. *Table 3* contains a summary of study characteristics, results, and risk of bias to facilitate comparison.

Discussion

The current systematic review aimed to assess the available evidence on effectiveness of nutrition interventions in improving dietary intake in adults attending CR, and describe the reporting of the identified nutrition interventions using the TIDieR checklist.[25] Results of the review highlight a gap in the published literature regarding high-quality, effective nutrition interventions based on current evidence.[72–74]

Of 11 RCTs identified, five reported statistically significant improvements in dietary intake outcomes,[34,36,38,39,41] and five were assessed as low risk of bias.[33,35,38–40] Only one study reported dietary intake change (intervention participants reduced energy, protein, fat, and carbohydrate intake) *and* was assessed as being at low risk of bias.[39] None of the included studies measured dietary intake using a tool specifically validated within a CR population. In addition, details of the nutrition interventions were generally poorly reported, contributing to difficulty in interpreting the lack of statistically significant change in dietary intake outcomes observed in included studies.

Recent evidence for diet and CVD prevention highlights the efficacy of a dietary patterns approach, where overall intakes of nutrient

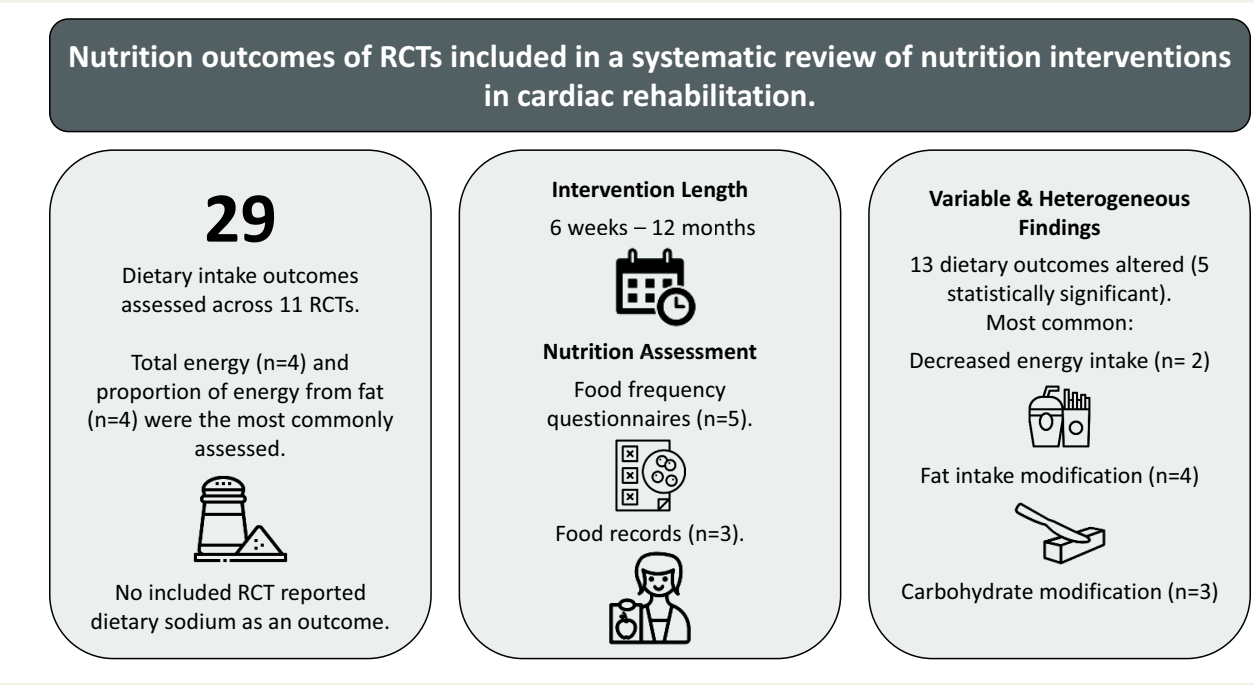


Figure 2 Summary of nutrition outcomes of included randomized controlled trials in a systematic review of nutrition interventions in cardiac rehabilitation.

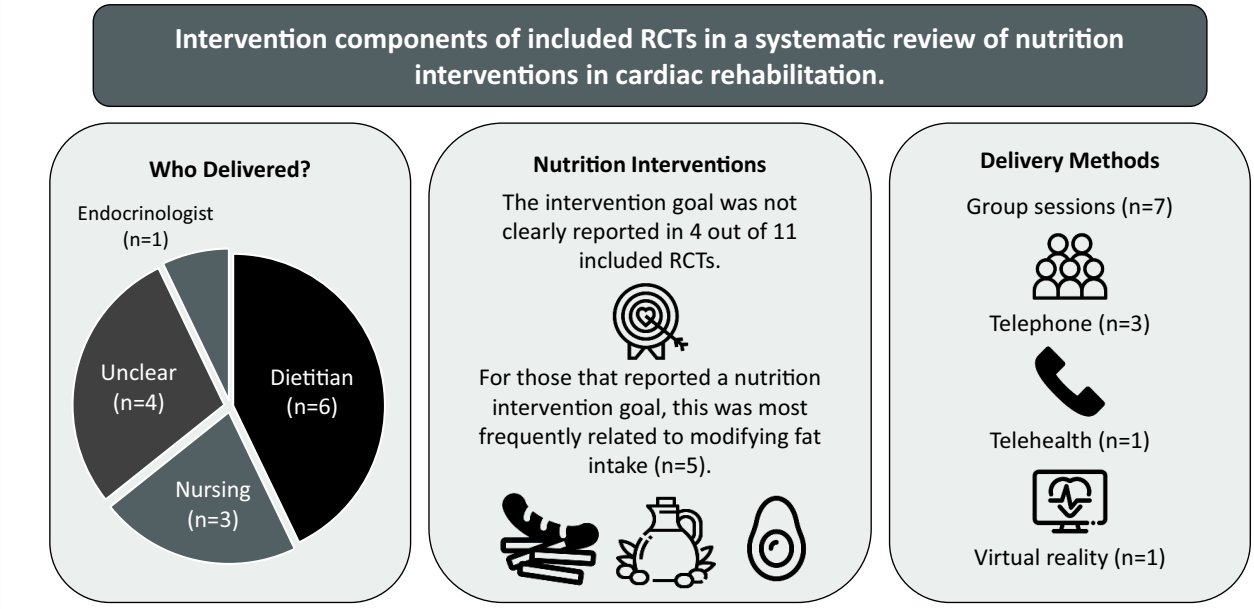


Figure 3 Summary of intervention reporting within included randomized controlled trials in a systematic review of nutrition interventions in cardiac rehabilitation.

rich foods and diet quality, rather than individual nutrients are the focus.[72–74] Frequently reported dietary intervention aims and outcomes in the current systematic review were measures of total dietary fat and/or energy intake. While measured in some included RCTs, no studies in the current review reported statistically significant improvements in fruit and vegetable intakes, whole grains, or unsaturated fat intakes. No included studies reported a nutrition goal specifically relevant to diet quality or used a valid measure of diet quality as an outcome. Furthermore, no included studies sought to modify or measure dietary sodium intake, despite sodium reduction

Table 3 Summary of study characteristics and results from randomized controlled trials included in a systematic review of nutrition interventions in cardiac rehabilitation, organized by risk of bias and results

Study (year of publication)	Result	Intervention	Reporting summary	Risk of bias	Relevance to nutrition practice in cardiac rehabilitation
Luisi *et al.*[39] (2015)	Intervention group showed reduced energy, protein, fat (total, saturated, monounsaturated), and carbohydrate intake, compared with control	Nutrition only	Dietitian and endocrinologist delivered intervention on European guidelines for eating and CVD. Dose unclear	+	Individual nutrition counselling (in addition to standard education at CR) is effective in reducing dietary energy intake
Leslie *et al.*[38] (2004)	Multiple positive changes early in the intervention, not sustained to 12 months	Nutrition only	Nurse delivered intervention to increase fruit, vegetables, oily fish. Decrease saturated fats. 4 × 1 h sessions over 8 weeks	+	The individual counselling approach used in this study may present modest gains compared with the resources required to implement
Jolly *et al.*[35] (2007)	Nil significant	Combination	Nurse delivered unclear dose of intervention, nutrition goals not reported	+	Unable to assess. Appears to be minimal difference between home and hospital-based CR in terms of dietary intake outcomes
da Silva Vieira *et al.*[33] (2017)	Nil significant	Combination	Unclear	+	Unable to assess
Midence *et al.*[40] (2016)	Nil significant	Combination	Unclear	+	Unable to assess
Conrad *et al.*[32] (2000)	Nil significant	Nutrition only	Dietitian provided 3 × 1 h sessions to modify fat intake (diet containing ≤10% energy from fat)	?	Extreme reductions in fat intake may not be achievable long term
Jiang *et al.*[34] (2007)	Significant improvement in dietary intake (Step II diet adherence score, based on saturated fat, cholesterol intake)	Combination	Nurse delivered unclear dose of intervention to modify fat intake	?	Improvement in dietary fat intake may be achieved through nurse-led intervention
King *et al.*[36] (2000)	Significant reductions in fat and energy intake in the weight reduction groups (not observed in weight maintenance group)	Nutrition only	Dietitian delivered unclear dose of intervention to modify fat, carbohydrate intake	?	The role of diet in complementing exercise-based outcomes of CR may need to be further considered
Kubilius *et al.*[37] (2012)	Nil significant. Trends towards improvement in fish, lean protein, fruit, vegetable, and wholegrain intakes	Combination	Intervention to increase fruit, vegetable, wholegrain, fish intake. Avoid fatty red meat. Use unheated vegetable oils. Unclear who delivered or dose	?	Patients in the rehabilitation group made dietary changes. Statistical significance not reported, so difficult to assess
Sundin *et al.*[41] (2003)	Significant change in diet habits in intervention group (diet habit index)	Combination	Dietitian delivered unclear intervention with unclear dose	?	Unable to assess
Yates *et al.*[42] (2015)	Nil significant	Combination	Dietitian delivered fat/fibre modification intervention, unclear dose	?	Unable to assess

CR, cardiac rehabilitation.

being known to confer reductions in blood pressure.[75] Given that multiple recent large cohort studies have shown significant associations between higher diet quality and lower risk of cardiovascular morbidity and mortality,[15,16,21] effective interventions to improve diet quality in patients attending CR are an important area for future research.[20]

Generally, the descriptions of the nutrition components of RCTs included in this review were not reported in a manner that would

enable complete replication by other researchers or clinicians. This finding is consistent with previously published literature in the context of CR.[76] In a systematic review of exercise interventions, descriptions of intervention providers and dose were incomplete in one-quarter to one-third of the identified studies, even after authors of the identified articles were contacted for clarification.[76] Cardiac rehabilitation is a complex intervention, consisting of multiple components. It is important that all components of these multifactorial interventions are clearly outlined in published research, to advance future research and practice in this area, and improve patient outcomes.

Articles included in the current systematic review did not describe the strategies, tools, and techniques employed within the interventions used to facilitate nutrition-related behaviour change. Furthermore, only two studies reported the use of a theoretical framework to guide intervention development. These findings are similar to that of other published systematic reviews which have found intervention theory and dietary behaviour change strategies are not clearly reported in the context of CVD.[77,78] Nutrition behaviour is inherently complex, influenced by a range of non-modifiable factors including socio-economic status, education, and geographic considerations such as access to affordable food, and location of food stores.[79,80] Patients attending CR may find it difficult to make and maintain dietary changes, even when supported with intensive nutrition interventions such as that in Leslie *et al.*,[38] which included four 1 h sessions of individualized counselling. Given the complexity of nutrition-related behaviour change, and the difficulties in sustaining lifestyle change among patients who attend CR,[65,81] it is of note that few studies included in this review described evidence-based behaviour change methods.

Approximately half of the interventions in the current systematic review were delivered by qualified dietitians. The remainder were delivered by nursing staff or, qualifications for who delivered the intervention were not clearly reported. While most programmes globally include a dietitian,[4,82] the nature of dietitian involvement in CR has not been widely reported.[83] For example, it is unclear if dietitian involvement is limited to education or if it includes other components such as nutrition counselling, and dietitian availability may constrained by lack of resources.[83] In cases where a cardiac rehabilitation programme does not have access to a qualified dietitian, other health professionals, such as nursing staff, provide fewer nutrition interventions with less variety; programmes with qualified dietitians were more likely to provide one-on-one nutrition intervention than programmes without.[84] Furthermore, CR nurses are not required to complete formal training regarding nutrition,[85] and a large proportion of cardiovascular specialists perceive nutrition to be a gap in their medical training.[86] Although qualified dietitians should provide individualized nutrition care to patients undergoing CR with complex co-morbidities,[3,18] it may be the case that other CR staff members have more patient contact and opportunities to support nutrition-related behaviour change than dietitians. These health professionals may benefit from professional development to support dietary optimization for patients who undertake CR. Future research could investigate interventions to support these staff members to provide basic nutrition interventions in an evidence-based manner.

Findings of the current systematic review may be limited in their generalizability due to population characteristics of the included studies. For example, the mean age of participants was >57 years, and females were generally underrepresented. Information regarding some CR populations, for example, those with heart failure or frailty, was not included in the current available evidence.

The lack of high-quality dietary intervention studies also limits findings of this review; due to overall poor study quality and heterogeneity, a meta-analysis was not able to be conducted. This systematic review had no exclusion criteria based on study quality if articles were identified as RCTs, resulting in one RCT of only seven participants being included in the review;[32] findings should be interpreted with caution in the light of this limitation. The relative age of the body of evidence should also be considered, with 6 of 11 studies published more than 10 years ago. In addition, none of the included studies investigated or were powered for clinical endpoints relevant to cardiac rehabilitation, such as recurrent cardiovascular events or death.

In conclusion, evidence regarding effective nutrition interventions in CR is lacking. There are few high-quality studies published to date that can inform practice, and many interventions are reported in a manner that does not allow replication. To advance the field of nutrition and CR, interventions that effectively improve diet quality are required. Such interventions should be informed by the best available evidence on dietary patterns, CVD outcomes, and behaviour change theory, be clearly reported, and consider long-term patient adherence.

Supplementary material

Supplementary material is available at *European Journal of Cardiovascular Nursing* online.

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Conflict of interest: none declared.

Data availability

The data underlying this article are available in the article and its online supplementary material.

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