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Review Article

Food literacy programmes in secondary schools: a systematic literature review and narrative synthesis of quantitative and qualitative evidence

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Abstract

Objective: The current review aimed to synthesise the literature on food literacy interventions among adolescents in secondary schools, the attitudes and perceptions of food literacy interventions in secondary schools, and their effects on dietary outcomes.

Design: The systematic review searched five electronic databases from the earliest record to present.

Setting: The studies selected for the review were from sixteen countries: Australia (*n* 10), Canada (*n* 1), China (*n* 1), France (*n* 1), Greece (*n* 2), Iran (*n* 1), South Africa (*n* 1), South India (*n* 1), Kenya (*n* 1), Norway (*n* 2), Portugal (*n* 1), Denmark (*n* 1), Northern Ireland (*n* 1), USA (*n* 17), UK (*n* 1) and Sweden (*n* 2).

Participants: Adolescents aged 10–19 years.

Results: Forty-four studies were eligible for inclusion. Adolescents with greater nutritional knowledge and food skills showed healthier dietary practices. Studies found a mixed association between food literacy and long-term healthy dietary behaviour. Two studies showed an improvement in adolescents' cooking skills and food safety knowledge; six studies showed an improvement in overall food safety knowledge; six studies showed an improvement in overall food and nutritional knowledge; and two studies showed an improvement in short-term healthy dietary behaviour.

Conclusions: Food literacy interventions conducted in a secondary-school setting have demonstrated a positive impact on healthy food and nutritional knowledge. However, there appears to be limited evidence supporting food literacy interventions and long-term dietary behaviours in adolescents. More evidence-based research is required to adequately measure all domains of food literacy and more age-specific food literacy interventions.

Keywords
Adolescents
Secondary school
Food literacy
Systematic review
Dietary behaviours

Obesity has been identified as a significant health concern in the 21st century[1,2]. Poor dietary practices developed in childhood have been identified as a critical contributor to the development of preventable lifestyle diseases, including overweight and obesity and CVD[3,4]. In Australia, over one-quarter of adolescents are overweight or obese[5]. The importance of developing a healthy dietary behaviour during adolescence is critical in the prevention of obesity[3].

Healthy dietary intake is essential for physical development, growth and normal weight management throughout adolescence[2]. Adolescents aged 12–18 years are advised to consume three servings of fruit and four servings of vegetables each day[6]. Globally and in Australia, the majority of adolescents do not consume sufficient fruit and vegetables, instead consuming high-fat, energy-dense, nutrient-poor foods[7,8]. Among adolescents aged 14–18 years, nearly three-quarters (73 %) were consuming below the recommended guideline amounts and over half (59 %) were having fewer than 1·5 servings of fruit and vegetables daily, including 41 % who usually consumed less than 1 serving/d[5].

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In response to the prevalence of inadequate dietary practices among adolescents, secondary schools have implemented numerous healthy food policies to promote healthy dietary behaviours[9,10]. However, interventions focusing on improving food and nutrition knowledge have been limited to changing only short-term dietary behaviour[11]. Food literacy is a relatively new and emerging concept used to describe a range of skills and knowledge around food, its uses, and daily dietary behaviours associated with healthy eating[12]. The term 'food literacy' is defined as: 'a collection of interrelated knowledge, skills, and behaviours required to plan, manage, select, prepare and eat foods to meet needs and determine food intake'[13] (p. 72). This term has been used increasingly in food and nutrition policy and research. Food literacy has emerged as a framework to connect food-related knowledge, cooking skills, and capacity to foster and develop food and nutritional knowledge to assist in changing dietary behaviour[14].

Critical attributes of food literacy consist of nutrition knowledge, cooking skills, eating behaviours, knowledge of where food originates from and the ability to prepare healthy nutritious foods[15]. The school environment has been identified by the WHO as an ideal setting in which youth consume approximately one-third to one-half of their daily food intake[16,17]. Research exploring food literacy in secondary schools has emerged as a promising approach to fostering healthy dietary behaviours and educating students on health literacy knowledge[18]. Research into schools adopting a health-promoting approach suggests that nutrition programmes using a health-promoting school approach can increase participants' consumption of high-fibre foods, healthier snacks, water, milk, fruit and vegetables[19]. Primary studies examining the effectiveness of food literacy programmes and interventions have identified an overall increase in nutrition-related knowledge and cooking skills, but minimal change in long-term healthy dietary behaviours[20,21].

To date, only two literature reviews have explored food literacy programmes in secondary schools and the relationship between food literacy and dietary intake for adolescents[20,21]. Brooks and Begley[20] explored the effectiveness of food literacy programmes targeting adolescents, their food literacy components and programme effectiveness in predominantly in Western countries. Vaitkeviciute *et al.*[21] conducted a systematic review from a global perspective to investigate the relationship between food literacy and adolescents' dietary intake, and identified that food literacy might play a role in shaping adolescents' dietary intake. Furthermore, the review identified that more rigorous research methods are required to assess the causality between food literacy and adolescent dietary intake to confirm the extent of the relationship[21]. Schoolyard garden programmes targeted to adolescents are emerging as a potential strategy in the school setting to increase preference for and improve dietary intake of fruit and vegetables[22]. Reviewing interventions in the school environment with the addition of a school-based garden and students' and home-economics teachers' attitudes and perceptions of food literacy interventions may provide an additional insight into the field of food literacy. Given the fact that food literacy has emerged recently in academia and government policies as an essential topic over the past decade, a comprehensive overview of studies that report on the effects and perceptions of food literacy interventions in secondary schools would provide an insight into food literacy interventions in secondary schools[23,24].

The primary aim of the current review was to synthesise the literature on food literacy interventions in secondary schools and report on the associations among adolescents. Second, the review aimed to explore adolescents' and home-economics teachers' perceptions of food literacy interventions in secondary schools and their effects on dietary outcomes. Home-economics teachers predominantly provide education on culinary skills, food and nutrition in secondary schools. Although on a global scale culinary skills and nutrition can be taught by other topics in schools, home economics is the dominant topic in which food literacy can be taught in the secondary-school setting. Therefore, the objectives of the current review were to:

1. Report on the effect of food literacy interventions conducted in a secondary-school setting.
2. Explore adolescents' attitudes and perceptions of food literacy programmes and the topic of home economics.
3. Explore home-economics teachers' perspectives on food literacy programmes and the topic of home economics.

Methods

The current systematic literature review is registered with PROSPERO, the International Prospective Register of Systematic Reviews (CRD42017074204). As food literacy is a relatively new emerging term, changes were made to the protocol registered on PROSPERO. Our original inclusion criteria were: (i) studies focused on adolescents with low literacy; and (ii) to report valid and reliable measures of food literacy. However, as the review unfolded, two things became clear: in many cases, the evidence adhering to these two requirements is sparse given the notable diversity of study designs and intervention outcomes on food literacy research. Second, we could not gain critical insight from the parameters that we initially set. We therefore extended our criteria to a broader range of literature focusing on qualitative studies exploring secondary-school food literacy interventions regarding the social, biochemical and non-nutritional aspects.

A comprehensive systematic literature review search was conducted following the reporting recommendations

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outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement[25]. As recommended in the PRISMA statement, we completed the standard PRISMA checklist to provide further details of the implementation of the study (see online supplementary material). For the present systematic review, 'food literacy' was defined as 'a collection of inter-related knowledge, skills and behaviours required to plan, manage, select, prepare and eat foods to meet needs and determine food intake'[13] (p. 54). In light of the ubiquitous term of food literacy, the key components and attributes that the review focuses on are cooking skills, dietary behaviours, healthy food choices, food culture and knowledge.

Databases and keywords

The emerging concept of food literacy broadly consists of food and nutrition knowledge, skills and capacity to assist in making informed food choices and improve dietary behaviours[12]. Due to the multifaceted definition of food literacy, relevant search terms based on each component of food literacy were informed by the food literacy definition of Vidgen and Gallegos[13] and encompass the following factors: knowledge, skills and behaviours with food planning, management, selection, preparation and eating. The following databases were selected as they offer broad coverage of allied health topics, including nutrition and public health literature: Medline, CINAHL, PsycINFO, Scopus and Web of Science (Science Citations Index and Social Citations Index). All electronic databases were searched from the earliest record to present. The PICOS (problem, intervention, comparison, outcome and setting) approach was applied to the quantitative and qualitative search[26]. For quantitative studies: problem = (effects of food literacy interventions), intervention = (food literacy intervention), outcome = (behaviours, healthy food choices, culture) and setting = (interventions conducted in secondary schools). For qualitative studies, the PICOS was reformulated with outcome = (changes in, or perceptions about, food literacy in secondary schools, or associations between food literacy and dietary intake and perceptions about secondary school-based food literacy programmes).

Students attending primary schools and/or outside the age range of 10–19 years were excluded from the study. Primary schools in some countries may end at age 12 years; middle school may consist of youth aged 12–14 years; and high school may end at the age of 16–17 years. To ensure that only students in secondary schools were included, the age of the participants was identified as the key exclusion criterion. Search terms and MeSH headings in the title, abstract and index terms were initially identified in SCOPUS, and the resulting keywords were used for the remaining databases (Table 1). An academic librarian who had expertise in health-related literature assisted with the development of MeSH headings and keywords, and wild cards were applied to words in the plural.

Eligibility criteria

Studies were included in the current systematic review if they met the following inclusion criteria: (i) peer-reviewed and primary, original research; (ii) written in English; (iii) adolescents aged between 10 and 19 years old; (iv) the outcome of a programme related to an improvement in dietary habits, healthy food choices, nutrition knowledge and cooking skills; (v) cross-sectional, mixed-methods, quantitative and or qualitative; and (vi) no restriction on the year of publication. Studies were excluded if they were a personal opinion; a systematic review and meta-analysis; and if they focused on disease-related nutrition interventions for adolescents, such as for obesity, anorexia nervosa or type 2 diabetes mellitus, or included participants with dietary, medical conditions, mental health conditions and learning difficulties.

Procedures and synthesis

One researcher (C.J.B.) conducted the systematic literature search, full-text screening and extraction of studies. A PRISMA flow diagram was used to document the systematic review's search and selection process of studies for inclusion (see Fig. 1). A list of potentially relevant articles from each database was identified, exported and saved into EndNote® version X8. Duplicates were identified and removed; potentially relevant articles were scanned to confirm relevance for full review by two authors independently (C.J.B. and P.R.W.). Both researchers (C.J.B. and P.R.W.) independently assessed and extracted the quantitative and qualitative data from papers included in the review using the standardised data extraction tool JBI-MASt-ARI and JBI-QARI, respectively[27]. Two independent reviewers conducted each stage of the review. Any reviewer conflicts were discussed to arrive at a consensus decision with the aid of the third reviewer (M.J.D). Ineligible articles were removed from the list after noting the reason for exclusion. Due to the various study designs and outcome measures, a meta-analysis was not conducted.

Outcomes assessed

The effects of food literacy interventions were based on measures of dietary outcomes (such as changes in students' nutrition knowledge, cooking self-efficacy, fruit and vegetable choice, preference and consumption) and dietary intake (dietary recalls, FFQ) was assessed. Qualitative research was investigated to understand adolescents' and home-economics teachers' attitudes, understandings and perspectives on food literacy programmes in the secondary-school environment.

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Table 1 SCOPUS search strategy

Advanced search
TITLE-ABS-KEY(Adolescen* OR Teen* OR Youth* OR Student* OR 'young adult*' OR 'high school*' OR Highschool* OR 'secondary school*' OR child* OR 'pre-adolescen*' OR preadolescen*) AND TITLE-ABS-KEY(REALM OR 'rapid estimate of adult literacy in medicine' OR 'test of functional health literacy in adults' OR TOFHLA OR 'newest vital signs' OR NVS OR 'short range achievement test' OR SAHLSA OR 'Wide range achievement test' OR WRAT OR 'Food literac*' OR 'nutrition* literac*' OR 'health literac*') AND TITLE-ABS-KEY(((school OR class*) W/3 food W/2 (program* OR initiative* OR project*)) OR (cook* W/3 (program* or class*)) OR 'home economics')

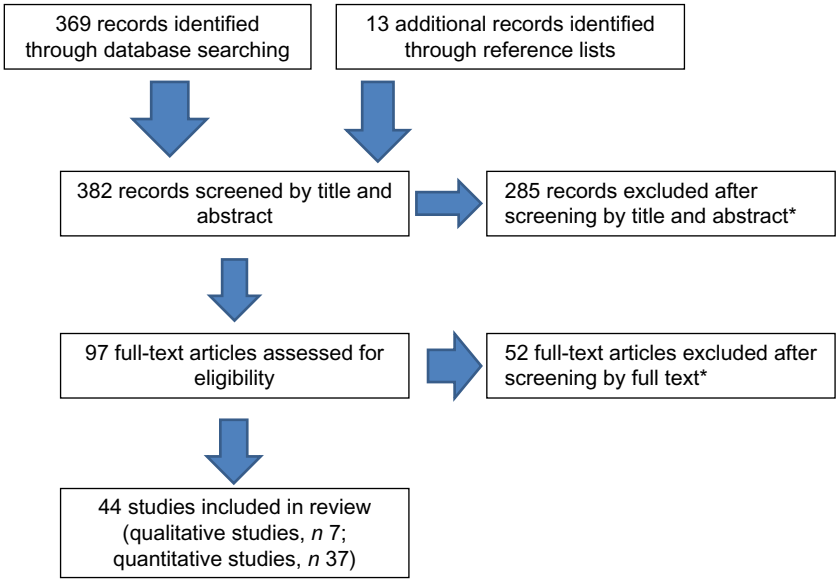

Fig. 1 (colour online) Flow diagram of information through the different phases of the review: flowchart of the literature search and review process. *Reasons for exclusion: study population not adolescents (adults or young children, *n* 70); study did not address the main objective of the present review (*n* 246); study was conducted outside the secondary-school setting (*n* 14); study was in the form of a poster or a personal opinion publication (*n* 4); study was in the form of a literature review, eating disorders or PhD thesis (*n* 4)

Risk of bias assessment

Studies were assessed for risk of bias in methodological quality by two independent researchers (C.J.B. and P.R.W.). The Academy of Nutrition and Dietetics' Quality Criteria Checklist (QCC)[28] was utilised to check the risk of bias in the included quantitative studies. The QCC consists of ten criteria that assess the quality of each quantitative study. The QCC tool was used to assess the scientific rigour of included quantitative nutritional studies. Each study's attributes were assessed by the QCC and were classified as positive, negative or neutral. An overall quality score was given to each individual study. If individual QCC criteria were not appropriate, the overall score was based only on the appropriate QCC criteria. Qualitative studies were assessed for their methodological rigour and quality based on the critical appraisal checklist for qualitative studies provided by the National Institute for Health and Care Excellence[29]. The checklist includes fourteen criteria under the following domains: the theoretical approach and clarity of its aims; the rigour of the methods; how well the data collection was carried out; the relationship between the researcher and participants and reliability of the methods; the richness of the data and rigour and reliability of the analysis and findings; and the reporting of ethical issues[29].

Results

A total of 382 papers were retrieved from five databases. From these studies, 285 did not qualify for review as they were not relevant to the topic, did not incorporate adolescents, the interventions were not conducted on school grounds or were not of empirical evidence (e.g. personal opinions). A full-article review was conducted on the remaining ninety-seven articles, after which fifty-two articles did not meet all the criteria and were excluded. Forward and backward searching, as well as a screening of Brooks and Begley[20] and Vaitkeviciute *et al.*[21], resulted in a total of forty-four publications (qualitative studies, *n* 7; quantitative studies, *n* 37). The flow diagram of the systematic review is presented in Fig. 1. A narrative synthesis was used to report the associations of the findings.

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Overview of studies

The studies in the systematic review were published between 1990 and early 2017. Studies were conducted in Australia (*n* 10)[30–39], Canada (*n* 1)[40], China (*n* 1)[41], France (*n* 1)[42], Greece (*n* 2)[43,44], Iran (*n* 1)[45], South Africa (*n* 1)[46], South India (*n* 1)[47], Kenya (*n* 1)[48], Norway (*n* 2)[49,50], Portugal (*n* 1)[51], Denmark (*n* 1)[52], Northern Ireland (*n* 1)[53], the USA (*n* 17)[54–70], the UK (*n* 1)[71] and Sweden (*n* 2)[72,73].

Study designs included cross-sectional (*n* 16), quasi-experimental (*n* 13), pre–post intervention (*n* 1), randomised controlled trial (*n* 1) and longitudinal cohort study (*n* 1), observational (*n* 1), mixed methods (*n* 4) and qualitative (*n* 7). The number of adolescent participants ranged from twenty-two to 1488. The number of home-economics staff ranged from five to 118. Tables 2 and 3 provide an overview of the included studies, consisting of: country in which the study was conducted; study design; target group/sample size; duration of programme; theoretical underpinning; dietary outcome measure; food literacy attributes; and key findings.

Risk of bias assessment

Table 4 provides an overall risk score for the quantitative studies. The majority of quantitative studies were identified as positive, with two studies being average[45,59] in rating quality. Table 5 provides an overall evidence grading for the qualitative studies. The majority of studies were identified as positive '++', with one being '+'[47].

Quantitative and mixed-methods studies

Programme type and duration

Thirty-seven quantitative or mixed-methods studies were identified. They consisted of practical cooking classes (*n* 5)[58,60,61,68,71], reading nutritional labels (*n* 2)[59,70], school-based gardens (*n* 5)[34,35,57,64,67], school supplementary food programmes (*n* 1)[48], technology interventions (*n* 6)[42,43,48,63,65], lectures about nutritional education and food safety (*n* 14)[33,40,41,44–46,49–52,56,62,66,69], and home-economics teachers' perspectives on food literacy in secondary schools (*n* 6)[30–32,36,38,40]. Duration of the interventions varied and was dependent on the type of study intervention and aspects of food literacy being investigated. The shortest duration of a study was 1 week[68] and the most extended duration of a study was 10 years[62].

Theoretical basis for programme development

Theoretical underpinnings used in the studies were Social Cognitive Theory (*n* 5)[33,57,63,67,70], the Transtheoretical Model (*n* 1)[63], the Health Belief Model (*n* 1)[33], the Theory of Planned Behaviour (*n* 1)[33] and the Analysis Grid for Environments Linked to Obesity planning model (*n* 1)[39].

The review identified four broad approaches in how food literacy programmes have been administered in secondary schools: (i) food knowledge and change in dietary intake and behaviour (self-efficacy)[33,36,42,44,46,48–50,52,61,63,69]; (ii) garden-based interventions[34,35,57,64,67]; (iii) gendered differences and nutritional knowledge and behaviour[33,34,39,45,46,49,56,59,65,66]; and (iv) adolescent[37,47,53–55,72,73] and home-economics staff perspectives on food literacy[30–32,36,38–40].

Observational and intervention studies

Food knowledge and change in dietary intake and behaviour (self-efficacy)

Nine studies investigated the relationship between food knowledge and dietary intake[44,46,48,50,52,56,61,63,69] and five studies investigated food knowledge and behaviour[33,42,49,51,69]. Eight studies showed a positive impact of knowledge[33,44,46,51,52,61,63,66]. One study showed a negative impact on nutritional knowledge and dietary intake[45]. Two studies were not able to indicate a clear relationship between food knowledge and dietary intake[56,69].

Two studies investigated adolescent reading ability and nutrition labels[59,70]. One study identified that nutrition label reading ability does not relate to healthier diets among adolescents[59]. Adolescent boys' reading of nutrition labels was associated with higher fat intake[59]. One study investigated the effects of a culturally targeted energy labelling intervention on food purchasing behaviour and found that after the intervention, there was a mean decline in purchased energy of 20 % and unhealthy foods[70].

Garden-based nutrition interventions

Five studies investigated the relationship between school-based garden interventions and fruit and vegetable consumption. Four of the five studies demonstrated positive results[35,57,64,67]. One study showed an overall increase from a 10-week intervention with nutrition education and garden for overall willingness to taste vegetables ($P < 0{\cdot}001$) and overall taste ratings of vegetables ($P < 0{\cdot}001$)[35]. Three studies showed a higher fruit and vegetable intake and preference, self-efficacy and knowledge[57,64,67]. One study showed an overall increase in fruit consumption (before to after) by 1·12 servings ($P < 0{\cdot}001$) for students at experimental school 2, and vegetable consumption increased significantly by 1·44 servings ($P < 0{\cdot}001$)[64]. The intervention consisted of a control group and two treatment groups. One group consisted of a 12-week nutrition programme and the other treatment group consisted of garden-based activities. Adolescents who participated in garden-based activities had a significant increase in vitamin A, vitamin C and fibre intake[64]. One study was not able to show any significant difference in fruit and vegetable intake between genders[34].

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Table 2 Summary of quantitative studies included in the current systematic review on food literacy programmes in secondary schools

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
1	Dewhurst and Pendergast (2011)[31], Australia	Cross-sectional	Home-economics teachers (*n* 186)	Not stated	Not stated	Not applicable	Home-economics teachers' perceptions on home economics and its relationship to sustainable development	Survey	There is agreement in the cross-cultural comparison findings on the importance of education for sustainable development
2	Dewhurst and Pendergast (2008)[32], Australia	Cross-sectional	Home-economics teachers (*n* 186)	Not stated	Not stated	Not applicable	Teachers' perspective on home economics	Survey	The field of sustainable development education has neglected studies of Home Economics education and its teachers' perceptions about sustainable development education
3	Gracey *et al.* (1996)[33], Australia	Cross-sectional	15–16 years (*n* 391)	Not stated	SCT, TPB, HBM	Not applicable	Nutritional knowledge, beliefs and behaviours	30-item food variety score; fat, fish, soft drinks and water consumption questionnaire	Nutritional knowledge scores were significantly greater in females
4	Jaenke *et al.* (2012)[34], Australia	Quasi-experimental	11–12 years of age (*n* 127)	10 weeks	Not stated	Classes assigned to wait-list control, nutrition education only (NE) or nutrition education plus garden (NE+G) groups	F&V intake	Five-item food preference performance assessment tool; 24 h recalls	In the *post hoc* analysis by gender, both boys and girls in NE+G and NE groups were more willing to taste vegetables compared with control boys and girls post-intervention ($P < 0{\cdot}001$, $P = 0{\cdot}02$). Boys in the NE+G group were more willing to taste all vegetables overall compared with NE boys at post-test ($P = 0{\cdot}05$) and this approached significance for girls ($P = 0{\cdot}07$). For overall tasting scores, a group effect was seen in girls only ($P = 0{\cdot}05$)
5	Morgan *et al.* (2010)[35], Australia	Quasi-experimental	11–12 years (*n* 127), 54 % boys	10 weeks	Not stated	10-week intervention with nutrition education and garden (NE&G), nutrition education (NE) only and control groups. F&V knowledge	Taste vegetables, identify vegetables, willingness to taste vegetables	24 h recalls	School gardens can positively improve primary-school students' willingness to taste vegetables and their vegetable taste ratings
6	Pendergast and Dewhurst (2012)[36], Australia	Cross-sectional	Home-economics teachers (*n* 1188)	Not stated	Not stated	Not applicable	Provide insights on food literacy curriculum	Online survey	Differences in home-economic teachers' understanding on food literacy

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
7	Ronto *et al.* (2016)[37], Australia	Mixed method	Home-economics teachers (*n* 205)	Not stated	Not stated	Not applicable	Examines home-economics teachers' perspectives of the importance, curriculum, self-efficacy and food environments	20-item cross-sectional survey	Many environmental barriers were reported that could influence food literacy education in Australian high schools such as: lack of teaching materials, facilities and human resources; the perceived inadequacy of the Australian school curriculum; non-supportive school canteens; and negative role modelling
8	Ronto *et al.* (2016)[38], Australia	Cross-sectional	Home-economics teachers (*n* 205)	Not stated	ANGELO framework	Not applicable	Home economic teachers' experience of food literacy education in Australian high schools	Survey	Home economic teachers rated aspects of food literacy including preparing and cooking food, knowing about healthy foods, and food safety and hygiene practices as very important. They indicated animal welfare, where food comes from, and plan and manage time for food shopping to be the least important aspects of food literacy. Home-economics teachers reported that students' involvement in food literacy activities resulted in healthier diets and improved food practices, but the schools' food environments are not comprehensively supportive of food literacy
9	Ronto *et al.* (2016)[39], Australia	Mixed method	Home-economics teachers (*n* 205)	Not stated	Not stated	Not applicable	Examines home-economics teachers' perspectives of the importance, curriculum, self-efficacy and food environments	20-item cross-sectional survey	Many environmental barriers were reported that could influence food literacy education in Australian high schools such as: lack of teaching materials, facilities and human resources; the perceived inadequacy of the Australian school curriculum; non-supportive school canteens; and negative role modelling
10	Slater (2013)[40], Canada	Mixed methods	Teachers (*n* 13)	10 years	Not stated	Not applicable	Examined the experiences and perceptions of Home Economics Food and Nutrition (HEFN) programming by teachers and school officials	Administrative records, in-depth interviews and surveys	Results revealed that although enrolment, including boys, increased slightly over the study period, the majority of children do not take HEFN classes. Further, enrolment decreased significantly from grades 7 (45·77 %) to 12 (7·61 %). HEFN education faces significant challenges

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
11	Zhou *et al.* (2016)[41], China	Mixed study	10–15 years of age (*n* 1058)	9 months	Not stated	Educational intervention consisted of both prize quiz game about nutrition and food safety	Nutrition knowledge, good personal eating habits, the prevention of nutrient deficiency diseases and food safety knowledge	Effectiveness evaluation questionnaires	Nutrition knowledge scores increased for the intervention group
12	Turnin *et al.* (2016)[42], France	Quasi-experimental	13–16·4 years of age (*n* 580)	1 year	Not stated	Nutri-Advice Kiosk – nutrition skills and food choices	Nutrition skills and food choice	Children's food choice competency changes and BMI	Across the study, children chose significantly less cheese and pastry or desserts, and significantly more starchy food and dairy, and tended to choose F&V more often
13	Petralias *et al.* (2016)[42], Greece	Quasi-experimental	10·4 years of age (*n* 25 349)	8-month intervention	Not stated	Students received a daily healthy meal designed by nutrition specialists	Food insecurity	Food Security Survey Module Questionnaire (FSSM)	About 64·2 % of children's households experienced food insecurity at baseline. The study findings suggest that participation in a school-based food aid programme may reduce food insecurity for children and their families in a developed country in times of economic hardship
14	Tsartsali *et al.* (2009)[44], Greece	Cross-sectional	15–17 years (*n* 200)	Not stated	Not stated	Not applicable	Adherence to the Mediterranean diet pattern (MDP)	MDP questionnaire, FFQ and KIDMED index score	More than half of participants had poor or very poor actual MDP knowledge. Actual knowledge was the only predictor of MDP adherence
15	Mirmiran *et al.* (2007)[45], Iran	Cross-sectional	10–18 years (mean age 14 (SD 1) years; *n* 7669)	Not stated	Not stated	Not applicable	Nutritional knowledge and dietary intake	Willett semi-quantitative FFQ; nutritional knowledge, attitudes and practice (KAP) questionnaire; BMI	Significant difference between genders in KAP, with females having higher nutrition knowledge scores. Males had better nutritional practices
16	Venter and Winterbach (2010)[46], South Africa	Cross-sectional	17–18 years (*n* 168)	Not stated	Not stated	Not applicable	Dietary fat knowledge questionnaire	A screening questionnaire for fat intake	The association between fat knowledge scores and intake of the participants was significant

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
17	Gewa *et al.* (2013)[48], Kenya	Randomised controlled trial	2–15 years of age (*n* 182)	2 years	Not stated	Schools randomised to one of four snack groups: (i) control (no food supplement); (ii) vegetarian supplement (a feeding based on a traditional local dish); (iii) milk supplement; and (iv) meat supplement	Diet quality, nutrient intake	24 h recalls	There was no evidence that schoolchildren who received supplementary snacks at school experienced reduced intakes at home or that intakes by other family members were increased at the expense of the schoolchild's intake
18	Klepp and Wilhelmsen (1993)[49], Norway	Quasi-experimental	Age not stated (*n* 447)	12 months	A theoretical framework, organising factors believed to influence the changes in eating patterns of adolescents into four structures: available food products, social environment, personality factors and behavioural factors	Education programme, followed up by a survey	Healthy eating behaviour between males and females	Short FFQ, healthy eating knowledge score	Programme demonstrated ability to integrate curriculum activities designed to modify students' eating behaviour in home economics courses
19	Øverby *et al.* (2012)[50], Norway	Cross-sectional	Age 10–12 years (*n* 1488)	7 years	Not stated	No intervention	Frequency of consumption of unhealthy snacks (soda, candy, potato chips) from 2001 to 2008	Questionnaire surveys	Between 2001 to 2008, the frequency of unhealthy snack consumption decreased from 6·9 to 4·6 times/week ($P = 0{\cdot}001$). The decrease was largest in the schools that had been included in the national free school fruit programme (22·8 times/week). The effect of the school fruit programmes was significant in reducing the frequency of unhealthy snack consumption in children of parents without higher education (from 7·8 to 4·0 times/week; $P = 0{\cdot}004$)

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
20	da Rocha Leal *et al.* (2011)[51], Portugal	Cross-sectional	7th, 8th, 9th grade (mean age 13·5 years; *n* 390)	2 months	Not stated	Not applicable	Cooking habits and skills, adherence to the Mediterranean diet	KIDMED index score	One in ten adolescents did not know how to cook. Better cooking habits and skills were positively related with adolescents' adherence to the Mediterranean diet
21	Osler and Hansen (1993)[52], Denmark	Cross-sectional	12–14 years (*n* 674)	Not applicable	Not stated	Not applicable	Nutrition, sugar, fat, fibre	Frequency questionnaire assessing the consumption of fourteen different food items	Adolescents had better knowledge about fat and sugar than dietary fibre. The mean nutrition knowledge increased with healthier dietary habits
22	Chapman *et al.* (1997)[56], USA	Pre–post intervention	14–18 years (*n* 72, females only)	Not stated	Not stated	Two groups, one control and one experimental. Experimental group received nutrition education	Nutrition knowledge	24 h dietary recall and modified version of nutrition knowledge and attitudes questionnaire	Post-test nutrition knowledge scores increased significantly and were higher than in the control group
23	Evans *et al.* (2012)[57], USA	Quasi-experimental	Low-income adolescents aged 12–14 years (*n* 214) in 6th grade	10 weeks; three 1 h nutrition education sessions in regular class time, 45 min four times per week in school garden	SCT	The Sprouting Healthy Kids intervention consisted of six components: (i) in-class lessons; (ii) after-school gardening programme; (iii) farm-to-school; (iv) farmers' visits to schools; (v) taste testing; (vi) field trips to farms	F&V consumption	F&V consumption; motivation for eating F&V; self-efficacy for eating F&V; F&V preference; preference for unhealthy foods; knowledge. Student SHK Questionnaire	Students who were exposed to two or more intervention components scored significantly higher on self-efficacy, knowledge, preferences for unhealthy foods and increased intake of F&V ($P < 0{\cdot}05$)
24	Gans *et al.* (1990)[58], USA	Observational	Age not stated (*n* 105)	1 year	Not stated	Heart Healthy Cook-off programme	Nutrition, food purchasing techniques and heart-healthy cooking methods and education on the relationship between diet and blood cholesterol	Blood cholesterol SCORE (screening, counselling and referral event)	Forty per cent had elevated blood cholesterol level of 170 mg/dl or above. A statistically significant decrease in blood cholesterol level was observed during a 12-week time period. The Cook-off is a fun, effective programme for teaching secondary-school students about heart healthy
25	Huang *et al.* (2004)[59], USA	Cross-sectional	10–19 years (*n* 301)	Not stated	Not stated	Not applicable	Reading nutrition labels	Fat screener	Boys reading nutrition labels was associated with higher fat intake. Frequency of reading nutrition labels was not associated with healthier diet

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
26	Jarpe-Ratner *et al.* (2016)[60], USA	Quasi-experimental	8–13 years of age (*n* 271)	10 weeks	Not stated	Ten-week (2 h/week) chef-instructor-led programme held in cafeteria kitchens after school	Nutrition knowledge, cooking self-efficacy, F&V liking and consumption, and communication to family about healthy eating	Quasi-experimental pre–post survey design	Nutrition knowledge score increased from 0·6 to 0·8, cooking self-efficacy score from 3·2 to 3·6, and vegetable consumption score from 2·2 to 2·4 (all $P < 0·05$). Increased score for communication about healthy eating (4·1 to 4·4; $P < 0·05$) 6 months after the end of the course
27	Larson *et al.* (2006)[61], USA	Cross-sectional	11–18 years (*n* 4746)	Not stated	Not stated	Not applicable	Preparation and shopping for food	Youth/Adolescent FFQ	Greater involvement in food tasks was significantly related gender, school grade, race, SES, family meal frequency and weight status
28	Laska *et al.* (2012)[62], USA	Longitudinal cohort	15–28 years (*n* 1321)	10 years	Not stated	Not appropriate	Enjoyment of cooking, food preparation, relationship between food practices in adolescence	Youth/Adolescence FFQ and Willett semi-quantitative FFQ	Adolescents who helped prepare food for dinner were more likely to engage in food preparation as emerging adults (19–23 years old)
29	Long and Stevens (2004)[63], USA	Quasi-experimental	12–16 years old (*n* 121)	1 month	SCT and TM	Combination of 5 h of web-based instruction and 10 h of classroom curriculum, compared with nutrition education embedded in the standard school curriculum during a 1-month period	Self-efficacy for healthy eating and eating behaviour	Six questionnaires; Youth/Adolescence FFQ	The intervention group had significantly higher scores for self-efficacy for F&V, self-efficacy for lower fat, usual food choices and dietary knowledge of fat compared with the control group. No difference was found between groups in food consumption. Self-efficacy was significantly associated with dietary knowledge of lower fat, usual food choices, and was inversely associated with lower fat consumption in the hypothesised model of eating behaviour. The intervention was tailored to the social and developmental preferences of adolescents and effectively increased self-efficacy for healthy eating

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
30	McAleese and Fada (2007)[64], USA	Quasi-experimental	10–13 years of age (mean age 11·11 years; *n* 99)	12 weeks	Not stated	Control group: three 24 h food recall workbooks before and after the intervention. Two treatment groups: (i) garden-based activities; (ii) 12-week nutrition education programme	F&V consumption	24 h recall food workbooks	Greater increase in F&V servings in adolescents in the garden-based nutrition group (0·8 (SD 0·8) to 1·0 (SD 1·4), $P < 0·001$ for fruit; 1·9 (SD 0·6) to 2·6 (SD 1·7), $P < 0·001$ for vegetables) compared with controls. Also, significant increases in vitamin A ($P = 0·004$), vitamin C ($P = 0·016$) and fibre ($P = 0·001$) intakes
31	Miller (2014)[65], USA	Cross-sectional	Age not stated, 12th grade (*n* 1800)	2 months	Not stated	Observation of students' food item choices	Food choice of breakfast selection of milk, juice and yoghurt	Observations and checklists	Secondary-school females were more likely to choose yoghurt than males (OR = 1·931, $P = 0·0033$). Elementary students who chose no milk were more likely to choose yoghurt than students who chose either white milk (OR = 3·592, $P \leq 0·0001$) or chocolate milk (OR = 2·273, $P = 0·0005$). Secondary students who chose no milk were more likely to choose yoghurt than students who chose white milk (OR = 3·494, $P = 0·0060$)
32	Pirouznia (2001)[66], USA	Cross-sectional	10–13 years (*n* 532)	Not stated	Not stated	Not applicable	Nutritional knowledge and eating behaviour	CANKAP questionnaire	Females had higher mean nutrition knowledge scores than boys in the 7th and 8th grades. There was no correlation between nutrition knowledge and eating behaviour in both genders in the 6th grade, and a correlation only for males in the 7th and 8th grades
33	Ratcliffe *et al.* (2011)[67], USA	Pre–post quasi-experimental study	11–13 years (*n* 232)	13 weeks	SCT	236 students completed the Garden Vegetable Frequency Questionnaire and 161 students completed a taste test	Knowledge, attitudes, vegetable consumption	Vegetable Frequency Questionnaire; Garden Vegetable Frequency Questionnaire; 24 h recall	Students were able to identify vegetables and had an increased preference for vegetables generally

Table 2 *Continued*

	Study details, country	Study design	Sample	Duration of intervention or study	Theory	Food literacy intervention	Food literacy attributes	Outcome measure	Key findings
34	Schober *et al.* (2016)[68], USA	Quasi-experimental	Age not stated (24 districts)	1 week	Not stated	The LiveWell@School Food Initiative consisted of: (i) a 1 d food services operation seminar for the FSD and financial director and a 2 d culinary workshop for the FSD and their kitchen staff; (ii) on-site chef consultation in school districts; (iii) action planning; and (iv) and equipment grant	Culinary training, action planning and equipment grants	Questionnaire, in-person review of school food records with FSD	Data show that districts changed an average of 17·4 entrées and 19·7 side dishes over the course of the year
35	Trexler and Sargent (1993)[69], USA	Cross-sectional	14–18 years (n 600)	Not stated	Not stated	Nutrition knowledge questionnaire	Cholesterol, saturated fat, total fat and sodium	24 h dietary recall	Physiological knowledge of sodium was significantly associated with sodium intake, but other dietary knowledge scores were not associated with dietary intakes
36	Williams *et al.* (2016)[70], USA	Quasi-experimental	8–11 years of age (n 225)	Unclear	SCT, TRA, positive feedback loops	One control school and two intervention schools (three 1 h, assembly-style, hip-hop themed, multimedia classes)	Food purchases and calorie labels	Hip Hop HEAL multimedia classes	A mean total of 225 children participated in two baseline pre-intervention sales with and without calorie labels; 149 children participated in immediate post-intervention food sales; while 133 children participated in the delayed sales. No significant change in purchased energy was observed in response to labels alone before the intervention. However, a mean decline in purchased energy of 20 % ($P < 0·01$) and unhealthy foods ($P < 0·01$) was seen immediately following the intervention compared with baseline purchases, and this persisted without significant decay after 7 d and 12 d
37	Caraher *et al.* (2013)[71], UK	Quasi-experimental intervention	9–11 years (n 169)	2–4 weeks	Not stated	Professional chefs delivered three sessions to one class over a year	Food, health, nutrition and cookery skills	Vegetable consumption scale, cooking confidence, food preparation	There was an improvement in cooking skills and confidence to prepare food, and average reported vegetable consumption increased after the session with the chef

SCT, Social Cognitive Theory; TPB, Theory of Planned Behaviour; HBM, Health Belief Model; ANGELO, Analysis Grid for Environments Linked to Obesity; TM, Transtheoretical Model; TRA, Theory of Reasoned Action; F&V, fruit(s) and vegetable(s); FSD, food service director; SES, socio-economic status.

Table 3 Qualitative studies included in the current systematic review that focus on adolescents' and home-economics teachers' attitudes and perceptions of food literacy programmes in secondary schools

	Study details, country	Population	Key findings	Theoretical underpinnings	Attitudes/perceptions	Recommendations for interventions/programmes
1	Ronto *et al.* (2017)[30], Australia	Home-economics teachers (*n* 22)	Home-economics teachers stated that time was insufficient to develop sustainable food-related life skills and introduce broader concepts of food literacy such as environmental sustainability	Not stated	Lack of financial resources, non-supportive school food environments, including school canteens, were reportedly major factors that prevented food literacy education and healthy dietary behaviour of adolescents	Increasing the status of food literacy education in schools would assist in changing dietary behaviour in the home setting
2	Swaminathan *et al.* (2009)[47], South India	7–15 years of age (*n* 307)	Interviews of participants revealed seven concepts. Older children from higher SES's perception of the meaning of healthy eating was largely based on diet composition. Unhealthy foods were not related to age group and SES. Knowledge did not translate into eating choice, with no difference in intake of fried foods/snacks, aerated drinks, fast foods, sweets and chocolates evident across age, group, gender, SES and mother's education level	Not stated	Difficulties in changing dietary behaviour	More targeted programmes on healthy eating education are required for people from low-SES areas
3	McKinley *et al.* (2005)[53], Northern Ireland	11–12 years old (52 boys, 54 girls)	A number of barriers to, and motivations for, healthy eating that should be accounted for when planning nutrition intervention strategies aimed at children moving into adolescence	Not stated	Major barriers to healthy eating were taste, appearance of food, filling power, time/effort, cost, choice/availability, risk rebellion and body image/weight concerns	Changes at a policy level are required to attempt to address some of the barriers to, and motivations for, healthy eating. Addressing barriers such as available, attractive and affordable healthy foods in the school canteen may prove more difficult without changes at policy level

Table 3 *Continued*

	Study details, country	Population	Key findings	Theoretical underpinnings	Attitudes/perceptions	Recommendations for interventions/programmes
4	Chatterjee *et al.* (2016)[54], USA	9–12 years of age, 13–19 years of age (*n* 32)	Ten themes emerged from focus groups and interviews, in three categories: impressions of the food, insufficient potion size, dislike of the taste, appreciation of the freshness, increased unhealthy food consumption outside school), impact of learning (learning what's healthy, the programme's innovativeness, control *v.* choice), concerns about stakeholder engagement (lack of student/family engagement, culturally incompatible foods)	Not stated	Major barriers identified: changes to improve taste, stakeholder engagement, large school food programme changes to address stakeholder concerns, and advocacy activities to address larger regulatory and environmental issues	Programmes consisting of incorporating culturally appropriate recipes in the school's menus and working with local restaurants to promote healthier offerings
5	Lukas and Cunningham-Sabo (2011)[55], USA	86 girls and 92 boys (*n* 178). Teachers and food educators. Age not stated	Students in cooking interventions described positive experiences with curriculum integration into academic subjects and were more likely to consider classmates friends	Not stated	The perceived influences of home and school environments can assist in improving nutrition education programmes	Students' voices can be used as an evaluation of school-based programmes
6	Bohm *et al.* (2016)[73], Sweden	10–16 years (*n* 59)	Meat was seen as 'central' to nutritional health, sensory experience, culture and social relationships	Gee's (2010) 'D' discourse analysis	Gendered discourses of absence, deviance and unattainability restricted some students' access to vegetarian foods	To counteract restricted access to vegetarian foods, Home and Consumer Studies teachers can redesign activities in the subject with the help of critical food literacy
7	Bohm *et al.* (2015)[74], Sweden	Students 10–16 years of age (*n* 59); teachers (*n* 5)	Results indicated that gender discourse of absence, deviance and unattainability restricted some students' access to vegetarian foods	Gee's (2013) big 'D'	Not applicable	A redesign of discourse could facilitate a reduction in meat consumption

SES, socio-economic status.

Table 4 Quality assessment attributes for each quantitative study included in the current systematic review, assessed by the Academy of Nutrition and Dietetics' Quality Criteria Checklist[28]

	Study details, country	Clear research question	Participant selection free from bias	Comparable study groups	Participant withdrawals or response rate described	Use of blinding	Description of intervention protocol and/or data collection procedures	Outcomes clearly defined	Appropriate statistical analysis	Conclusion supported by results	Unlikely funding bias	Overall score
1	Dewhurst and Pendergast (2011)[31], Australia	+	+	N/A	+	N/A	+	+	+	+	N/A	7/7
2	Dewhurst and Pendergast (2008)[32], Australia	+	+	+	+	N/A	+	+	+	+	N/A	8/8
3	Gracey *et al.* (1996)[33], Australia	+	+	N/A	–	N/A	+	+	+	+	+	7/8
4	Jaenke *et al.* (2012)[34], Australia	+	+	+	NR	N/A	+	+	+	+	N/A	7/8
5	Morgan *et al.* (2010)[35], Australia	+	+	+	+	N/A	+	+	+	+	N/A	8/8
6	Pendergast and Dewhurst (2012)[36], Australia	+	+	N/A	+	N/A	+	+	+	+	N/A	7/7
7	Ronto *et al.* (2016)[37], Australia	+	N/A	N/A	NR	N/A	+	+	+	+	N/A	5/6
8	Ronto *et al.* (2016)[38], Australia	+	+	N/A	N/A	N/A	+	+	+	+	N/A	6/6
9	Ronto *et al.* (2016)[39], Australia	+	+	N/A	NR	N/A	+	+	N/A	+	N/A	5/6
10	Slater (2013)[40], Canada	+	+	N/A	NR	N/A	+	+	+	+	N/A	6/7
11	Zhou *et al.* (2016)[41], China	+	+	+	+	+	+	+	+	+	N/A	9/9
12	Turnin *et al.* (2016)[42], France	+	+	+	NR	+	+	+	+	+	N/A	8/9
13	Petralias *et al.* (2016)[42], Greece	+	+	+	NR	N/A	+	+	+	+	N/A	7/8
14	Tsartsali *et al.* (2009)[44], Greece	+	+	N/A	+	N/A	+	+	+	+	NR	7/8
15	Mirmiran *et al.* (2007)[45], Iran	+	–	N/A	–	N/A	+	+	+	+	NR	5/8
16	Venter and Winterbach (2010)[46], South Africa	+	+	N/A	+	N/A	+	+	+	+	NR	7/8
17	Gewa *et al.* (2013)[48], Kenya	+	+	+	+	+	+	+	+	+	N/A	9/9
18	Klepp and Wilhelmsen (1993)[49], Norway	+	+	+	+	+	+	+	+	+	N/A	9/9
19	Øverby *et al.* (2012)[50], Norway	+	+	+	+	N/A	+	+	+	+	N/A	8/8
20	da Rocha Leal *et al.* (2011)[51], Portugal	+	+	N/A	+	N/A	+	+	+	+	+	8/8
21	Osler and Hansen (1993)[52], Denmark	+	+	N/A	+	N/A	+	+	+	+	+	8/8
22	Chapman *et al.* (1997)[56], USA	+	+	+	–	–	+	+	+	+	NR	7/10
23	Evans *et al.* (2012)[57], USA	+	+	+	NR	+	+	+	+	+	N/A	8/9
24	Gans *et al.* (1990)[58], USA	+	+	+	NR	N/A	+	+	+	+	N/A	7/8
25	Huang *et al.* (2004)[59], USA	+	–	N/A	–	N/A	–	+	+	+	NR	4/7
26	Jarpe-Ratner *et al.* (2016)[60], USA	+	+	+	N/R	N/A	+	+	+	+	N/A	7/8
27	Larson *et al.* (2006)[61], USA	+	+	N/A	–	N/A	+	+	+	+	NR	6/7
28	Laska *et al.* (2012)[62], USA	+	+	N/A	+	N/A	+	+	+	+	NR	7/8
29	Long and Stevens (2004)[63], USA	+	+	+	+	NR	+	+	+	+	N/A	8/9
30	McAleese and Fada (2007)[64], USA	+	+	+	+	N/A	+	+	+	+	N/A	8/8
31	Miller (2014)[65], USA	+	+	+	+	+	+	+	+	+	N/A	9/9
32	Pirouznia (2001)[66], USA	+	+	N/A	–	N/A	+	+	+	+	NR	6/8
33	Ratcliffe *et al.* (2011)[67], USA	+	N/A	+	NR	NR	+	+	+	+	NR	6/8
34	Schober *et al.* (2016)[68], USA	+	+	+	+	+	+	+	+	+	N/A	9/9
35	Trexler and Sargent (1993)[69], USA	+	+	N/A	–	N/A	+	+	+	+	+	7/8
36	Williams *et al.* (2016)[70], USA	+	+	+	+	+	+	+	+	+	N/A	9/9
37	Caraher *et al.* (2013)[71], UK	+	+	N/A	+	–	+	+	+	+	+	8/9

N/A, not applicable (due to study design); +, positive overall score; NR, not reported; –, negative overall score (this score is given if criterion is not met).

Table 5 Quality appraisal for each qualitative study included in the current systematic review, assessed by the National Institute for Health and Care Excellence's critical appraisal checklist for qualitative studies[29]

	1. Is a qualitative approach appropriate?			2. Is the study clear in what it seeks to do?		
Qualitative study	Appropriate	Inappropriate	Not sure	Clear	Unclear	Evidence grading
Ronto *et al.* (2017)[30], Australia	✓			✓		++
Swaminathan *et al.* (2009)[47], South India			✓	✓		+
McKinley *et al.* (2005)[53], Northern Ireland	✓					++
Chatterjee *et al.* (2016)[54], USA	✓			✓		++
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		++
Bohm *et al.* (2016)[73], Sweden	✓			✓		++
Bohm *et al.* (2015)[74], Sweden	✓			✓		++

	3. How defensible is the research design?			4. How well was the data collection carried out?		
Study design and data collection	Defensible	Indefensible	Not sure	Appropriate	Inappropriate	Not sure
Ronto *et al.* (2017)[30], Australia	✓			✓		
Swaminathan *et al.* (2009)[47], South India	✓					✓
McKinley *et al.* (2005)[53], Northern Ireland	✓			✓		
Chatterjee *et al.* (2016)[54], USA	✓			✓		
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		
Bohm *et al.* (2016)[73], Sweden	✓			✓		
Bohm *et al.* (2015)[74], Sweden	✓			✓		

	5. Is the role of the researcher clearly described?			6. Is the context clearly described?		
Validity	Clear	Unclear	Not sure	Clear	Unclear	Not sure
Ronto *et al.* (2017)[30], Australia	✓			✓		
Swaminathan *et al.* (2009)[47], South India		✓			✓	
McKinley *et al.* (2005)[53], Northern Ireland	✓			✓		
Chatterjee *et al.* (2016)[54], USA	✓			✓		
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		
Bohm *et al.* (2016)[73], Sweden	✓			✓		
Bohm *et al.* (2015)[74], Sweden	✓			✓		

	7. Were the methods reliable?		
Validity continued	Reliable	Unreliable	Not sure
Ronto *et al.* (2017)[30], Australia	✓		
Swaminathan *et al.* (2009)[47], South India		✓	
McKinley *et al.* (2005)[53], Northern Ireland	✓		
Chatterjee *et al.* (2016)[54], USA	✓		
Lukas and Cunningham-Sabo (2011)[55], USA	✓		
Bohm *et al.* (2016)[73], Sweden	✓		
Bohm *et al.* (2015)[74], Sweden	✓		

	8. Is the data analysis sufficiently rigorous?			9. Are the data rich?		
Analysis	Rigorous	Not rigorous	Not sure	Rich	Poor	Not sure
Ronto *et al.* (2017)[30], Australia	✓			✓		
Swaminathan *et al.* (2009)[47], South India		✓			✓	
McKinley *et al.* (2005)[53], Northern Ireland	✓			✓		
Chatterjee *et al.* (2016)[54], USA	✓					✓
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		
Bohm *et al.* (2016)[73], Sweden	✓			✓		
Bohm *et al.* (2015)[74], Sweden	✓			✓		

	10. Is the analysis reliable?			11. Are the findings credible?		
Analysis continued	Reliable	Unreliable	Not Sure	Credible	Not credible	Not sure
Ronto *et al.* (2017)[30], Australia	✓			✓		
Swaminathan *et al.* (2009)[47], South India		✓			✓	

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Table 5 *Continued*

Analysis continued	10. Is the analysis reliable?			11. Are the findings credible?		
	Reliable	Unreliable	Not Sure	Credible	Not credible	Not sure
McKinley *et al.* (2005)[53], Northern Ireland	✓			✓		
Chatterjee *et al.* (2016)[54], USA	✓			✓		
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		
Bohm *et al.* (2016)[73], Sweden	✓			✓		
Bohm *et al.* (2015)[74], Sweden	✓			✓		

Relevance and conclusions	12. Are the findings relevant?			13. Conclusions		
	Relevance	Irrelevant	Not sure	Adequate	Inadequate	Not sure
Ronto *et al.* (2017)[30], Australia	✓			✓		
Swaminathan *et al.* (2009)[47], South India		✓			✓	
McKinley *et al.* (2005)[53], Northern Ireland	✓			✓		
Chatterjee *et al.* (2016)[54], USA	✓			✓		
Lukas and Cunningham-Sabo (2011)[55], USA	✓			✓		
Bohm *et al.* (2016)[73], Sweden	✓			✓		
Bohm *et al.* (2015)[74], Sweden	✓			✓		

Ethics	14. How clear and coherent is the reporting of ethics?		
	Appropriate	Inappropriate	Not sure
Ronto *et al.* (2017)[30], Australia	✓		
Swaminathan *et al.* (2009)[47], South India	✓		
McKinley *et al.* (2005)[53], Northern Ireland	✓		
Chatterjee *et al.* (2016)[54], USA	✓		✓
Lukas and Cunningham-Sabo (2011)[55], USA	✓		
Bohm *et al.* (2016)[73], Sweden	✓		
Bohm *et al.* (2015)[74], Sweden	✓		

Grading the evidence:
++ All or most of the quality criteria have been fulfilled. Where they have been fulfilled the conclusions of the study or review are thought very unlikely to alter.
+ Some of the criteria have been fulfilled. Where they have been fulfilled the conclusions of the study or review are thought unlikely to alter.
– Few or no criteria fulfilled. The conclusions of the study are thought likely or very likely to alter.

Gender differences in nutritional knowledge and dietary behaviour

Nine studies investigated gender differences on the impact of nutrition knowledge and fruit and vegetable intake[33,34,45,46,49,56,59,65,66]. Four studies revealed that females have greater nutritional knowledge than males[33,45,46,66]. One study found a gender difference only in fruit and vegetable preferences, with girls rating carrot higher than boys in taste ratings ($P = 0{\cdot}04$)[34]. One study identified that although both boys and girls had a reasonable level of nutritional knowledge, only boys had good nutritional practices[45]. Two studies investigated nutrition education and behaviour changes. One study explored milk and yoghurt selection in a school breakfast programme and reported females were more likely to choose yoghurt than males[65]. One study assessed healthy eating behaviour and healthy eating knowledge before and after the intervention at 5- and 12-month follow-ups[49]. The results of the study showed that there was a short-term positive effect on eating behaviours in males, as well as maintaining a positive impact on healthy eating knowledge.

The effectiveness of cooking and food safety

Six studies investigated cooking skills and food safety[41,58,60,61,68,71]. Four out of five studies utilised experienced chefs and hands-on cooking with the adolescents[58,60,68,71] and only one study used lectures and prize-based games about nutrition and food safety[41]. Studies that utilised experimental cooking and nutritional education programmes led by chef instructors showed positive results in overall cooking confidence, cooking skills and tasting new foods[71]. One study found that experimental cooking and nutrition education programmes led by chef instructors might be an effective way to improve nutrition in low-income communities[60]. Nutritional knowledge score increased from 0·6 to 0·8, cooking self-efficacy score from 3·2 to 3·6, and vegetable consumption score from 2·2 to 2·4 (all $P < 0{\cdot}05$). Increased score for communication about healthy eating (4·1 to 4·4; $P < 0{\cdot}05$) was observed 6 months after the end of the course[60]. One study investigated the effects of the LiveWell@School Food Initiative in Colorado and identified an increase in the proportion of fresh, from-scratch cooking foods (using fresh ingredients compared with

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cooking using processed foods) and a decrease in energy, fat, saturated fat and sodium that contributed to a healthier school food environment[68]. One study investigated the effectiveness of a school-based nutrition and food safety education programme among primary- and junior-high-school students in China[41]. It found that after adolescents participated in the school-based cooking programme, they enjoyed tasting new foods, making new meals and learning new cooking skills. Participants reported an increase in their food skills, following recipes and preparing foods.

Qualitative studies

Adolescent attitudes and perceptions on food literacy

Seven studies investigated adolescents and their attitudes about cooking classes in secondary schools and their understanding of healthy and unhealthy eating[37,47,53–55,72,73]. Two studies specifically investigated adolescents' attitudes and views on school cooking interventions[54,55]. Lukas and Cunningham-Sabo's study conducted focus groups interviews with students to obtain the classroom experiences about the Cooking with Kids programme[55]. The findings from this study were that students described positive experiences with the programme and its curriculum integration into academic subjects. Another study investigated students' perspectives on a high-school food programme and identified that all stakeholders appreciated the programme, but there were some disagreements regarding the impression of how cooking skills are taught to students regarding culturally incompatible foods[54].

Five studies investigated adolescents' perceptions of healthy and unhealthy eating by qualitative research methodology[37,47,53,72,73]. The overall consensus of adolescents' attitudes towards healthy eating was 'fruit', 'vegetable' and 'salads' were viewed as healthy and processed foods were viewed as less-healthy foods[53]. A potential barrier identified in one study was that adolescents are interested in developing food skills but have limited opportunities to develop these skills in school or the home environment[53]. One study investigated adolescents' perspectives on food literacy and its impact on their dietary behaviours. Adolescents were required to rank twenty-two aspects of food literacy in order of importance. Adolescents ranked food and nutrition knowledge as more important than food skills and food capacity[37].

Home-economics teachers' perspectives on home economics subjects in secondary schools

Seven studies investigated home economics in secondary schools and teachers' perspectives on home economics in secondary schools[30–32,36,38–40]. One study explored home-economics teachers' views on the role of secondary schools in enhancing adolescents' food literacy and promoting healthy dietary behaviour[30]. They identified cooking skills, knowledge about healthy foods, and food safety and hygiene practices as very important. The overall consensus regarding barriers and perceptions on home economics in secondary schools was: lack of teaching materials and facilities, less importance of home economics compared with science and maths-based subjects, no supportive school canteens and negative role modelling of staff[38].

Dietary behaviour outcome measures

In studies that measured dietary intake, this was done by FFQ (*n* 11), 24 h dietary recalls (*n* 6), KIDMED Index (*n* 2), other questionnaires and surveys (*n* 27), interviews (*n* 2), focus groups (*n* 4), audio/video-taping (*n* 2), and observations and checklists (*n* 2).

Discussion

The purposes of the current systematic review were to provide a recent and comprehensive overview of worldwide studies on the effects of food literacy programmes in secondary schools, and on adolescents' and home-economics teachers' attitudes and perspectives on food literacy programmes in secondary schools. No study used a valid and reliable food literacy tool. There has been increasing consideration of food literacy as a significant influence on children and young people's eating patterns[74,75]. Previous studies investigating the implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach have identified that the school environment, via home economics, can provide an ideal setting for the teaching and practice of food literacy skills and healthy dietary behaviour[19]. For the present review, we aimed to extend previous systematic reviews[20,21] on this topic and to include areas where further research is needed.

The effects of secondary-school food literacy interventions were challenging to assess because of varying study designs, intervention strategies, research aims and outcome measures, resulting in inconsistencies in the overall findings of food literacy. Furthermore, it was difficult to determine which type of school-based programme or intervention was most effective. Of the forty-four studies included in the review, interventions that were implemented for a minimum of 4 weeks and had used a validated and reliable evaluation measure that incorporated psychological constructs such as self-efficacy and knowledge were found to show changes in short-term dietary behaviour.

The quality of studies included in the current review should be considered when interpreting their findings. The majority of quantitative studies were identified as positive, with two studies being average[45,59] in rating quality. Although randomised controlled trials should provide more reliable evidence on the effects of interventions[76], the one randomised controlled trial included[48] did not show greater quality than the quasi-experimental or

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observational or mixed-method studies. The majority of qualitative studies were identified as positive ('++'), with one being '+'[47]. The findings suggest that food literacy studies typically satisfy quality requirements.

Regarding sample size, only two out of twenty-five interventions reported conducting a statistical power calculation[34,35]. Since the studies reviewed used a convenience sample, with only two studies reporting a power calculation; only reporting *P* values with minimal mention of standard deviations and effect sizes, as such the results from these studies should be interpreted with caution. All of the studies used self-reported dietary intake as the outcome measure, which may have resulted in some potential respondent bias. Of the twenty-five interventions, seven studies did not describe the participant withdrawal/drop-out or response rate in their studies; and only one study discussed a blinding procedure[48]. Only one study out of twenty-three demonstrated long-term dietary behaviour from adolescence to adulthood. From the studies examined, it is not clear whether the observed effects were long term regarding changes in dietary behaviour.

Of the articles reviewed, only nine studies explicitly stated a theoretical underpinning in their design[33,38,49,57,63,67,70,72,73], with the most popular theoretical underpinning being the Social Cognitive Theory. Theory-driven interventions typically demonstrated more associations with changes in positive dietary behaviour compared with other studies[57,67].

The present review identified there is a paucity of studies showing secular dietary behaviours of food literacy interventions. Laska *et al.*'s[62] longitudinal study investigated the involvement in food preparation, showing that it tracks over time between adolescence (15–18 years) to emerging adulthood (19–23 years) and the mid-to-late twenties (24–28 years). The study focused on home preparations, dietary quality and meal preparation. The findings suggested that food skills and behaviours learned in adolescence were sustained later in life. From that study, food preparation taught to adolescents may have some effect on altering dietary behaviour.

In comparison to Robinson-O'Brien *et al.*'s review[22] of garden-based nutrition interventions, the findings from the current review showed that they have the potential to promote an increase in preferences and improve dietary intake concerning fruit and vegetables. Four studies in our review reported that adolescents' exposure to garden-based nutrition education was associated with an increase in fruit and vegetable intake[35,57,64,67]. One study reported no improvement in fruit and vegetable intake[34]. It is inconclusive for the long-term dietary intake of fruit and vegetables based on garden-based interventions. With regard to garden-based interventions, some studies provided pre and post[67] or only post-intervention data[57], some did not include a control condition or included control and comparison groups but assigned only one group per condition, and could have resulted in possible statistical outcomes due to clustering.

Of the articles reviewed for adolescents' attitudes and perceptions of food literacy, only seven studies used qualitative methods alone[37,47,53–55,72,73]. Two of the articles used qualitative methods to assist in quantitative methods[37,47]. The overall consensus from adolescents and their attitudes to food literacy in the school environment were that students held a clear understanding on what food items constitute healthy and unhealthy eating[72,73] and described an overall positive experience with the school food programmes that are integrated into the school curriculum[55]. The results from qualitative studies investigating adolescent perspectives of the term 'food literacy' have revealed that there are multiple discourses on the term[37,72,73]. Adolescents appear to rank food and nutrition knowledge as more important than food skills and food capacity (positive attitudes towards cooking and nutrition knowledge)[37]. A majority of students did not apply the food knowledge that they learned in home-economics classes due to low confidence in cooking skills and the food environment surrounding their school and home.

Of the articles reviewed for home-economics teachers' attitudes and perspectives on food literacy, only five studies used qualitative methods[30–32,36,39]. The studies identified that home-economics teachers rated aspects of food literacy, including cooking food, the nutritional content of food, and food safety and hygiene practices, as important skills. However, school food environments are not comprehensively supportive of food literacy. The findings from home-economics teachers' attitudes and perspectives on food literacy programmes in secondary schools suggest that there may be some external factors affecting home-economics teachers' ability to present culinary skills effectively to secondary-school students[30,38]. External factors identified by Ronto *et al.*[38] were materials and facilities, human resources, non-supportive school canteen systems, negative role modelling and the importance of home economics from a parent's perspective[30]. Increased internal support from school leadership and healthy school food environments could assist home-economics teachers' attitudes and perspectives on food literacy programmes taught in secondary schools.

Future research conducted in the field of food literacy in the school environment should focus on providing teachers with greater support and adequate training in nutritional knowledge, a universal definition, and evaluation techniques and instruments to measure all aspects of food literacy. None of the studies reviewed incorporated a validated and reliable tool to measure multiple constructs of food literacy. Studies investigating food literacy have measured only one or two aspects of the concept, mainly nutritional knowledge and food preferences. It appears further research is required to develop a valid and reliable tool that measures all attributes that cover the food literacy concept. Only one study utilised a randomised controlled trial research design, and thirteen studies utilised a quasi-experiment and one study used a pre–post intervention,

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resulting in an inability to assess causality between food literacy and dietary intake. Future studies examining dietary behaviour should include a theoretical basis for programme development. Given that food and nutrition literacy is a context-specific concept, the development of a valid and reliable tool to assess adolescents' food literacy in the school setting could help to overcome the challenges of food and nutritional knowledge assessments in the school setting, tailor targeted evaluation programmes and identify gaps in school food literacy programmes.

Strengths and limitations of the systematic review

As a strength, the systematic review followed the PRISMA reporting guidelines. Second, the review included qualitative studies to ascertain adolescents' and home-economics teachers' perspectives on food literacy interventions in secondary schools. As food literacy is an emerging term in the literature, qualitative research can assist in understanding the facilitators and barriers to effective school-food based interventions[23].

The main limitation of the review's design is the inclusion of a broad range of studies. As a result, a meta-analysis could not be conducted. Definitive conclusions from the studies reviewed could not be determined due to multiple definitions of the term food literacy[77]. Due to the variations in definitions used across reviewed studies, it was challenging to incorporate strict parameters regarding only essential terms. Finally, the relative effectiveness of each different intervention could not be determined or generalised. Most of the studies measuring food knowledge and dietary intake were based on self-reported measures that may influence the reporting of actual and ideal dietary intake.

Conclusions

In the current systematic review, we reviewed and synthesised the literature on food literacy interventions in secondary schools and reported on the associations among home-economics teachers and adolescents and their effects on dietary outcomes. The review identified that food literacy interventions conducted in a secondary-school setting have been useful in improving food and nutritional knowledge. There was only one study identified in the review that indicated any effect on long-term dietary behaviour. That study evaluated the involvement in food preparation activities in adolescence and into early adulthood. To date, there appears to be no consensus on the definition of food literacy, which has resulted in difficulties in developing a valid and reliable measure resulting in minimal empirical evidence regarding measuring food literacy in the adolescent population. The evidence presented in the review recommends the creation and adoption of a validated and reliable tool to measure food literacy attributes. Further high-quality randomised controlled trials and longitudinal studies could then be conducted to ascertain dietary behaviours among adolescents.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980019001666

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