



Review Article

The relationship between food literacy and dietary intake in adolescents: a systematic review

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Abstract

Objective: The aim of the present systematic review was to investigate the evidence on the association between food literacy and adolescents' dietary intake.

Design: The review included searches of six databases with no restriction on the year of publication or language.

Setting: The studies eligible for review were from five countries/regions: USA (*n* 6), Europe (*n* 4), Australia (*n* 1), Middle East (*n* 1) and South Africa (*n* 1).

Subjects: Adolescents aged 10 to 19 years.

Results: Thirteen studies were eligible for inclusion. None of the studies investigated all aspects of food literacy. Eight studies reported a positive association between food literacy and adolescents' dietary intake. For example, adolescents with greater food knowledge and frequent food preparation behaviours were shown to have healthier dietary practices. Three studies found a mixed association of food literacy and adolescents' dietary intake. For example, adolescents who frequently helped to prepare dinner had healthier dietary intake, but food shopping tasks were associated with less healthy food choices. Two studies found no association between measures of food literacy and adolescents' dietary intake.

Conclusions: Food literacy may play a role in shaping adolescents' dietary intake. More rigorous research methods are required to effectively assess the causality between food literacy and adolescents' dietary intake in order to confirm the extent of the relationship. Evidence recommends public health practitioners and policy makers consider new public health strategies that focus on increasing understanding of food literacy in adolescence.

Keywords
Food literacy
Eating behaviours
Adolescents
Systematic review

Obesity is one of the most serious public health challenges of the 21st century^(1,2). Overweight and obesity is the fifth leading cause of global deaths⁽¹⁾ and its prevalence has increased substantially over the past two decades^(2,3). Obesity is associated with an increased risk of physical and psychosocial conditions, including type 2 diabetes, cardiovascular and liver diseases as well as social stigmatisation, low self-esteem and depression⁽⁴⁾. There is an increasing focus on the factors influencing the establishment of behavioural risk factors for obesity and related chronic diseases. Specifically, health-related behaviours established in adolescence often continue into adulthood and influence the risk of obesity^(3,5,6).

Adolescence is a transition period between puberty and adulthood, and refers to young people aged 10 to 19 years⁽⁷⁾.

Adolescence is a period of increased autonomy and independent decision making that may influence health-related behaviours⁽⁸⁾. Dietary intake is one way that adolescents express their independence⁽⁸⁾, reinforcing the importance of promoting healthy eating in this stage of life^(5,6). Adolescents' dietary patterns are characterised by frequent snacking, fast-food consumption and meal skipping; and many adolescents do not meet nutrition recommendations^(8,9). Adolescents and young adults are among the most frequent consumers of restaurant meals, away-from-home meals and packaged snacks⁽⁹⁾. These dietary intake patterns promote weight gain and are associated with increased risk of obesity, type 2 diabetes, CVD and some cancers⁽⁹⁻¹¹⁾. Therefore, it is essential that public health promotion strategies and interventions focus

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on promoting healthy dietary intake during adolescence and subsequently into adulthood.

Previous attempts to reduce the prevalence of adolescent overweight and obesity have displayed minimal to modest outcomes^(12–14). Interventions are generally successful in increasing nutrition-related knowledge but do not observe improvements in dietary intake⁽¹⁵⁾. It has been suggested that these outcomes have occurred because previous interventions have failed to connect nutrition-related knowledge, skills and critical decision making about dietary intake⁽¹¹⁾. Collectively, these concepts are called ‘food literacy’ and could be the key to improving the outcomes of future interventions in this area.

The concept of ‘food literacy’ is relatively new⁽¹⁰⁾. Early studies defined food literacy as ‘the capacity of an individual to obtain, process and understand basic information about food and nutrition as well as the competence to use that information in order to make appropriate health decisions’⁽¹⁶⁾. Defined in this way, food literacy is not just nutrition knowledge; it includes skills and behaviours, from knowing where food comes from to the ability to select and prepare these foods and behave in ways that meet nutrition guidelines. Recently, the definition has been broadened and described 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’⁽¹⁷⁾.

The concept of food literacy builds upon the work that has been done around the relationship between food knowledge and food choices, more broadly, the relationship between knowledge and behaviour. A number of well-respected behaviour change theories, such as Bandura’s Social Cognitive Theory, explain how knowledge creates the precondition for change including the self-regulation of health-related habits such as food choices^(18,19). Although knowledge regarding healthy eating behaviour is necessary, the extensive research on behaviour change suggests that knowledge on its own is often not sufficient to change individual behaviour (including food choices)⁽²⁰⁾. This highlights the need to move beyond knowledge to more inclusive concepts such as literacy to effect change in behaviours of interest, including diet^(21,22). As such, the concept of food literacy offers an integrative framework for investigating and understanding the factors shaping food intake and dietary patterns at an individual level.

Clarifying the influence of food literacy on dietary intake is important for the development of effective obesity prevention and management strategies. In addition, understanding the extent of the association may assist in predicting the impact of health promotion strategies that focus on improving food literacy in order to improve individuals’ dietary intake. Most food literacy interventions in adolescents have focused on process evaluation outcomes such as participant satisfaction, intentions, attitudes or preferences for healthy foods, or changes in learned

skills and behaviours, rather than changes in dietary intake^(23–31). Therefore, it is important to critically review literature that has investigated associations between food literacy and dietary intake of adolescents. The present systematic review aimed to investigate the association between food literacy and adolescents’ dietary intake.

Methods

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement checklist, which is a tool commonly used in reporting systematic reviews⁽³²⁾. For the purpose of the present review, ‘adolescence’ was defined as individuals aged from 10 to 19 years and ‘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’⁽¹⁷⁾.

Search methods

Articles were sourced from electronic searches of six databases: MEDLINE (EBSCO Host), Cochrane Library, PsycINFO, Web of Science, PubMed and Scopus. These databases afford broad coverage of allied health, including nutrition and public health, literature. Due to the multifaceted definition of food literacy, a food literacy definition matrix was developed to identify relevant search terms based on each component of food literacy. The matrix was informed by previous definitions of food literacy^(16,17,33) and encompassed factors of knowledge, skills and behaviours with food planning, management, selection, preparation and eating. The following search terms were identified and used in combinations to search each database: ‘food literacy’, ‘nutrition literacy’, ‘nutrition’, ‘food’, ‘diet’, ‘nutrition knowledge’, ‘food knowledge’, ‘cooking knowledge’, ‘food preparation knowledge’, ‘food skills’, ‘cooking skills’, ‘food preparation’, ‘food purchasing’, ‘food selection’, ‘food labels’, ‘label reading’, ‘adolescent’, ‘youth’, ‘teenager’, ‘teens’. To complement this search strategy, forward citation searching was undertaken on the reference list of articles considered for review.

Study selection

A list of potentially relevant articles from each database was identified, exported and saved into EndNote[®] version X6. Duplicates were identified and removed; relevant articles were scanned to confirm relevance for full review by three authors independently. Articles were included for consideration if the title, abstract or the keywords indicated the study measured an aspect of food literacy and a measure of dietary intake in adolescents. Studies were limited to adolescent populations aged 10 to 19 years without mental health or learning difficulties. If the age range of participants extended beyond 10 to 19 years, then



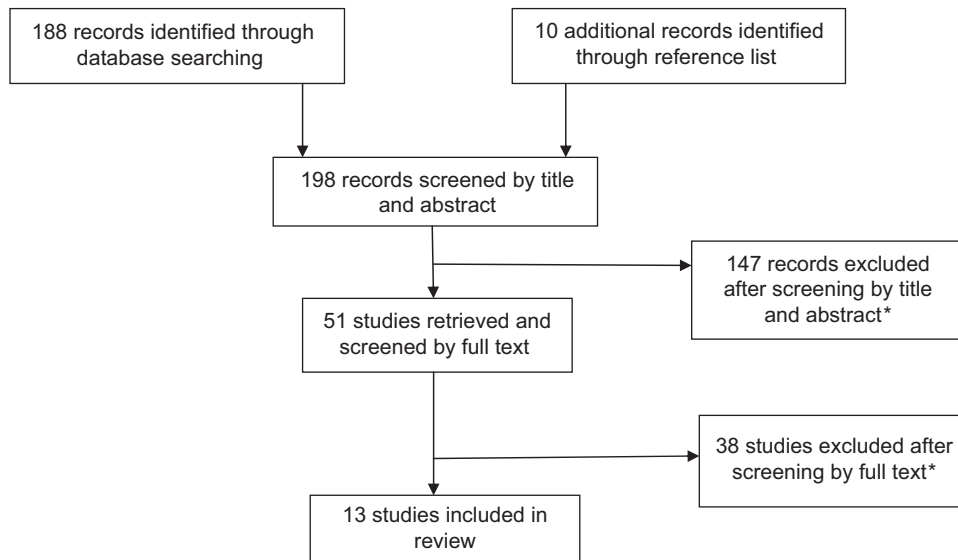


Fig. 1 Flowchart of the literature search and review process. *Reasons for exclusion: study population not adolescents (adults or young children; n 69); study did not address the main objective of the present review (n 31); study had no food literacy or dietary intake measure (n 85)

the studies were included if the mean age was ≥ 10 years or ≤ 19 years. There was no restriction on the year of publication or language. Differences in selections were discussed before the list of included studies was finalised. Ineligible articles were removed from the list after noting the reason for exclusion. The PRISMA flow diagram was used to document the systematic review search and selection processes of the study (see Fig. 1)⁽³²⁾.

Data extraction and analysis

The key information from each study selected for review was extracted carefully by one researcher (R.V.) into a prepared evidence worksheet for comparison and quality assessment suggested by the American Dietetic Association guidelines⁽³⁴⁾. The key information included title, year, author, study design, purpose, study population characteristics, study protocol, outcome variables and results. This information is summarised in Table 1.

Outcomes assessed

Relevant study outcomes to the review were those that reflected measures of food literacy (such as food knowledge, food skill and food behaviours) and dietary intake (such as dietary recalls, FFQ). Some of the studies considered for review focused on other food-related measures, such as social connectedness from community gardens/kitchens, acculturation or migration outcomes in changing dietary habits, and these studies were included only if they also investigated the outcomes of an aspect of food literacy on measures of dietary intake.

Quality assessment

According to the PRISMA checklist, risk of bias of methodological quality within each individual study was

assessed by two independent researchers (R.V. and L.E.B.) using the American Dietetic Association Quality Criteria Checklist (QCC)⁽³⁴⁾, see Table 2. The QCC is a tool that addresses scientific rigour and is commonly used to assess studies in the field of nutrition. The QCC includes ten criteria that assess the applicability to practice and scientific validity of each study. Through this tool, the quality attributes of each study were classified as positive, neutral or negative. The outcomes of the quality assessment are shown in Table 2.

Results

A total of 198 articles were retrieved from the six database searches. Of those studies, 147 did not qualify for further review as they were not relevant to the topic, did not incorporate adolescents, did not incorporate relevant outcome measures or were not an original research article (e.g. editorials). A full article review was conducted on the remaining fifty-one studies, after which an additional thirty-eight were excluded. Of those thirty-eight studies, eight were found not to be a study (i.e. describing an education intervention process or did not have evaluation measures) and thirty did not include a measure of food literacy or a dietary intake measure (see Fig. 1).

Summary of included studies

Table 1 provides a summary of each study included for the review. The studies were published between 1993 and 2013 and included ten cross-sectional studies^(5,35–43), two intervention studies^(44,45) and one longitudinal cohort study⁽⁹⁾. One of the cross-sectional studies⁽³⁸⁾ was a part of the longitudinal cohort study⁽⁹⁾. Six of the studies were

Table 1 Summary table of studies included in the present systematic literature review and narrative description

Study details	Study design	Target group	Food literacy measure	Outcome measure	Summary of findings
Caraher <i>et al.</i> (2013) ⁽⁴⁴⁾ , UK	Quasi-experimental intervention	9–11 years (<i>n</i> 169)	Cooking confidence scale	Vegetable consumption scale	Participants enjoyed tasting new foods, making new dishes, learning new fruit and vegetable cutting skills, wanted to have more sessions with a chef. Adolescents increased their individual food preparation skills. At post-test cooking confidence and vegetable consumption increased significantly ($P=0.002$) in the intervention group
Laska <i>et al.</i> (2012) ⁽⁹⁾ , USA	Longitudinal cohort	15–28 years (<i>n</i> 1321)	Involvement in household food tasks questionnaire	Youth/Adolescent 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), such as buying fresh vegetables, writing a grocery list, preparing dinner with chicken, fish or vegetables, and preparing an entire dinner for two or more people. It was significantly associated with enjoyment of cooking ten years later among both genders ($P=0.003$)
Leal <i>et al.</i> (2011) ⁽⁵⁾ , Portugal	Cross-sectional	7th, 8th, 9th grade (mean age 13.5 years; <i>n</i> 390)	Cooking habits and skills questionnaire	KIDMED index score	Better cooking habits and skills were positively related with adolescents' adherence to the Mediterranean diet. Adolescents with higher KIDMED index scores knew how to cook better, cooked more often, enjoyed cooking, would like to cook more frequently and would like to learn how to cook better ($P<0.001$)
Venter and Winterbach (2010) ⁽³⁵⁾ , South Africa	Cross-sectional	17–18 years (<i>n</i> 168)	Dietary fat knowledge questionnaire	A screening questionnaire for fat intake	The association between fat knowledge score and intake of the participants was significant ($P<0.05$). Adolescents who followed a diet high in fat mostly obtained a poor fat knowledge score, while the participants who followed a diet desirable in fat content mostly obtained an average fat knowledge score. Fat knowledge scores were poor; more females achieved average scores than males
Tsartsali <i>et al.</i> (2009) ⁽³⁶⁾ , Greece	Cross-sectional	15–17 years (<i>n</i> 200)	Mediterranean dietary pattern (MDP) knowledge questionnaire	FFQ and KIDMED index score	More than half of participants had poor or very poor actual MDP knowledge. Perceived MDP knowledge was positively correlated with vegetable consumption, while actual knowledge was negatively correlated with meat consumption. Actual knowledge was the only significant predictor of MDP adherence ($P=0.03$)
Mirmiran <i>et al.</i> (2007) ⁽³⁷⁾ , Iran	Cross-sectional	10–18 years (mean age 14 (SD 1) years; <i>n</i> 7669)	Nutrition knowledge, attitudes and practices (KAP) questionnaire	Willett semi-quantitative FFQ	There were significant differences between genders in knowledge, attitudes and practices score ($P<0.001$), females having higher nutrition knowledge scores, while males had better nutritional practices. There was a significant correlation between nutritional knowledge and attitudes scores ($P<0.001$), but the correlation between nutritional knowledge and behaviour scores was weak (not significant)
Larson <i>et al.</i> (2006) ⁽³⁸⁾ , USA	Cross-sectional	11–18 years (<i>n</i> 4746)	Involvement in household food tasks questionnaire	Youth/Adolescent FFQ	Greater involvement in food tasks was significantly related to sex (female), grade level (middle school), race (Asian-American), socio-economic status (low), family meal frequency (high) and weight status (overweight). Food preparing was positively associated with fruit consumption in males ($P<0.01$) and fruit and vegetable consumption in females ($P<0.01$). Food preparing was also inversely associated with carbonated beverages consumption among females ($P=0.01$) and fried food consumption among males ($P<0.01$). Food shopping frequency was related to greater consumption of fried foods among females ($P<0.01$)

Table 1 Continued

Study details	Study design	Target group	Food literacy measure	Outcome measure	Summary of findings
Huang <i>et al.</i> (2004) ⁽³⁹⁾ , USA	Cross-sectional	10–19 years (<i>n</i> 301)	Frequency of nutrition label reading	'Fat screener'	A greater proportion of females reported always reading nutrition labels and a smaller proportion never reading ($P=0.04$) than males. African-Americans had higher percentage of energy from fat than Caucasians and other ethnicity groups. Boys who always read nutrition labels consumed the greatest percentage of energy from fat; in girls, percentage of energy from fat did not differ significantly. Frequency of reading nutrition labels was not associated with healthier diet
Pirouznia (2001) ⁽⁴⁰⁾ , USA	Cross-sectional	10–13 years (<i>n</i> 532)	Comprehensive assessment of nutrition knowledge, attitudes and practices (CANKAP) questionnaire	CANKAP questionnaire	Knowledge score did not differ by gender in 6th grade, while in 7th and 8th grades girls scored significantly higher ($P=0.000$), with the same patterns for eating behaviour. No correlation was found between nutrition knowledge and eating behaviour in both genders in the 6th grade, and only males in 7th and 8th grades. There was a correlation ($P<0.006$) between nutrition knowledge and eating behaviour of females in the 7th and 8th grades
Chapman <i>et al.</i> (1997) ⁽⁴⁵⁾ , USA	Pre-, post-intervention	14–18 years (<i>n</i> 72; females only)	Modified version of nutrition knowledge and attitude questionnaire	24 h dietary recall	Post-test nutrition knowledge scores increased significantly and were higher than in the control group. Total 24 h dietary intake: both (pre- and post-test) intakes were low for meeting the nutrition needs of females involved in competitive sports. Post-test fat intake decreased in the intervention group, but carbohydrate consumption increased for both groups from the pre-test. The experimental group demonstrated a correlation between the nutrition knowledge pre-test score and carbohydrate intake and the highest negative correlation was seen between nutrition knowledge score and fat intake
Gracey <i>et al.</i> (1996) ⁽⁴¹⁾ , Australia	Cross-sectional	15–16 years (<i>n</i> 391)	Nutrition knowledge questionnaire based on the Australian dietary guidelines	30-item food variety score and fat, fish, soft drinks, water consumption questionnaire	Nutrition knowledge scores were significantly greater in females ($P=0.011$). Consumption of fat and soft drinks was significantly higher in males ($P=0.000$). Nutrition knowledge score was not significant in the regression model compared with fat intake score. There was a significant positive relationship with nutrition knowledge and food variety score as a dependent variable
Osler and Hansen (1993) ⁽⁴²⁾ , Denmark	Cross-sectional	12–14 years (<i>n</i> 674)	Nutrition (sugar, fat and fibre) knowledge questionnaire	Frequency questionnaire assessing the consumption of 14 different food items	Adolescents had better knowledge about fat and sugar than dietary fibre; immigrant children had significantly lower overall knowledge than native children. Respondents with healthy habits had higher knowledge than groups with opposite habits. Mean overall nutrition knowledge increased with increasing number of healthy dietary habits. Significant personal predictors of healthy dietary behaviour were knowledge and health attitudes
Trexler and Sargent (1993) ⁽⁴³⁾ , USA	Cross-sectional	14–18 years (<i>n</i> 600)	Nutrition knowledge questionnaire	24 h dietary recall	Participants from 'high risk' diet category exceed the American Heart Association dietary intake recommendations. Sodium knowledge was significantly related to sodium intake ($P=0.0042$). No other significant relationship between knowledge scores and diet quality were found

Table 2 Quality assessment attributes for each study assessed using the Quality Criteria Checklist (QCC)

Study	Criteria scores										
	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	Conclusions supported by results	Unlikely funding bias	Overall quality rating*
Caraher et al. (2013) ⁽⁴⁴⁾	+	+	+	+	-	+	+	+	+	NR	+
Laska et al. (2012) ⁽⁹⁾	+	+	N/A	+	N/A	+	+	+	+	+	+
Leal et al. (2011) ⁽⁵⁾	+	+	N/A	+	N/A	+	+	+	+	+	+
Venter and Winterbach (2010) ⁽³⁵⁾	+	+	N/A	+	N/A	+	+	+	+	+	+
Tsartsali et al. (2009) ⁽³⁶⁾	+	+	N/A	+	N/A	+	+	+	+	+	+
Mirmiran et al. (2007) ⁽³⁷⁾	+	-	N/A	-	N/A	+	+	+	+	NR	Ø
Larson et al. (2006) ⁽³⁸⁾	+	+	N/A	-	N/A	+	+	+	+	+	+
Huang et al. (2004) ⁽³⁹⁾	+	-	N/A	-	N/A	+	+	+	+	NR	+
Pirouznia (2001) ⁽⁴⁰⁾	+	+	N/A	-	N/A	+	+	+	+	NR	+
Chapman et al. (1997) ⁽⁴⁵⁾	+	+	+	-	-	+	+	+	+	NR	+
Gracey et al. (1996) ⁽⁴¹⁾	+	+	N/A	-	N/A	+	+	+	+	+	+
Osler and Hansen (1993) ⁽⁴²⁾	+	+	N/A	+	N/A	+	+	+	+	+	+
Trexler and Sargent (1993) ⁽⁴³⁾	+	+	N/A	-	N/A	+	+	+	+	+	+

N/A, not applicable (due to cross-sectional design of study); NR, not reported.

*+, positive overall score: this overall score is given if criteria 2, 3, 6 and 7 of the QCC and one additional criterion have received a positive score. Ø, neutral overall score: this score is given if more criteria are met than for a negative overall score but an overall positive score is not reached. -, negative overall score: this score is given if six or more QCC criteria are not met.

conducted in the USA^(9,38-40,43,45), four were conducted in Europe^(5,36,42,44) and one each in Australia⁽⁴¹⁾, the Middle East (Iran)⁽³⁷⁾ and South Africa⁽³⁵⁾. The number of participants ranged from seventy-two to 7669. The age range of adolescent participants was 10 to 19 years.

Questionnaires were used for data collection in all studies. None of the studies investigated all aspects of food literacy (knowledge, skills and behaviours); nine studies investigated the relationship between food knowledge and dietary intake^(5,35-37,40-43,45), one study investigated the relationship between food skills (such as cooking) and dietary intake⁽⁴⁴⁾ and four studies investigated the relationship between food behaviours (such as shopping or food preparation) and dietary intake^(5,9,38,39). Only two studies investigated two of the three aspects of food literacy^(5,44). Dietary intake was measured by FFQ^(9,36-38), 24 h dietary recalls^(43,45), KIDMED index scores^(5,36) and other questionnaires^(35,39-42,44).

The outcomes of the quality assessment are shown in Table 2. Eleven studies were assessed to have a positive quality rating, one study received a neutral rating and one study received a negative rating. Due to most studies utilising a cross-sectional design, some parts of the assessment checklist were not applicable and the checklist was modified in order to optimally evaluate the quality of cross-sectional studies. For these studies, the criteria about comparable groups were not applicable, and the criterion about describing the intervention protocol was modified to 'description of data collection procedures'. The main reasons for not achieving a positive quality rating were most often linked to omissions in the write-up of the manuscript such as participant selection and blinding processes and withdrawals/dropouts or response rates of participants.

The relationship between aspects of food literacy was examined in three broad approaches: (i) relationship between food knowledge and dietary intake; (ii) relationship between food skills and dietary intake; and (iii) the relationship between food behaviours and dietary intake.

Food knowledge

Of the nine studies that investigated the relationship between food knowledge and dietary intake, six studies showed a positive impact of knowledge^(5,35,36,40-42), one study showed a negative impact of knowledge⁽³⁷⁾ and two studies were not able to identify a clear relationship between food knowledge and dietary intake^(43,45). More specifically, adolescents with greater food knowledge were shown to follow healthier dietary practices⁽⁴²⁾ and ate a larger variety of foods⁽⁴¹⁾. In addition, adolescents with greater cooking knowledge followed healthier dietary practices⁽⁵⁾. Interestingly, two studies reported mixed findings, such as reduced fat intake but increased carbohydrate intake⁽⁴⁵⁾; and an association for sodium knowledge and intake, but not other nutrients⁽⁴³⁾. Only one study found a weak, non-significant association between food knowledge and dietary behaviours, whereby adolescents with good



nutrition knowledge had similar dietary practices compared with other participants⁽³⁷⁾. Four studies revealed that females had greater food knowledge than males^(35,37,40,41). Surprisingly, one study found that females had greater food knowledge but poorer dietary practices compared with males⁽³⁷⁾.

Food skills

Only one study investigated the relationship between food skills and dietary intake⁽⁴⁴⁾. That intervention study found that after participating in a school-based cooking programme, adolescents enjoyed tasting new foods, making new dishes and learning new cooking skills⁽⁴⁴⁾. Following the intervention, participants reported an increase in their food skills such as cutting fruits and vegetables, following recipes, measuring ingredients and preparing foods. Cooking confidence of adolescents increased significantly, as did vegetable consumption⁽⁴⁴⁾.

Food behaviours

Of the four studies that investigated the relationship between food behaviour and dietary intake, two studies found a positive impact of food preparation behaviours^(5,9), one study found a variable impact of food behaviours⁽³⁸⁾ and one study found no impact of food behaviours on dietary intake⁽³⁹⁾. Specifically, one study found that frequent cooking was associated with healthier dietary practices⁽⁵⁾. Similar findings were observed in the longitudinal cohort study by Laska *et al.*, which revealed that food preparation behaviours track over time⁽⁹⁾. Adolescents who assisted to prepare dinner were more likely to engage in food preparation-related behaviours as emerging adults (19–23 years old) such as buying fresh vegetables, writing grocery lists and preparing dinner with chicken, fish or vegetables⁽⁹⁾. Likewise, helping to prepare food for dinner was associated with increased enjoyment of cooking ten years later⁽⁹⁾. Interestingly, one study found that more frequent food preparation was associated with increased fruit consumption in male adolescents and increased fruit and vegetable consumption in female adolescents, and was also negatively associated with unhealthy food choices, including soft drink consumption in females and fried food consumption among male adolescents⁽³⁸⁾. Only one study did not find any relationship between food behaviours and dietary intake, and specifically found that frequency of reading food labels was not associated with dietary intake⁽³⁹⁾. Interestingly, three studies found that female adolescents were more involved in food-related tasks and read food labels more frequently compared with male adolescents^(9,38,39).

Discussion

The present systematic review investigated the association between food literacy and the dietary intake of adolescents. Overall, the evidence from the review suggests that food

literacy may play a role in shaping youth eating behaviours^(5,9,35,36,40–42,44). In addition, findings suggest that food skills and behaviours learned in adolescence are sustained later in life⁽⁹⁾. For example, Laska *et al.*'s longitudinal study found that adolescents who assisted in preparing dinner were more likely to engage in food preparation behaviours five years later⁽⁹⁾. However, the study quality, tools utilised for collecting data and measured aspects of food literacy should be acknowledged when interpreting the findings of the systematic review.

The studies in the systematic review incorporated a variety of methodological approaches to their study design. The lack of randomised controlled trials and emphasis on cross-sectional studies reduces the ability to clarify the strength and nature of the association between aspects of food literacy and dietary intake. Furthermore, most of the studies used tools that were developed for the specific investigation being reported and did not incorporate validated tools to measure aspects of food literacy^(36,39,41–43). For food literacy to become established as an important concept in understanding the complex relationships between food knowledge, skills and behaviours and dietary choices, instruments that encompass the identified aspects of food literacy must be developed and validated. Also, none of the studies incorporated a holistic and comprehensive tool to measure food literacy. Rather, studies measured only one or two aspects of food literacy. For example, Osler and Hansen's study measured food knowledge and dietary intake of Dutch adolescents⁽⁴²⁾ and Caraher *et al.* investigated the impact of a cooking programme with a chef on adolescents' vegetable consumption and food preparation skills⁽⁴⁴⁾. This suggests that further research is required to develop comprehensive, validated tools for measuring food literacy in order to increase the strength of future research in this area.

The quality of the studies included in the review should be considered when interpreting their findings. Although most of the studies received a positive overall quality rating^(5,9,35,36,38,40–45), it should be acknowledged that the QCC quality assessment checklist was modified appropriately to assess the studies that utilised a cross-sectional study design. Seven studies did not describe the participant withdrawals/dropouts or response rate in their studies^(37–41,43,45); and neither of the intervention studies described the blinding procedures utilised to prevent the possibility of measurement bias^(44,45). These attributes of the study limit confidence in determining the extent of the association between food literacy and dietary intake. Nevertheless, it should be noted that Caraher *et al.*'s cooking intervention study received a positive overall quality rating and also found a positive relationship between food literacy and dietary intake⁽⁴⁴⁾. In addition, the two studies that reported no significant impact of aspects of food literacy on dietary intake received neutral and negative overall quality ratings^(37,39). There is clearly a need for more rigorous research to effectively assess the



causality between food literacy and adolescents' dietary intake in order to confirm the extent of the relationship.

None of the reviewed studies utilised the term 'food literacy' in their description of the study outcomes. This is likely due to food literacy being a relatively new concept and only recently defined⁽¹⁷⁾. While broadly defined food literacy encompasses food knowledge, skills and behaviours, almost all studies investigated a specific aspect of food literacy, with most of them using food knowledge as a proxy of food literacy^(5,17,35–37,40–43,45). Previous interventions for addressing adolescent overweight and obesity aimed to increase food knowledge of adolescents as the best public health strategy⁽¹⁵⁾; however, this narrow focus may offer an explanation why many interventions up to date have displayed minimal or modest outcomes in reducing the prevalence of adolescent overweight and obesity. The present systematic review highlights the possible positive influence of food skills and behaviours on adolescents' dietary intake. For example, Caraher *et al.*'s study reported an increase in vegetable consumption of adolescents after the cooking programme with a chef⁽⁴⁴⁾. However, these studies require further support from future research, as only one study has investigated the impact of food skills on dietary intake and only four studies have investigated the impact of food behaviours on adolescents' dietary intake^(5,9,38,39,44).

The present systematic review highlights the opportunities for future research. First, as most of the studies employed a cross-sectional study design, it is currently not possible to clarify any causal contributions of food literacy on adolescents' dietary behaviours. Therefore, future research should consider a longitudinal approach to be able to investigate the potential causal contribution of food literacy on adolescents' dietary intake. Second, there are opportunities for future research to develop validated tools that comprehensively measure food literacy. These tools would enhance the comparability of findings between studies and subsequently increase the confidence in interpreting findings of the body of research in this area. Finally, there is an opportunity to investigate which aspects of food literacy are critical for improving adolescents' dietary intake, including possible differences in male and female adolescents. There is currently a lack of evidence about the impact of food skills and behaviours on adolescents' dietary intake. Investigating the relative influence of the components of food literacy may further inform the development of public health policies that aim to address adolescent overweight and obesity.

One of the main strengths for the present review is the systematic nature of its methodology that differs from a traditional review in which previous work is described but not systematically identified, assessed for quality and synthesised⁽⁴⁶⁾. Introduction of bias was minimised by independent researchers using the same data extraction worksheet for each individual study and quality assessment checklist. The systematic review used six databases,

which afford broad coverage of allied health, including nutrition and public health, literature. Although there are some inconsistencies in the findings of the studies, the existing research has important implications for public health practitioners and policy makers. Overall, the findings suggest that there is an influence of food literacy on dietary intake and that increasing food literacy in adolescence may be an appropriate public health strategy to address the growing prevalence of adolescent overweight and obesity.

Limitations

The present systematic review is subject to two notable limitations. First, it was challenging to compare the findings of reviewed studies due to differences in study designs, data collection methods and participant samples. The bias of this limitation was minimised through the use of the same evidence worksheet for each individual study. In addition, the studies were grouped in accordance with the food literacy definition matrix, which helped to identify major themes and report the findings. Second, most of the evidence on the impact of aspects of food literacy on dietary intake is based on self-reported data, which may influence the reporting of actual food skills capabilities⁽⁴⁴⁾ and dietary intake by participants and reduces confidence in study outcomes. Some participants may have reported inaccurate information, responded in a socially desirable way or their answers may be subject to recall error⁽⁴⁷⁾. Recognising these limitations, it is equally important to acknowledge that self-report data on food consumption have been shown to be as reliable as more formal 24 h dietary recall assessment⁽⁴⁷⁾.

Conclusions

The present systematic review found that food literacy may influence adolescents' dietary intake. It is apparent there is a lack of research that has measured all aspects of food literacy over time or longitudinally to determine the strength and nature of the association with dietary intake. The review identifies the need for rigorous research methods to attain a greater understanding of the influence of food literacy on dietary intake. The systematic review suggests that improving food literacy in adolescence may improve individuals' food skills and healthier dietary behaviours. The evidence recommends public health promotion practitioners and policy makers to consider new public health strategies that focus on increasing food literacy in adolescence.

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