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REVIEW

Nutrition literacy programme to enhance nutrition literacy, dietary behaviour, food security, and health outcomes among adults: A systematic review

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ABSTRACT

Introduction: Morbidity and mortality among adults with non-communicable diseases (NCDs) are associated with poor dietary behaviours, often influenced by food security constraints. An important approach is to promote nutrition literacy to change dietary behaviours and health outcomes. The impact of nutrition literacy (NL) programmes on adults is recognised in the literature. However, there is a lack of studies that have comprehensively analysed their effects. This study aimed to conduct a literature review about NL programmes for adults to enhance nutrition literacy, dietary behaviour, food security, or health outcomes. **Methods**: A systematic review was conducted on original articles from ScienceDirect, PubMed, Scopus, and CINAHL, published between 2014 and 2024, targeting adults aged 18 years and over. **Results:** Ten studies were eligible for inclusion; the most commonly used model was the Social Cognitive Learning Theory. Interventions focused on nutrition education, workshops, skills training/hands-on activities, consultations, family involvement, online interventions, and home visits, typically lasting 4 to 16 weeks. Assessments were conducted at baseline, post-intervention, and follow-up (3 to 12 months), showing significant enhancements in one or more outcomes, including nutrition literacy, dietary behaviour, food security, or health outcomes. **Conclusions:** NL programmes showed an improvement in nutrition literacy, dietary behaviour, food security, and health outcomes. However, some studies were limited by small sample sizes, the absence of a control group, and a lack of follow-up. For future directions, high-quality randomised controlled trials and longitudinal studies could be conducted to ascertain outcomes.

Keywords: adults, dietary behaviour, food security, health outcomes, nutrition literacy

INTRODUCTION

Non-communicable diseases (NCDs) are a major global health concern due to their impact on death rates and overall health, requiring immediate prevention and management actions by the World Health Organization (WHO). It has been reported that around 44 million people worldwide die from NCDs each year, and 18 million of these deaths occur before the

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age of 70 years (WHO, 2024). According to reports, obesity among adults aged 18 years and over has increased to 67.5% (NCD-RisC, 2024). These diseases contribute to a reduced quality of life and premature death among adults due to complications. Tackling these health problems continues to be a major obstacle in promoting positive health results in this age group.

One of the major risk factors for NCDs is unhealthy dietary behaviour. Thus, an essential aspect of enhancing the health outcomes of adults with NCDs involves changing dietary behaviour, defined as the ability to express or act upon food-related matters, encompassing both the eating process and the composition of foods consumed (Marchello *et al.*, 2021; Marijn *et al.*, 2018). Another significant consideration for adults is the issue of food security. Food security encompasses a person's physical, social, and economic ability to obtain sufficient food, access to food, utilisation of food, and food stability, with implications for both malnutrition and overnutrition (FAO, 2006; IFPRI, 2022). Food insecurity can lead to malnutrition, unhealthy diets (Militao *et al.*, 2024; Nagata *et al.*, 2019; Pourebrahim *et al.*, 2024), and increased risk of NCDs such as heart diseases, diabetes, and cancer. Illness and death from NCDs among adults are linked to dietary behaviour under food security constraints.

Nutrition literacy is also a crucial factor related to dietary behaviour, food security, and health outcomes in adults (Begley *et al.*, 2019; Gibbs *et al.*, 2018; Taylor *et al.*, 2019). Nutrition literacy (NL) refers to an individual's capacity to obtain, process, understand, and apply basic nutrition information in order to make appropriate dietary decisions that support a healthy diet in daily life (Krause *et al.*, 2018; Vettori *et al.*, 2019). Past research has found that nutrition literacy is related to healthy/unhealthy dietary patterns, dietary habits, and diet quality (Gibbs *et al.*, 2018; Natour, Al-Tell & Ikhdour, 2021; Taylor *et al.*, 2019). Poor nutrition literacy is associated with food insecurity (Begley *et al.*, 2019; Chyne *et al.*, 2017) and health outcomes in adults, including waist circumference and blood pressure levels (Julsukon *et al.*, 2019).

Based on the above, nutrition literacy positively impacts dietary behaviour, food security, and health outcomes in adults. Currently, research is underway on programmes aimed at promoting nutrition literacy across various age groups, and there is a literature review encompassing programmes for promoting food and nutrition literacy in different age brackets, including childhood (Velpini, 2022), adolescence (Bailey, Drummond & Ward, 2019), and childhood to adulthood (Cabezas & Nazar, 2023). However, there is a lack of reviews specifically focused on individual adults. This gap limits guidance for health professionals and public health agencies in promoting better dietary behaviours, food security, and health outcomes among adults to reduce NCD morbidity and mortality.

This literature review aimed to explore the effectiveness of NL programmes targeting adults aged 18 years and over, to inform future programme development. The objectives were to identify the key components of nutrition literacy most commonly addressed in these programmes and assess their effects on participant outcomes, including nutrition literacy, dietary behaviours, food security, and health outcomes, as well as to describe the characteristics of the programmes, such as duration/follow-up, theoretical foundations, interventions, measured outcomes, and key findings.

METHODOLOGY

Search strategies

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement (Page, McKenzie & Bossuyt, 2021). The review protocol was pre-registered in PROSPERO (CRD42024531938). The search was carried out in ScienceDirect, PubMed, Scopus, and CINAHL. Publications from January 2014 to December 2024 were included.

The search strategy was developed and implemented based on the PICO model. The search used the following terms: ("adult" OR older adult*) AND ("NCDs" OR chronic disease*) AND ("nutrition literacy" OR food literacy) AND ("intervention" OR "programme") AND ("dietary behaviour" OR eating behaviour*) OR ("food security" OR food insecurity*) OR ("health outcomes" OR BMI* OR body mass index* OR waist circumference* OR blood pressure* OR fasting capillary glucose* OR total cholesterol*)

Eligibility and quality assessment

Double screening was independently conducted by two reviewers using the following inclusion and exclusion criteria.

Inclusion criteria

Population [adults, defined by the World Health Organization as individuals aged 18 years and over], intervention [programmes or interventions with nutrition literacy as the central focus; those explicitly stating that their primary outcomes were nutrition literacy, dietary behaviour, food security, or health outcomes], comparison [usual care, no intervention, and pre-intervention (in the case where there was no control group, quasi-experiments were considered control groups)], outcome [improvements from the programmes included changes in nutrition literacy, dietary behaviour, food security, and health outcomes (body mass index (BMI), waist circumference, blood pressure and total cholesterol)], and study design [randomised controlled trials (RCTs), cluster RCTs, or quasi-experiments].

Exclusion criteria

Study outcomes that did not involve NL programmes that increased nutrition literacy, dietary behaviour, food security, or health outcomes. Non-experimental publications, including editorials, letters to the editor, review articles, and systematic reviews, were excluded from the review.

Data extraction and synthesis

A descriptive analysis was performed to extract data from each included study. The variables obtained from the selected articles were (a) author, publication year, and country; (b) type of study; (c) participants and sample size; (d) duration/follow-up period; (e) theoretical foundations; (f) intervention/nutrition literacy areas addressed; (g) outcomes measured; and (h) key findings. Data from each study were independently extracted by two reviewers (JK and UI); any disagreements were resolved through discussion between the reviewers.

Study risk of bias assessment

A methodological quality assessment of the studies was independently performed by JK and UI. The Joanna Briggs Institute (JBI) Critical Appraisal tool was used to evaluate the risk of bias in RCTs (Barker *et al.*, 2023) and quasi-experimental studies (Tufanaru *et al.*, 2020). Two JBI critical appraisal tools were employed: one for quasi-experiments with nine criteria and another for RCTs with thirteen criteria. Response options included "Yes", "No",

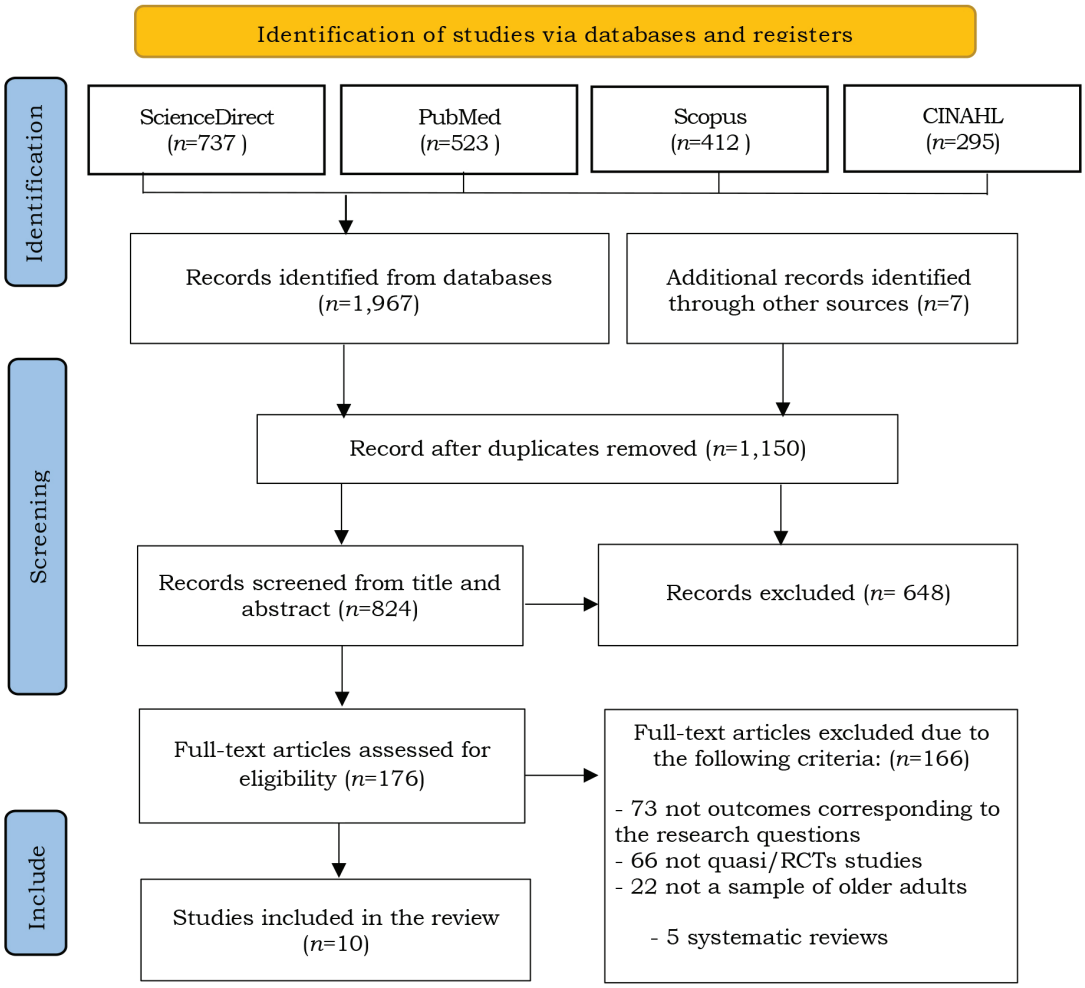

Figure 1. Flowchart on the identification of studies using the preferred reporting items for systematic reviews and meta-analyses (PRISMA 2020)

"Uncertain", and "Not Applicable (NA)". A scoring system, developed by reviewers (JK, UI, and PP), established a cut-off score for inclusion at 65% of the total criteria for the JBI critical appraisal tool (scores <5 for quasi-experiments and <8 for RCTs). The agreement measurement was calculated by the intraclass correlation coefficient (ICC), with a value close to 1 as perfectly reliable and close to 0 as no agreement (Koo & Li, 2016). The ICC in this study was 0.986, indicating excellent reliability.

RESULTS

A total of 1,974 studies were obtained through database searches. Additionally, a manual search was conducted, during which the references of the systematic studies retrieved from the databases were examined. As a result, seven articles were selected for title and abstract evaluation. After removing duplicates, 824 titles and abstracts were screened for eligibility. Of these, 648 were excluded for not meeting the inclusion criteria and 176 full-text articles were assessed against the

Table 1. Risk of biases present within each study

Author, Year	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*Total*	*Percent*
For randomised controlled trials (RCTs)[†]															
Duncan *et al.* (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	13/13	100.0
Xie *et al.* (2023)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	13/13	100.0
For quasi-experiment[‡]															
Wallace, Lo & Devine (2016)	Y	Y	Y	N	Y	N	Y	Y	Y					7/9	77.8
Abdelwahed, Algameel, & Tayel (2018)	Y	Y	Y	N	Y	Y	Y	Y	Y					8/9	88.9
Boontanon *et al.* (2019)	Y	Y	Y	Y	Y	N	Y	Y	Y					8/9	88.9
Chongmontri (2019)	Y	Y	Y	N	Y	N	Y	Y	Y					7/9	77.8
Smith *et al.* (2020)	Y	Y	Y	Y	Y	Y	Y	Y	Y					9/9	100.0
West *et al.* (2020)	Y	Y	Y	N	Y	N	Y	Y	Y					7/9	77.8
Ng *et al.* (2022)	Y	Y	Y	N	Y	N	Y	Y	Y					7/9	77.8
Rees *et al.* (2022)	Y	Y	Y	Y	Y	Y	Y	Y	Y					9/9	100.0

Y: Yes; N: No

[†]1-13: Questions from the Critical Appraisal Tool for RCTs were 1. Was true randomisation used for assignment of participants to treatment groups? 2. Was allocation to treatment groups concealed? 3. Were treatment groups similar at baseline? 4. Were participants blinded to treatment assignment? 5. Were those delivering the treatment blinded to treatment assignment? 6. Were treatment groups treated identically other than the intervention of interest? 7. Were outcome assessors blinded to treatment assignment? 8. Were outcomes measured in the same way for treatment groups? 9. Were outcomes measured in a reliable way? 10. Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analysed? 11. Were participants analysed in the groups to which they were randomised? 12. Was appropriate statistical analysis used? 13. Was the trial design appropriate and any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?

[‡]1-9: Questions from the Critical Appraisal Tool for quasi-experiments were 1. Was it clear in the study what was the "cause" and what was the "effect" (i.e., there was no confusion about which variable came first)? 2. Were the participants included in any comparisons similar? 3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest? 4. Was there a control group? 5. Were there multiple measurements of the outcome both pre- and post- the intervention/exposure? 6. Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed? 7. Were the outcomes of participants included in any comparisons measured in the same way? 8. Were outcomes measured in a reliable way? 9. Was appropriate statistical analysis used?

Table 2. Study characteristics and results of literature research

Author, year, country	*Type of study*	*Participants / Sample size*	*Duration/ follow-up*	*Theoretical foundations*	*Intervention/ Nutrition literacy areas addressed*	*Outcomes measured*	*Key findings*
Wallace, Lo & Devine (2016)/ USA	Mixed, Quasi-experimental	Older adults (≥60 years)/ (*n*= 72)	4 weeks, weekly 3-hour sessions / no follow-up stated	Social Cognitive Theory	The nutrition education sessions included information on dietary improvements to reduce risk factors for non-communicable disease, ingredient and recipe selection, planning and preparation of a two-course meal, and meal sharing.	Nutrition knowledge, dietary patterns, cooking and behaviour.	Intervention participants increased overall knowledge, consumed a greater variety of vegetable, used less salt, and increased spice usage.
Abdelwahed, Algameel, & Tayel (2018)/ Egypt	Quasi-experimental	Older adults (60-89 years)/ (*n*=100)	6 weeks, 6days/ week, two 1-2 hours. sessions/ 3 months	Not stated	Nutrition education was conducted in six consecutive sessions, including programme expectations, breaking the ice, nutritional needs, a healthy diet, and elderly malnutrition.	Knowledge about healthy eating, proper nutrition, and nutritional status.	Significant improvements in nutritional knowledge and the elderly's total Mini Nutritional Assessment were observed post-programme and at the three-month follow-up.
Duncan *et al.* (2018)/ New Zealand	Cluster randomised controlled trial	35–65 years/ *n*=313 (EG = 154, CG = 159)	16 weeks, five 60-minute home visits/ 4, 12 months	Not stated	The intervention group received motivational interviewing for physical activity and healthy eating, encouraging family involvement in the home-based consultation session.	Body mass index, waist circumference, blood pressure, blood cholesterol, triglycerides, 5-year cardiovascular disease risk.	Significant improvements in body mass index, waist circumference (cm), total cholesterol, TC/HDL ratio -5 year cardiovascular disease risk and fast food consumption
Boontanon *et al.* (2019)/ Thailand	Quasi-experimental	Older adults (60-80 years)/ *n*=68 (EG=34, CG=34)	12 weeks, 3times/ week, 30-minute sessions/ no follow-up stated	Not stated	The intervention group received nutritional literacy in activities, including nutrition assessment, food selection, setting goals to change behaviour, and nutrition communication.	Overall and domain-specific nutrition literacy.	Significant improvements in Overall and domain-specific nutrition literacy
Chongmontri (2019)/ Thailand	Quasi-experimental	(55-89 years)/ *n*=20	8 weeks, five 1-2 hours. sessions/ no follow-up stated	Dee Fink's Taxonomy of Significant Learning	The food literacy programme had four sub-programmes covering healthy food, including selecting, planning, preparation, and eating.	Food and nutrition knowledge, food behaviours and health outcomes.	Significant improvements in food and nutrition knowledge levels, food behaviour levels, food skills levels, body mass index, fat percentage, and waist circumference.

to be continued...

Table 2. Study characteristics and results of literature research *(continued)*

Author, year, country	*Type of study*	*Participants / Sample size*	*Duration/ follow-up*	*Theoretical foundations*	*Intervention/ Nutrition literacy areas addressed*	*Outcomes measured*	*Key findings*
Smith *et al.*, (2020)/ Not stated	Quasi-experimental	Older adults (mean age = 74.49 years)/ *n*=430 (EG=163, CG=267)	12 weeks, twice-weekly 90-minute sessions/ 3, 6 months	Social cognitive learning and self-efficacy	Small group education covered healthy diet components, balanced diet elements, portion sizes, food labels, cooking modifications, and healthy choices outside the home.	Dietary behaviours, self-efficacy, and perceived social support for a healthy diet.	Significant improvements in fast food consumption, fruit/vegetable consumption, water consumption, and social support
West *et al.*, (2020)/ Australia	Quasi-experimental	18–74 years/ *n*=21	6 weeks, totaling 15 hours/no follow-up stated	Social Cognitive Theory	Nutrition education and skills training integrated activities, goal setting, and practical cooking, concluding with shared meals.	Food security, cooking confidence, and eating behaviours.	Significant improvements in food security, cooking confidence, food preparation, nutrition knowledge and vegetable consumption
Ng *et al.*, (2022)/ Australia	Quasi-experimental	25–67 years/ *n*=29	4 weeks /no follow-up stated	Not stated	The "Online Med Diet Challenge" encouraged a Mediterranean eating style with infographics, how-to videos, and recipes/cooking tips/ nutrition labels/nutrition and disease relationships within the Facebook.	Food literacy and fruit and vegetable consumption.	Post-intervention, food literacy increased between 21% and 45% across each survey component, with participants reporting an increase in fruit and vegetable consumption.
Rees *et al.* (2022)/ Australia	Quasi-experimental	18–75 years/ *n*=657 (EG=493, CG=164)	7 weeks, weekly 90-min sessions. / 6 months	Not stated	Hands-on cooking sessions using weekly recipes for skill and knowledge about nutritious foods, enabling increased cooking confidence, skill development, and food literacy, including knife handling skills, food budget planning, and healthy options.	Cooking confidence, eating behaviours, mental health, and body mass index	Significant improvements in cooking confidence, ability to change eating habits overcome lifestyle barriers and general and mental health. No changes in food acquisition, consumption, or knowledge.
Xie *et al.* (2023)/ China	Randomised Controlled Trial	Older adults (≥65 years)/ *n*=201 (EG=101, CG=100)	12 week/ no follow-up stated	Not stated	The intervention group received ONSs and family-centered nutrition education and medical counseling, including biweekly nutrition lectures, promotion, Q&A sessions, diet behaviour supervision, and personalised guidance.	Weight, height, nutrition and functional status, Mini Nutritional Assessment-Short Form, grip strength, and activities of daily living.	Significant improvements in Nutrient intake weight, body mass index, significantly higher compared to the control group.

EG: Experimental group; CG: Control group

Table 3. Summary of intervention methods and strategies applied to improve nutrition literacy, dietary behaviour, food security, and health outcomes

No	*Intervention methods and strategies*	*Author, year of publications*	*Study theme*	*Frequency of studies using intervention methods and strategies*	*Percentage of studies using intervention methods and strategies (%)*
1	Nutrition education	- Wallace, Lo & Devine (2016) - Abdelwahed, Algameel & Tayel (2018) - West *et al.* (2020) - Xie *et al.* (2023)	Nutrition literacy Dietary behaviour Health outcomes	4	23.5
2	Workshop	- Boontanon *et al.* (2019) - Chongmontri (2019) - Smith *et al.* (2020) - West *et al.* (2020)	Nutrition literacy Dietary behaviour Food security Health outcomes	4	23.5
3	Skills training/ Hands-on activities	- Chongmontri (2019) - West *et al.* (2020) - Rees *et al.* (2022)	Nutrition literacy Dietary behaviour Food security	3	17.6
4	Consultation	- Duncan *et al.* (2018) - Xie *et al.* (2023)	Nutrition literacy Dietary behaviour Health outcomes	2	11.8
5	Family involvement	- Duncan *et al.* (2018) - Xie *et al.* (2023)	Dietary behaviour Health outcomes	2	11.8
6	Online interventions	- Ng *et al.* (2022)	Nutrition literacy Dietary behaviour	1	5.9
7	Home visits	- Duncan *et al.* (2018)	Dietary behaviour Health outcomes	1	5.9

eligibility criteria. Ultimately, ten studies were included. The literature screening process and results are shown in the PRISMA 2020 flow chart (Figure 1).

Study risk of bias assessment

A summary of the risk of bias assessment is provided in Table 1. The included studies met 100% of the criteria on the JBI Critical Appraisal Tool for RCTs and 78.8%-100.0% of the criteria for quasi-experiments.

Characteristics of included studies

The characteristics of ten articles, including author/year of publication/ country, type of study, participants/ sample size, duration/follow-up, theoretical foundations, intervention/ nutrition literacy areas addressed, outcomes measured, and key findings, are summarised in Tables 2 and 3.

Studies were conducted in Australia (*n*=3), Thailand (*n*=2), the United States of America (USA) (*n*=1), Egypt (*n*=1), New Zealand (*n*=1), China (*n*=1), and one unstated (*n*=1). The review comprised two RCTs and eight quasi-experiments, published from January 2014 to December 2024.

Participants/sample size

Number of participants across all investigations ranged from 20 to 657 adults. The age range was 18 to 89 years.

Duration/follow-up

Duration of the interventions varied between 4 and 16 weeks, consisting of 30 minutes to 3 hours of weekly sessions. Outcomes were measured at two time points: baseline and post-intervention, with follow-up assessments ranging from 3 to 12 months.

Theoretical foundations

Four out of the ten studies indicated the theoretical foundations used in their intervention, most commonly the Social Cognitive Learning Theory and Dee Fink's Taxonomy of Significant Learning.

Characterisation of the intervention

The intervention methods and strategies implemented to improve nutrition literacy, dietary behaviour, food security, and health outcomes were diverse, with most studies employing more than one approach. The summarised methods included nutrition education (23.5%) (Abdelwahed, Algameel & Tayel, 2018; Wallace, Lo & Devine, 2016; West *et al.,* 2020; Xie *et al.,* 2023), workshops (23.5%) (Boontanon, Kaenork & Surapatthanachart, 2019; Chongmontri, 2019; Smith *et al.*, 2020; West *et al.*, 2020), skills training/hands-on activities (17.6%) (Chongmontri, 2019; Rees *et al.*, 2022; West *et al.*, 2020), consultations (11.8%) (Duncan *et al.*, 2016; Xie *et al.,* 2023), family involvement (11.8%) (Duncan *et al.*, 2016; Rees *et al.*, 2022; Xie *et al.*, 2023), online interventions (5.9%) (Ng *et al.*, 2022), and home visits (5.9%) (Duncan *et al.*, 2016).

The content addressed in these nutrition literacy programmes encompassed both nutritional knowledge and practical skills. Fundamental topics, such as reading nutrition labels, understanding portion sizes and food groups, the functions and primary sources of nutrients, and factors influencing nutritional status, were included. The programmes also covered issues such as malnutrition in adults and nutrition for individuals with NCDs, food planning, management, selection and preparation and cooking skills. More advanced aspects included meal sharing, nutrition communication, managing an appropriate nutrition budget, and making informed decisions when choosing healthy foods.

Outcomes measured

The measured outcomes identified were overall and domain-specific nutrition literacy, dietary behaviour (mainly fruit and vegetable consumption, wholegrain intake, and salt intake), food security and health outcomes including BMI, weight, height, waist circumference, blood pressure, blood cholesterol, and triglycerides.

Key findings

Of the ten studies reviewed, positive results in nutrition literacy, dietary behaviour, food security, and health outcomes were reported after the intervention, demonstrating significant differences between pre- and post-assessments or between the experimental and control groups.

Five studies showed an improvement in food and nutrition literacy (Boontanon *et al.,* 2019; Ng *et al.*, 2022) and nutrition knowledge (Abdelwahed, Algameel & Tayel, 2018; Wallace *et al.*, 2016; West *et al.,* 2020). Seven studies showed an improvement in dietary behaviour. Four studies reported increased consumption of fruits, vegetables, wholegrain, and spices, along with a decreased intakes of salt and fast food (Ng *et al.*, 2022; Smith *et al.*, 2020; Wallace *et al.*, 2016; West *et al.*, 2020). The other-three studies observed significant improvements in food behaviours, eating habits, food skills, and cooking confidence (Chongmontri, 2019; Rees *et al.*, 2022; West *et al.*, 2020).

One study reported improvements in food security, cooking confidence, food preparation, nutrition knowledge, and vegetable consumption (West *et al.*, 2020).

Four studies showed improvements in health outcomes. Three studies

reported significant improvements in BMI, waist circumference, fat percentage, total cholesterol, total cholesterol-to-High Density Lipoprotein cholesterol (TC/HDL) ratio, 5-year cardiovascular disease (CVD) risk, and grip strength (Chongmontri, 2019; Duncan *et al.*, 2016; Xie *et al.*, 2023). Additionally, one study reported significant improvements in the total Mini Nutritional Assessment (MNA) score among older adults (Abdelwahed *et al.*, 2018).

DISCUSSION

In recent years, there has been an increasing focus on nutrition literacy as a factor influencing dietary patterns. The purpose of the current systematic review was to provide a recent and comprehensive overview of studies that identify NL programmes affecting nutrition literacy, dietary behaviour, food security, and health outcomes, with a particular focus on the adult population, whose dietary habits play a crucial role in their future nutritional status and the development of NCDs. The results of this review suggested that, to date, there are few effective and innovative nutrition literacy programmes specifically designed for this target group. Of the ten studies included in this review, most NL programmes showed consistent positive effects on nutrition literacy, dietary behaviour, food security, and health outcomes, although only one study reported an impact on food security.

The development of NL has been supported by diverse methods and strategies employed in NL programmes. These included providing nutrition education and conducting workshops on healthy eating, covering key aspects such as food selection, meal planning, food preparation, and consumption. Additionally, the programmes incorporated nutrition assessments and delivered information aimed at preventing NCDs (Boontanon *et al.*, 2019; Chongmontri, 2019; Wallace *et al.*, 2016). Furthermore, the programmes integrated skill-building components such as goal setting and hands-on cooking sessions, which often concluded with shared meals (West *et al.*, 2020). Online components were also utilised, with nutritional information shared via Facebook using infographics and videos, accompanied by question and answer (Q&A) sessions to encourage active participation. These approaches contributed to the multifaceted development of nutrition literacy, particularly in enhancing the ability to understand and access nutritional information, engage in discussions, ask questions, share and express opinions on nutrition-related topics, and manage food budgets to make informed and healthy food choices (Boontanon *et al.*, 2019; Chongmontri, 2019; Ng *et al.,* 2022; Wallace *et al.*, 2016; West *et al.*, 2020).

Improvements in dietary behaviour included increased consumption of fruits and vegetables and reduced intakes of salt and fast food (Ng *et al.,* 2022; Smith *et al.,* 2020; Wallace *et al.*, 2016; West *et al.,* 2020). Developments in dietary behaviour, dietary habits, food-related skills, and cooking confidence (Chongmontri, 2019; Rees *et al.,* 2022; West *et al.,* 2020) have been partially attributed to NL programmes. These programmes featured skill training, demonstrations, and regular reviews on food selection, preparation, and cooking, covering topics such as cooking confidence, skill development, knife handling, choosing healthier options, and food budget planning (Chongmontri, 2019; Rees *et al.,* 2022; West *et al.,* 2020). In addition, online interventions via Facebook encouraged participants to share personal stories and nutrition advice, fostering discussion and peer support. These platforms also hosted

biweekly Q&A sessions with nutrition experts to promote active participant engagement (Ng *et al.,* 2022). In line with the digital era, the use of technology and media has proven to be an effective strategy for engaging adults. Nutrition initiatives targeting this population are recommended to take advantage of modern technologies such as internet-based applications, computer programmes, and social media.

Moreover, several programmes incorporated the Social Cognitive Theory to enhance self-efficacy, leading to improved self-regulation and more effective nutritional self-care. This review found that theory-based interventions resulted in positive changes in both behaviour and nutrition knowledge (Smith *et al.,* 2020; Wallace *et al.*, 2016; West *et al.,* 2020). Using theory as the foundation for programme design offers a clear conceptual framework and supports the development of more effective interventions that promote meaningful behavioural changes (McWhorter *et al.,* 2022).

One study reported an improvement in food security (West *et al.,* 2020), which may be attributed to the programme's inclusion of nutrition education and skills training. The programme addressed key areas such as eating for variety, eating for well-being, eating for balance, eating for the environment, and eating for choice. It integrated activities such as goal setting and hands-on cooking sessions that concluded with shared meals. Additionally, the programme applied Social Cognitive Theory, focusing on building self-efficacy (Bandura, 1998) to enhance its effectiveness. As a result, participants demonstrated increased nutrition knowledge and skills, leading to improved food access and greater food sufficiency, as well as reduced concerns about hunger or receiving inadequate amounts of food. This finding aligns with Food and Agriculture Organization (FAO)'s (2023) definition of food insecurity, which states, "A person is food insecure when they lack regular access to enough safe and nutritious food for normal growth and development and an active and healthy life." Moreover, the findings are consistent with previous studies that showed a link between food insecurity and low levels of nutrition literacy (Begley et al., 2019; Chyne et al., 2017).

This literature review reported improvements in health outcomes, based on key indicators, including BMI, waist circumference, total cholesterol, the TC/HDL ratio, and five-year CVD risk (Duncan *et al.*, 2016; Xie *et al.*, 2023), as well as fat percentage and the MNA score among older adults (Abdelwahed *et al.*, 2018; Chongmontri, 2019). These improvements may be attributed to the diverse range of activities incorporated into the programmes, such as lectures, skills training, and hands-on practice in real-life settings, in addition to the use of online platforms for sharing nutritional information. In addition, a portion of the study participants were older adults; involving family members in nutrition programmes and conducting home visits by health professionals who provided consultations to identify nutritional challenges and explore potential solutions played a crucial role in supporting dietary behaviour change and promoting sustainable improvements in health outcomes (Duncan *et al.*, 2016). This approach aligns with Sebern's Shared Care Theory (Sebern, 2005), which emphasises the importance of family involvement in the care of older adults with chronic illnesses to enhance the effectiveness of nursing care. These findings are also consistent with previous research indicating that participants whose family members received nutrition education demonstrated higher levels of nutrition literacy compared to those without

support from nutrition-informed family members (Monteiro, Fontes & Ferreira-Pêgo, 2021).

This review has some limitations that should be considered when interpreting the results. The data availability of published programmes was limited; some studies faced constraints such as small sample sizes, the absence of a control group, and the lack of a follow-up period, and an inability to account for various influencing factors such as economic, social, and educational conditions. Additionally, since nutrition literacy is an emerging term and not as clearly defined as food literacy, establishing the scope and specificity of this review was challenging. These limitations may impact both the breadth and precision of the findings.

However, it is important to note that interventions for adults often do not produce immediate results in terms of nutrition literacy, dietary behaviour, food security, and health outcomes, particularly when attempting to modify behaviours that are deeply embedded in family and social contexts. Therefore, studies should have an appropriate duration and include a follow-up period to assess the sustainability of the interventions. Despite these challenges, this review provides foundational insights that can serve as a platform for the development of future nutrition literacy programmes for adults.

CONCLUSION

NL interventions show promise in enhancing nutrition literacy, dietary behaviour, food security, and health outcomes for older adults. Social Cognitive Theory, commonly used in programme development, is linked to improvements in dietary behaviours and food security among adults. Effective types of interventions include education, skills training, hands-on activities, and online interventions via platforms like Facebook or Line. Additionally, family-involved home visits lasting 4 to 16 weeks (commonly 12 weeks) prove effective. Programme sustainability can be strengthened via follow-up assessments at least three months post-intervention. For future directions, high-quality RCTs and longitudinal studies should be implemented, taking into account economic, social, and educational factors to better ascertain outcomes. Although challenges persist, nutrition literacy presents opportunities to promote health and offers guidance for managing complications and controlling NCDs.

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Authors' contributions

Karnchanakomate J, conceptualised and designed the study, prepared the draft of the manuscript and reviewed the manuscript; Intarakamhang U and Prasittichok P, prepared the draft of the manuscript and reviewed the manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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