Nutrition Research Reviews (2024), 37, 179–193 doi:10.1017/S0954422423000148

Culinary medicine and healthy ageing: a comprehensive review

Jara Domper[1,2], Lucía Gayoso[1,2], Leticia Goni[3,4], Victor de la O[3,5], Usune Etxeberria[1,2]* and Miguel Ruiz-Canela[3,4]

[1]*Basque Culinary Center, Faculty of Gastronomic Sciences, Mondragon Unibertsitatea Donostia-San Sebastián, Spain*
[2]*BCC Innovation, Technology Center in Gastronomy, Basque Culinary Center, Donostia-San Sebastián, Spain*
[3]*Department of Preventive Medicine and Public Health, University of Navarra, IdiSNA, Pamplona, Spain*
[4]*Consorcio Centro de Investigaciones Biomédicas en Red (CIBERObn), Institute of Health Carlos III (ISCIII), Madrid, Spain*
[5]*Cardiometabolic Nutrition Group, IMDEA Food, CEI UAM + CSIC, Madrid, Spain*

Abstract

Culinary medicine (CM) represents a novel strategy to promote healthy ageing, as it improves adherence to healthy dietary patterns by providing nutritional education and training in cooking skills. We conducted a comprehensive review of the current scientific literature (2011–2022) concerning CM programmes implemented among participants over the age of 40. This review includes fourteen culinary-nutritional interventions. Each CM programme was analysed according to seven variables: health goal, study design, theoretical basis of the intervention, intervention duration, main outcomes, culinary intervention and the effectiveness of intervention. Although CM programmes showed low effectiveness in achieving positive results on psychosocial outcomes, they were successful in improving dietary intake and health-related outcomes. The interventions lasting for at least 5 months and employing study designs with two or more groups seemed to be important factors associated with achieving significant results. Significant results were observed regardless of the prevention phase defined as the health objective of the CM programme. The use of theoretical frameworks as an educational resource did not influence the effectiveness of the interventions. Other variables such as the inclusion of culinary outcomes, the optimisation of the culinary curriculum taught to the participants and the participation of a chef in the intervention are factors that should be taken into account. In addition, several educational components (cooking classes, hands-on cooking, free food delivery, individualized counselling) were promising for achieving health outcomes in ageing people. Our review has shown that CM programmes can be a powerful tool to improve the health status of ageing people.

Keywords: **Home food preparation: Elderly: Culinary-nutritional intervention: Home cooking: Culinary education**

(Received 1 December 2022; revised 2 August 2023; accepted 15 August 2023; accepted manuscript published online 22 August 2023)

Introduction

Healthy ageing is defined as 'the process of developing and maintaining the functional capacity that enables well-being in older adults'[1]. Although the consequences of the ageing process are visible in old age, risk factors that lead to health problems could be controlled and possibly prevented to achieve healthy ageing[2].

Enhancing healthy eating habits stands as one of the main preventive strategies to promote healthy ageing. Most dietary interventions have been focused on providing nutritional education based on calorie restriction[3]. In addition, several dietary patterns, such as the Mediterranean diet[4] or other plant-based diets[5], have been shown to be beneficial for healthy ageing through different biological pathways[6]. However, achieving and maintaining adherence to healthy eating habits remains a major barrier to the achievement of healthy ageing[7].

Culinary medicine (CM) has been recognised as a novel strategy to modify dietary habits[8], and has been defined as 'a new evidence-based field of medicine that combines the art of food and cooking with the science of medicine'[9]. Although not associated with any particular dietary pattern, CM recommendations are usually based on plant-based healthy eating patterns, including the Mediterranean diet[10]. This approach recognises culinary knowledge and skills as key resources for establishing and maintaining a healthy diet, but also for enjoying delicious food.

Despite the relevance of healthy ageing and CM, to our knowledge, no previous study has analysed the current scientific evidence on the effect of CM-based strategies to promote healthy ageing. Therefore, we aimed to review CM programmes aimed at promoting healthy ageing.

Material and methods

Selection criteria and search strategy (data source)

Inclusion criteria were CM programmes delivered to patients or healthy participants over the age of 40. CM programmes should

* **Corresponding author**: Usune Etxeberria, email: uetxeberria@bculinary.com

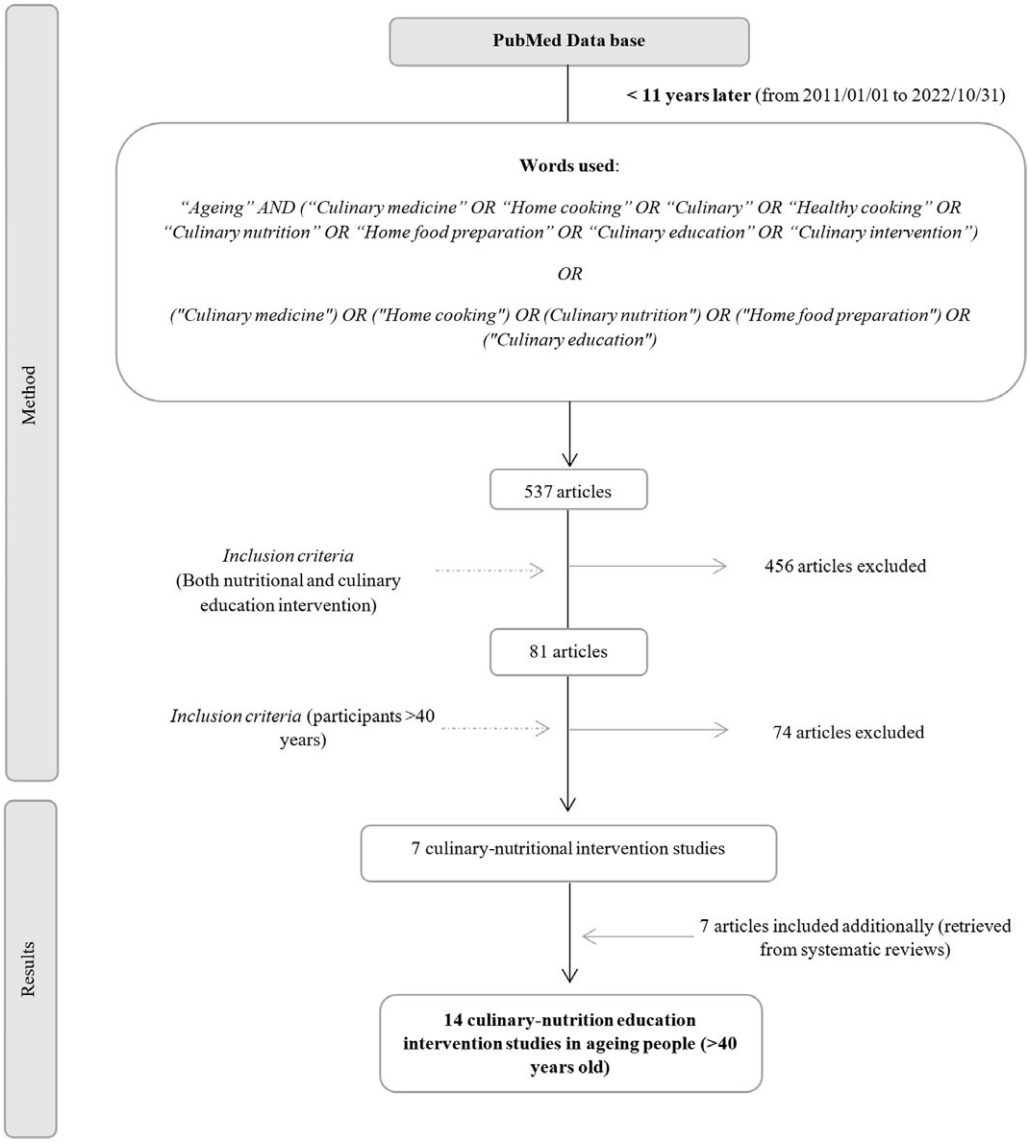

Fig. 1. Data source.

include both nutritional and culinary education. In addition, only studies written in English or Spanish and published in the last 11 years (2011–2022) were included.

The literature search was conducted using the PubMed database from January 2011 to October 2022 (Fig. 1). The search strategy was carried out by combining the word 'ageing' with several terms related to culinary or nutrition: 'ageing and culinary medicine' OR 'ageing and home cooking' OR 'ageing and culinary' OR 'ageing and healthy cooking' OR 'ageing and culinary nutrition' OR 'ageing and home food preparation' OR 'ageing and culinary education' OR 'ageing and culinary intervention'. To broaden the search and identify those studies that did not include the term 'ageing' but did include a dietary intervention, the following terms were used in isolation: ('culinary medicine'), ('home cooking'), ('culinary nutrition'), ('home food preparation'), ('culinary education').

Of the 537 articles initially retrieved, we excluded 456 articles that did not include a CM education programme (culinary-nutritional education). We additionally excluded seventy-four articles which were not delivered to people over 40 years of age, and therefore, seven studies met the inclusion criteria. After adding seven studies retrieved from two systematic reviews[11,12], we finally selected fourteen culinary-nutritional interventions[13–25] (Fig. 1).

Data extraction and synthesis

Seven variables were selected on the basis of previous research studies[11,26,27]. These variables were extracted and analysed from each selected study (Fig. 2): health goal, study design, theoretical basis of the intervention, intervention duration, main outcomes, culinary intervention and the effectiveness of each intervention.

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

Variables		Classification criteria				
Health goal		Not well-defined	Primary prevention	Secondary prevention	Tertiary prevention	Quaternary prevention
Trial design		Single-arm trial	Randomized controlled trial	Non-randomized trial		
Theoretical frameworks		Non-theory	SMA-model	SCT	ELT	
Intervention duration		< 5 months	≥ 5 months			
Main outcomes*		Dietary outcomes	Psychosocial outcomes	Health-related outcomes		
Culinary intervention	Professional educator*	Chef	Non-chef educator	No information on chef participation		
	Educational components*	Cooking demonstrations	Hands-on cooking	Other incentives		
Efficacy of programmes	Significance	Non-statistically significant results	Statistically significant results			
	Outcomes achieved* (and direction of results)	Dietary outcomes	Psychosocial outcomes	Health-related outcomes		
	Level of significance	p<0·05	p<0·01			

Fig. 2. Culinary medicine programmes: variables analysed and classification criteria.
Abbreviations: SMA, shared medical appointment; SCT, social cognitive theory; ELT, experiential learning theory.
*Non-excluding options

The health goals identified in each study were classified following the definitions provided by Kisling and colleagues[2], who distinguished different levels of prevention: primary prevention, secondary prevention, tertiary prevention and quaternary prevention. According to these authors, primary prevention aims to maintain a disease-free status in healthy individuals. Secondary prevention involves the early detection of disease and the treatment of these subclinical forms of the disease, if needed. Tertiary prevention focuses on the treatment of symptoms and sequelae of the disease during the clinical stage to minimise the severity of the disease. Finally, quaternary prevention aims to protect patients at risk of over-medicalisation from new medical interventions and to suggest ethically acceptable interventions[28]. The health status of the study participants was also taken into account in the classification. Accordingly, in trials that included both healthy and sick participants, the health goal was classified as not well defined, and all potential stages of prevention were included.

Trial design referred to the number of arms included and the use of randomisation to assign interventions. We recorded whether the interventions were based on a theoretical framework and, if so, which theoretical model was applied. The duration of the intervention was classified into interventions lasting less than 5 months and those lasting 5 months or more, as previously established by Murimi and colleagues[26].

Outcomes were assessed according to criteria previously established by Reicks and colleagues[11], who emphasised that the most common outcomes in this type of intervention are changes in dietary intake, psychosocial factors and health outcomes. The main outcomes were dietary outcomes, psychosocial outcomes and health-related outcomes. Dietary outcomes included energy and nutrient intakes, consumption of specific food groups, and eating patterns. Psychosocial outcomes included changes in behaviour, knowledge, confidence and attitudes. Finally, the assessment of health-related outcomes included anthropometric, physical activity and clinical outcomes.

In contrast to nutritional education, which has been extensively studied in dietary interventions, there is limited knowledge about culinary education. Therefore, three components of the culinary education intervention were extracted and analysed: first, the professional in charge of delivering the culinary education; second, the educational components used to deliver the culinary education; and third, the culinary curriculum developed in the intervention.

Finally, the effectiveness of the programmes referred to whether statistically significant results were observed for the main outcome and the direction of the association.

Results

A total of fourteen CM intervention programmes conducted with people over the age of 40 were selected (Table 1)[13–25,29].

The age of the participants ranged from 40 to 94 years old, and the sample size ranged from 21[14] to 468 participants[24]. Five CM programmes were conducted in the United States[13,14,16,20,23], two in Japan[17,21] and the remainder in Ireland[15], the United Kingdom[22], Italy[18], New Zealand[24], Canada[25], China[19] and Malaysia[29]. Three studies had a selection criterion based on gender, two of which included only women[17,20] and one only men[21]. With regard to the clinical condition of the participants, four studies included older adults at risk of social isolation or malnutrition[13,15,19,23], four studies included adults at risk of developing metabolic syndrome[18,29], cardiovascular disease (CVD)[16] or type 2 diabetes[22], one included patients with cancer[14] and another included men with hypertension[21]. Finally, two trials were conducted in pre-frail adults[17,24] and one in postmenopausal women[20].

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

Table 1. Culinary medicine studies reviewed

Reference	Study design (n)	Intervention / curriculum	Duration	Age range (Mean)	Study population	Aim of intervention	Main outcomes, data collection instruments and measurement points	Major findings
Teh and colleagues (2022)[24,52]	4 arm-RCT (468).	Senior Chef group ($n=117$): Nutrition education and cooking programme. 1 session of 3h each week for 8 weeks. Steady As You Go group ($n=118$): Exercise programme. 1 session of 1h each week for 10 weeks. Combined group ($n=118$): Combination of Senior Chef programme and Steady as you go group. 2 sessions each week for 10 weeks: 1 nutrition-cooking session and 1 exercise session. Social (control) group ($n=115$): Social gathering (games, craft, and conversations groups). 1 session each week for 10 weeks.	Programme duration: 2 years. Intervention duration: 10 weeks. +3.5- 9.5- and 21.5-month follow-up.	≥60 (80.3)	Pre-frail older adults. New Zealand.	To determine the effectiveness of a nutrition-based intervention, physical activity intervention, and the combined intervention on physical frailty in pre-frail older adults over 2 years.	Physical frailty status was assessed using the Fried frailty score. Assessments were made at five time points: at baseline, 10 weeks after baseline (immediately after the end of the intervention), and 3.5, 9.5 and 21.5 months after the end of the intervention.	• The mean Fried score declined (improved status) in the Steady As You Go group at 6 months compared with the control group ($p=0{\cdot}0049$) (95% CI −0·686 to −0·123). • No significant differences in the Fried score in other groups. • Compared with the control group, those in the combined group were 3·6 times (95% CI 1·06-12·18) more likely to transition to a robust state at the 24-month follow-up. This was not observed in the single programme groups. • After completion of the 8-week or 10-week programmes, 187 (40%) of 468 study participants continued at least one peer-led class. The continuation proportion was highest in the combined group (61%), followed by the Senior Chef group (51%), the Steady As You Go group (33%), and the control group (14%).
Diallo and colleagues (2020)[13]	Single-arm trial (139).	4 intervention sections, one of this was "Kitchen clinic" ($n=15$). Optional participation in the kitchen clinic: 8-weekly cooking class.	Programme duration: 2 years and 6 months. Kitchen clinic duration: 8 weeks.	45-94 (67)	Older adults at risk of social isolation. United States.	To describe the Healthy Meal Program, a community-academic partnership that aims to address the food insecurity and social isolation in older adults living in an urban setting.	Participation in the different interventions of the Healthy Meal Programme was recorded at each session.	• Out of 139 people encouraged to attend the kitchen clinic, only 15 attended at least 3 sessions. • 67.8% attended the cooking classes because they wanted to achieve a healthy weight and learn healthy cooking tips while using fresh vegetables. • 53.8% reported increased knowledge about healthy eating and enjoyed adding new vegetables to their weekly meals.
Schneeberger and colleagues (2018)[14]	Single-arm trial (21).	Non groups. 2h/visit every other week for 14 weeks (total of 7 visits). Visit 1 and 7: introductory and wrap-up. Visit 2: education and experience in nutrition. Visit 3 and 6: cooking classes. Visit 4: stress relief practices. Visit 5: physical activity.	Programme duration: 1 year and 1 month. Intervention duration: 14 weeks.	41-73 (55.9)	Breast cancer survivors. United States.	To evaluate the effectiveness of a comprehensive lifestyle medicine intervention on chronic disease risk factors and quality of life in breast cancer survivors.	Biometric (weight, BMI, body fat mass, lean body mass, body fat percentage), psychosocial, and dietary data were measured at baseline and after the 14 weeks of intervention using standard, validated measurement tools. Psychosocial data: perceived stress (4-item Perceived Stress Scale), depression (10-item Centre for Epidemiological Studies-Depression survey), patient activation (Patient Activation Measure), physical and mental quality of life (10-item Patient-Reported Outcomes Measurement Information System). Dietary data were assessed using the 10-item Patient-Reported Outcomes Measurement Information System blocks.	• At 14 weeks participants significantly reduced BMI (−2.5%, $p<0{\cdot}01$), weight (−2.6%, $p<0{\cdot}01$), fat (−3.2%, $p<0{\cdot}05$) and lean body mass (−2.1%, $p<0{\cdot}01$). • No differences in psychosocial variables. • Fat consumption score decreased in average weekly (−31.5%, $p<0.01$).
Power and colleagues (2016)[15]	Parallel RCT (100).	Control group ($n=50$): Nutritional-culinary guidebook and recipes. Intervention group ($n=50$): Nutritional-culinary guidebook and recipes + Visitor for cooking together (1 session of 90 minutes each week).	Programme duration: 6 months and 2 weeks. Intervention duration: 8 weeks. +4- and 18-week follow-up.	60–89 (74.4) 60–91 (75.3)	At risk of malnutrition (35.4%), malnourished (6.3%). At risk of malnutrition (20.8%), malnourished (6.3%). Ireland.	To investigate a mealtime intervention focusing on the improvement of self-efficacy, food enjoyment and energy intake among older adults living alone at risk of social isolation.	Self-efficacy, food enjoyment, and energy intake were assessed using, respectively, the General Self-Efficacy Scale, the Food Enjoyment Scale, and 24-h food recall. Assessments were made at four time points: at baseline, 8 weeks from baseline (immediately after the end of the intervention), and 4 and 18 weeks after the end of the intervention.	• Self-efficacy: treatment group improved their self-efficacy more than the control group over time ($p=0{\cdot}054$). • Food enjoyment: treatment group improved their food enjoyment more than the control group at all four time points ($p<0{\cdot}05$). • Energy intake: Males in the control and treatment groups improved their energy intake, whereas only females in the treatment group improved their intake ($p<0{\cdot}05$).

Table 1. (*Continued*)

Reference	Study design (n)	Intervention / curriculum		Duration	Age range (Mean)	Study population	Aim of intervention	Main outcomes, data collection instruments and measurement points	Major findings
Delichatsios and colleagues (2015)[16]	Feasibility pilot single-arm trial (70).	Non groups. Optional participation.	1 session monthly (90 minutes).	Programme duration: 4 years.	45-80	Adult patients with at least one cardiovascular risk factor. Boston, Massachusetts, United States.	To determine the feasibility of an innovative SMA model focuses on culinary skills as a method to teach nutrition concepts to patients with metabolic conditions.	Patient satisfaction with sessions based on the Shared Medical Appointment format and content was assessed after each session through an anonymous survey.	• 156 patient-visits over 4 years (average of 9 patients per session). • Most patients would recommend these sessions to others and would return for another session.
Kwon and colleagues (2015)[17]	3 arm-RCT (89).	Control group ($n = 31$). Exercise group ($n = 28$). Exercise and nutritional group ($n = 30$).	3 months: 1 health education session/ month. 1 month: 1 exercise session/week (1h). 3 months: 1 cooking and nutritional class/ week, 1 exercise session/week (1h) and 2 nutritional interventions.	Intervention duration: 3 months. +6-month follow-up.	70-84 (76.8)	Prefrail older women (>70 years old). Tokyo, Japan.	To examine whether a 12-week combined physical exercise training and nutritional intervention improves physical performance and enhances health-related quality of life among prefrail elderly women living in the community.	Physical performance and quality of life were assessed at the baseline, at the end of the 3-month intervention and 6 months after the intervention programme. Physical performance measures included muscle strength (handgrip strength measured by Smedley's hand dynamometer), balance (stork standing time with eyes open), and walking speed. The HRQOL questionnaire was used to measure the quality of life.	• Significantly improved handgrip strength in the exercise group (−3.0 to 8.0 kg) compared with the control group after intervention ($p < 0{\cdot}01$). • Exercise group (ranges in parenthesis): mental health score increased (−10.6 to 29.2) significantly after intervention ($p < 0{\cdot}05$). • Nutritional group (ranges in parenthesis): scores for physical role (−10.2 to 30.7), bodily pain (−9.8 to 29.0), emotional role (−17.0 to 38.3), and physical component summary (−6.8 to 22.2) increased significantly from baseline to postintervention ($p < 0{\cdot}05$). Scores for physical functioning (−24.7 to 14.1), physical role (−40.9 to 6.8), vitality (−12.3 to 6.2), emotional role (−25.5 to 4.3), physical component summary (−22.2 to 1.0), and mental component summary (−15.4 to 7.2) decreased significantly from postintervention to follow-up ($p < 0{\cdot}05$). • Bodily pain score decreased significantly in the 3 groups during the 6 months after the intervention ($p < 0{\cdot}05$).
Moreau and colleagues (2015)[25]	Single-arm trial (154).	Non groups. 1 workshop of 2h each week for 8 weeks. The workshops entailed two parts: 1) interactive nutrition education, and 2) hands-on cooking.		Programme duration: 4 years. Intervention duration: 8 weeks.	≥50 (–)	Community-dwelling adults aged 50 years and older. Quebec, Canada.	To determine if nutrition education-focused cooking workshops are effective in improving dietary quality, nutrition knowledge, and food preparation skills among community dwelling older adults.	At the baseline and after the intervention period, a five-section questionnaire was used to measure dietary habits, perceived autonomy, knowledge about nutrition and health, confidence in cooking and healthy eating.	• Significant improvements ($p < 0{\cdot}05$) in knowledge of health and nutrition issues, confidence in eating healthier meals, and desired dietary behaviours. • Dietary habits: significant improvements ($p < 0{\cdot}05$) for fruit and vegetable consumption, whole grain consumption, water intake, mild and soya drinks. • A significant association was observed between nutrition knowledge and confidence ($p = 0{\cdot}01$). • Increased confidence in eating healthier meals and meeting daily nutritional needs was a predictor of desired dietary habits ($p = 0{\cdot}01$).
Villarini and colleagues (2015)[18]	Pilot single-arm trial (186).	Non groups. General recommendations for Metabolic Syndrome +5 conferences, 5 cooking classes, and 12 physical activity sessions.		Intervention duration: 6 months.	≥45 (56.7)	>45 years old people. Perugia, Italy.	To evaluate the impact of a brief lifestyle intervention trial on changes in metabolic syndrome risk factors.	Physical activity and dietary habits were assessed by questionnaires at baseline and at the end of the 6 months of intervention. Self-measurements of anthropometry (weight, height, BMI, waist and hip circumference), biochemical parameters (cholesterol, triglycerides and glycaemia) and BP were performed by the enrolled subjects using medical equipment available in community pharmacies. The development of metabolic syndrome was assessed by the presence of three or more of the risk factors.	• Attendance to intervention programmes was generally low. • Anthropometric and clinical characteristics: a statistically significant difference ($p < 0{\cdot}05$) between baseline and follow-up was observed for body weight, BMI and total cholesterol. • Slight non-significant decrease in prevalence of metabolic syndrome. • Significant decrease in the prevalence of hypercholesterolemia in men ($p = 0{\cdot}020$).

Table 1. (*Continued*)

Reference	Study design (n)	Intervention / curriculum	Duration	Age range (Mean)	Study population	Aim of intervention	Main outcomes, data collection instruments and measurement points	Major findings
Chung and colleagues (2014)[19]	RCT (60).	Group A ($n=30$). One 1-day free food sample each week + 1 seminar on nutrition per week with 1-day recipe per week. Group B ($n=30$). Three 1-day free food sample each week + 1 seminar on nutrition per week with 1-day recipe per week.	Intervention duration: 3 weeks. +6-month follow-up.	59-95 (74.4)	Home-living adults. Hong Kong, China.	To evaluate a 3-week programme comprising cooking demonstrations with free food samples in motivating elderly adults to cook more and improve their nutritional status.	Patient satisfaction was measured by a questionnaire administered on day 7 of each of the 3 intervention weeks. Participants' nutritional status was assessed using the MNA score at baseline and 6 months after the nutrition education programme.	• Reduction in the proportion of participants at risk of malnutrition at 6 months. • Group B: MNA score increased (17.7 to 20.1) significantly ($p<0{\cdot}05$) from pre- to post-intervention measurements.
Peters and colleagues (2014)[20]	RCT (71).	Whole foods group ($n=22$). Whole foods, plant-based, macrobiotic-style foods rich in phyto-oestrogens. Moderate fat group ($n=49$). Moderate Fat plan with, and without 10 grams of ground flaxseed added daily.	Intervention duration: 1 year. 24 sessions involving hands-on cooking classes and behavioural sessions.	50-72 (57)	Healthy, free-living, postmenopausal women. New York, United States.	To determine the degree of dietary adherence or change in eating patterns, and demographic, psychosocial and study characteristics associated with adherence, in the Comparing Healthy Options in Cooking and Eating Study.	Adherence to the prescribed dietary pattern and dietary intake were measured by monthly 24-hour food recalls.	• Significantly increased adherence to the prescribed diet in both groups ($p<0{\cdot}05$). • No significant change in weight or BMI in either group. • There were no changes in attitudes over time (from baseline to 12 months).
Kitaoka and colleagues (2013)[21]	Non-RCT (71).	Control group ($n=32$). Any education, only data collection. Intervention group ($n=39$). 5 months (1 session/month of 4 hour). Cooking instructions sessions.	Programme duration: 8 years. Intervention duration: 5 months.	40-75 (65)	Free-living, high-normal, and stage 1 or 2 hypertensive men. Kyoto, Japan.	To evaluate the effect of a dietary educational programme for free-living, high-normal, and stage 1 or 2 hypertensive men.	At the baseline and after the intervention period, dietary intake was assessed by self-administered food frequency questionnaires, as well as blood pressure, and urinary sodium and potassium excretion.	• No statistically significant difference in mean systolic BP between the groups after the intervention. • Intervention group: awareness of salt restriction improved ($p<0{\cdot}01$), Japanese noodle soup consumption decreased ($p<0{\cdot}01$), frequency of canned vegetables decreased ($p<0{\cdot}05$), diastolic BP (mm Hg) decreased (93.0-87.0, $p<0{\cdot}01$), estimated sodium excretion (g/day) decreased (12.3-10.6, $p<0{\cdot}05$), urinary-sodium-to-potassium excretion ratio decreased (2.5-1.9, $p<0{\cdot}05$). • Control group: soup intake decreased ($p<0{\cdot}05$) and fruit consumption increased ($p<0{\cdot}05$), estimated sodium excretion (g/day) decreased (15.5-13.3, $p<0{\cdot}05$), estimated potassium excretion (mg/day) decreased (3877-3566, $p<0{\cdot}05$). • Intervention group vs. control group (food frequency): frequency of canned vegetables and noodle soup decreased ($p<0{\cdot}05$) and the intake of other vegetables increased ($p<0{\cdot}05$) in the intervention group. • Intervention group vs. control group (CVD risk factors): the intervention group significantly improved the urinary sodium-to-potassium excretion ratio ($p<0{\cdot}05$) compared with the control group.
Penn and colleagues (2013)[22]	Pilot study. Uncontrolled single-arm trial (134).	Non groups. 2 sessions of 1.5h each week: Cookery session, nutrition, and strategies for behaviour change. Online material.	Programme duration: 1 year. Intervention duration: 10 weeks. +3.5- and 9.5-month follow-up.	45-65 (53.6)	Adults with a FINDRISC ≥11. Middlesbrough, United Kingdom.	To assess the feasibility, acceptability and outcomes at a 12-month follow-up of a behavioural intervention for adults at risk of type 2 diabetes.	The amount and type of physical activity level was measured using a self-report instrument at baseline and at 3.5 and 9.5 months after the intervention period.	• Non-significant decreases in the BMI, weight, waist circumference and FINDRISC. • Changes were greater in the first 6 months of follow-up.

Table 1. (*Continued*)

Reference	Study design (n)	Intervention / curriculum		Duration	Age range (Mean)	Study population	Aim of intervention	Main outcomes, data collection instruments and measurement points	Major findings
Shahar and colleagues (2012)[29]	Non-RCT (47).	Control group ($n = 23$). Intervention group ($n = 24$).	General health education package. Three education sessions in the first 3 months (weeks 1, 3 and 8) and one session in the second 3 months (week 16).	Intervention duration: 6 months.	60-75 (66.5)	Rural older adults diagnosed with metabolic syndrome. Sabak Bernam, Selangor, Malaysia.	To determine the effectiveness of a nutrition education intervention package in improving anthropometric, clinical and biochemical indicators of rural older Malays with metabolic syndrome.	Anthropometric (BMI, waist circumference) and clinical parameters (BP, fasting blood glucose, fasting serum lipids, C-reactive protein, total cholesterol, HDL-c, LDL-c, triglycerides) were measured at baseline, 3 and 6 months.	• Intervention group (men): significant group effect (difference of two group means) for body weight ($p < 0{\cdot}05$) and BMI ($p < 0{\cdot}05$). • Intervention group (women): significant reduction ($p < 0{\cdot}05$) in waist circumference (−4.1%) and body weight (−0.2%). There were significant time effects for LDL-cholesterol ($p < 0{\cdot}05$), triglycerides ($p < 0{\cdot}01$), and diastolic BP ($p < 0{\cdot}01$). • Intervention group vs. control group: significant reduction in waist circumference for women in the intervention group ($p < 0{\cdot}01$). Men in the intervention group maintained total cholesterol level ($p < 0{\cdot}05$).
Wunderlich and colleagues (2011)[23]	Non-RCT (355).	Congregate meal. Home delivered meal.	Education sessions (4 per year) + interactive activities (cooking demonstrations and tips for shopping) + optional individual counselling. Education materials + optional individual counselling.	Intervention duration: 2 years.	≥60 (76)	Older adults. New Jersey, United States.	To examine the nutrition risk factor scores and nutrition behaviours of congregate meal and home delivered meal participants in a nutrition intervention.	Dietary habits were assessed at baseline and post- intervention using the Nutrition Survey Risk Screening Questionnaire.	• Nutrition risk factor scores improved after the intervention in both groups. Statistically significant in home-delivered meals (8.1 to 6.1, $p < 0{\cdot}01$). • Home-delivered meals showed an improvement in "eating 2 or more meals per day" (76 to 81.6%, $p = 0.310$). • Congregate meals showed a decrease in "more than 3 servings of alcohol drinking" (8.4 to 4.8%, $p = 0{\cdot}08$). • Non-significant improvement in consumption of 5 or more servings of fruit and vegetables in congregate meal group.

Abbreviations: *n*, sample size; RCT, randomized controlled trial; h, hour/s; CI, confidence interval; BMI, body mass index; SMA, shared medical appointment; HRQOL, health-related quality of life; BP, blood pressure; MNA, mini nutritional assessment; mm HG, millimetres of mercury; g, grams; CVD, cardiovascular disease; FINDRISC, finnish diabetes risk score; HDL, high density lipoprotein; LDL, low density lipoprotein.

Table 2. Culinary medicine programmes measured following variables analysed.

						Culinary intervention			Efficacy of programmes	
	Health goal	Trial design	Theoretical frameworks	Intervention duration	Main outcomes	Educator	Educational components	Curriculum	Significance	Outcomes achieved, direction of results and level of significance
Teh and colleagues (2022)[24,52]	Not well defined. P1–P2	RCT	Non-theory	<5 months	Health-related outcomes.	No information on chef participation.	Hands-on cooking. Other incentives.	1 weekly session for 8 weeks. 3 h per session. (Total: 8 sessions, 24 h)	SSR	Health outcome: Fried Frailty Score declined in one intervention group (95% CI −0·686 to -0·123)**.
Diallo and colleagues (2020)[13]	P3	Single-arm trial	Non-theory	<5 months	Psychosocial outcomes.	No information on chef participation.	Hands-on cooking. Other incentives.	1 weekly session for 8 weeks. (Total: 8 sessions)	Non-SSR	–
Schneeberger and colleagues (2018)[14]	P3	Single-arm trial	SMA-model	<5 months	Dietary outcomes. Psychosocial outcomes. Health-related outcomes.	Chef.	Cooking classes. Other incentives.	2 sessions in 14 weeks. 2 h per session. (Total: 2 sessions, 4 h)	SSR	Dietary outcome: fat consumption declined**. Health outcome: anthropometric measurements declined (BMI**, weight**, fat* and lean body mass*).
Power and colleagues (2016)[15]	Not well defined. P1–P2	RCT	SCT	<5 months	Dietary outcomes. Psychosocial outcomes.	Non-chef educator.	Hands-on cooking. Other incentives.	1 weekly session for 8 weeks. 1·5 h per session. (Total: 8 sessions, 12 h)	SSR	Dietary outcome: energy intake improved in females in the intervention group*. Psychosocial outcome: self-efficacy* and food enjoyment* improved in the intervention group.
Delichatsios and colleagues (2015)[16]	P3	Single-arm trial	SMA-model	–	Psychosocial outcomes.	Chef.	Cooking classes. Other incentives.	1 monthly session during the fall and spring. 1·5 h per session. (Total: –)	Non-SSR	–
Kwon and colleagues (2015)[17]	P3	RCT	Non-theory	<5 months	Health-related outcomes.	Non-chef educator.	Cooking classes. Hands-on cooking. Other incentives.	1 weekly session for 3 months. 2–3 h per session. (Total: 12 sessions, 24–36 h)	SSR	Health outcome: Physical** and mental* status improved in the exercise group after intervention; Physical* and mental* status improved in the nutritional group after intervention and declined during 6 months after intervention.
Moreau and colleagues (2015)[25]	Not well defined. P1–P2	Single-arm trial	Non-theory	<5 months	Dietary outcomes. Psychosocial outcomes.	Non-chef educator.	Hands-on cooking. Other incentives.	1 weekly session for 8 weeks. 2 h per session. (Total: 8 sessions, 16 h)	SSR	Dietary outcome: dietary habits improved*. Psychosocial outcome: nutrition and health knowledge, and confidence in healthy eating improved*.
Villarini and colleagues (2015)[18]	P3	Single-arm trial	Non-theory	≥5 months	Dietary outcomes. Health-related outcomes.	No information on chef participation.	Cooking classes.	(Total: 5 sessions)	SSR	Health outcome: anthropometric measurements (BMI, body weight), total cholesterol, and prevalence of hypercholesterolaemia declined*.

Table 2. (*Continued*)

						Culinary intervention			Efficacy of programmes	
	Health goal	Trial design	Theoretical frameworks	Intervention duration	Main outcomes	Educator	Educational components	Curriculum	Significance	Outcomes achieved, direction of results and level of significance
Chung and colleagues (2014)[19]	Not well defined. P1–P2	RCT	Non-theory	<5 months	Psychosocial outcomes. Health-related outcomes.	Non-chef educator.	Cooking classes. Other incentives.	1 weekly session for 3 weeks. (Total: 3 sessions)	SSR	Health outcome: MNA score improved* in one intervention group.
Peters and colleagues (2014)[20]	P1	RCT	SCT	≥5 months	Dietary outcomes.	No information on chef participation.	Cooking classes. Hands-on cooking. Other incentives.	1 weekly session for 14 weeks, 4 sessions in 2 months, and 6 sessions in 6 months. (Total: 24 sessions)	SSR	Dietary outcome: adherence to health patterns improved in both intervention groups*.
Kitaoka and colleagues (2013)[21]	P3	Non-RCT	Non-theory	≥5 months	Dietary outcomes. Health-related outcomes.	Non-chef educator.	Hands-on cooking. Other incentives.	1 monthly session for 5 months. 4 h per session. (Total: 5 sessions, 20 h)	SSR	Dietary outcome: dietary habits improved in both intervention and control group*. Health outcome: CVD risk factors declined in intervention*/** and control* group.
Penn and colleagues (2013)[22]	Not well defined. P2-P3	Single-arm trial	ELT	< 5 months	Health-related outcomes.	Non-chef educator.	Cooking classes. Other incentives.	2 or 3 sessions in 10 weeks. 1·5 h per session. (Total: 2 or 3 sessions, 3–4·5 h)	Non-SSR	–
Shahar and colleagues (2012)[29]	P3	Non-RCT	Non-theory	≥5 months	Health-related outcomes.	No information on chef participation.	Cooking classes.	1 session in 6 months. 1·5 h per session. (Total: 1 session, 1·5 h)	SSR	Health outcome: anthropometric measurements declined in intervention group** and total cholesterol maintained*.
Wunderlich and colleagues (2011)[23]	P3	Non-RCT	Non-theory	≥5 months	Dietary outcomes.	Non-chef educator.	Cooking classes. Other incentives.	4 sessions per year for 2 years. 1 h per session. (Total: 8 sessions, 8 h)	SSR	Dietary outcome: dietary habits improved in home-delivered meals group** and congregate meals group*.

Abbreviations: P1, primary prevention; P2, secondary prevention; RCT, randomized controlled trial; SSR, statistically significant results; CI, confidence interval; P3, tertiary prevention; SMA, shared medical appointment; BMI, body mass index; SCT, social cognitive theory; MNA, mini nutritional assessment; CVD, cardiovascular disease; ELT, experiential learning theory.

* $p < 0{\cdot}05$;

** $p < 0{\cdot}01$.

Variables analysed

Table 2 presents the analysis and characterisation of the seven variables selected for each study.

Health goal. The CM programmes were classified according to the level of prevention: primary, secondary, tertiary or quaternary prevention. Tertiary prevention was the most common[13,14,16–18,21,23,29], while only one study[20] was classified as a primary prevention programme. There were five trials in which the stage of prevention was not well defined due to lack of information[15,19,24,25] or the inclusion of people with different clinical status[22].

Study design. We found six studies with single arm[13,14,16,18,22,25], six trials with two arms[15,19–21,23,29], one trial[17] with three study arms (one control group and two intervention groups) and one trial[24] with four arms (one control group and three intervention groups). Five of the trials with two or more arms[15,17,19,20,24] were randomised, while three trials[21,23,29] used a non-randomisation method to allocate participants to the different arms. In one of these studies[21], the participants themselves chose to be included in the intervention or control group; in the study by Wunderlich and colleagues[23], older adults at risk of social isolation were allocated to the congregate or home-delivered group according to their ability to travel; and in the trial by Shahar and colleagues[29], participants were allocated according to where they lived. Of the fourteen studies, four were pilot studies[15,16,18,22] aimed to assess the feasibility of the interventions.

Use of theoretical frameworks. Five out of the fourteen studies reported the theoretical framework used to achieve the behavioural outcomes. Specifically, the Social Medical Appointment (SMA) model, used in two studies[14,16] aimed to help patients identify and apply healthy self-care practices in group visits where individual patient medical problems were addressed. Social Cognitive Theory (SCT) was used in two studies[15,20] and was based on improving self-efficacy as a tool to achieve health behaviour change. Finally, the study conducted by Penn and colleagues[22] aimed to achieve behavioural change using Experiential Learning Theory (ELT), which involves 'here and now' experience, observation of its effects and subsequent reflection.

Intervention duration. Eight out of the fourteen trials[13–15,17,19,22,24,25] had an intervention period of less than 5 months, and five trials[18,20,21,23,29] had a duration of 5 months or more. The intervention period could not be determined in one study[16], which only indicated that patients were invited to attend one or more monthly sessions offered in autumn and spring. Follow-up after the end of the intervention was reported in five trials[15,17,19,22,24]. The shortest follow-up period was 4 weeks[15], and the longest was 21·5 months[24].

Main outcomes. The outcomes measured were classified as dietary, psychosocial and health-related outcomes (Table 2). Of the seven studies that focused on dietary outcomes, one study measured changes in energy intake[15], and six[14,18,20,21,23,25] assessed some characteristics related to dietary habits, such as alcohol consumption, meals eaten per day, fruit and vegetable consumption, or fat and fibre consumption. One of these six trials assessed the adherence to the prescribed dietary patterns[20]. Psychosocial outcomes were assessed in six studies[13–16,19,25], namely participation and attendance[13], perceived stress, patient activation, physical and mental quality of life[14], food enjoyment and self-efficacy[15], patient satisfaction[16,19], participants' perceived autonomy, knowledge about nutrition and health, and confidence in cooking and healthy eating[25]. Eight trails assessed health-related outcomes: changes in anthropometric measures[14,18,29], physical activity[18,22] and clinical outcomes[17–19,21,24,29]. Clinical outcomes included changes in physical and mental status[17,19], biochemical and physiological parameters[18,21,29], quality of life (Health Related Quality of Life-HRQOL questionnaire)[17], physical frailty status (The Frailty Scale)[24] and development of metabolic syndrome[18].

Culinary intervention. A chef was involved in the intervention in two of the trials analysed[14,16], although in one of them[16] former physicians or other researchers took responsibility for training in cases where a chef was not available (Table 2). In seven trials[15,17,19,21–23,25] the culinary intervention was delivered by a physician, nutritionist, dietitian or other research staff, while in five trials[13,18,20,24,29] no information was given about the professionals involved.

Twelve trials[13–17,19–25] included at least two educational components (cooking classes, hands-on cooking or other incentives), while two trials included a single educational component (cooking classes)[18,29]. Cooking classes or demonstrations were provided in nine studies[14,16–20,22,23,29], while hands-on cooking experience, namely experiential learning in which participants cooked as part of the intervention, was provided in seven studies[13,15,17,20,21,24,25]. Examples of incentives included the provision of cooking instructions through videos, guidebooks and recipes[15,17,19,21,22,25]. In addition, free delivery of food[13,15,19,23], individual culinary and nutritional counselling[20,21,23], and tasting[14,16,17,20,24] were offered as incentives.

The curriculum of each study includes the total number of teaching classes delivered, the frequency of delivery and the total number of teaching hours. The full curriculum delivered was found in nine studies[14,15,17,21–25,29], while five studies[13,16,18–20] did not report the number of teaching hours delivered, the total number of teaching classes or the intervention period. The lowest number of classes delivered was one session[29] and the highest was twenty-four sessions[20]. The most common frequency of classes was one session per week[13,15,17,19,20,24,25], while the lowest frequency was one session in 6 months[29]. The total number of hours provided during the intervention could be obtained in nine studies[14,15,17,21–25,29], with the lowest being 1·5 h[29] and the highest being 24–36 h[17].

Efficacy of the CM programmes. In terms of the effectiveness of the CM programmes analysed, three studies[13,16,22] found no

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

statistically significant results, while eleven studies[14,15,17–21,23–25,29] found statistically significant results.

The main outcomes in the three studies that failed to demonstrate beneficial effects were participation in the CM programme[13], patient satisfaction with the sessions[16], and amount and type of physical activity level[22]. These studies shared three common characteristics. First, the duration of the intervention was not reported[16] or was less than 5 months[13,22]; second, the design involved a single group[13,16,22]; and third, only one outcome was measured[13,16,22].

Among the eleven trials with statistically significant results, six[14,15,20,21,23,25] found significant improvements in dietary outcomes, two[15,25] in psychosocial outcomes, and seven trials[14,17–19,21,24,29] reported statistically significant results for at least one health-related outcome. Four trials achieved significant results in more than one outcome: two trials found significant improvements in both dietary and psychosocial outcomes[15,25], and two trials found significant improvements in both dietary and health outcomes[14,21].

Six trials reported significant improvements in dietary outcomes such as energy intake[15], fat intake[14], salt consumption[21], alcohol consumption[23], food group consumption[20,21,25], water, milk and soy drink intake[25], and adherence to healthy dietary patterns[20]. Three of these trials used theoretical frameworks[14,15,20]. A single-arm study[14] reported a reduction in weekly fat intake in breast cancer survivors after 14 weeks of intervention. A randomised controlled trial (RCT)[15] that measured changes in energy intake found a significant reduction in female participants in the treatment group after 8 weeks of intervention, with a significant interaction between time, condition and sex. In the former study, the intervention group received a weekly visitor to cook together, in contrast to the control group, which only received a guidebook and recipes. A 1-year RCT[20] reported an improvement in food consumption in both intervention groups (whole-food group, moderate-fat group), which was translated into improved adherence to healthy eating patterns. Improvements in whole grain, fruit, vegetable, water, milk and soy drink consumption were observed in a single-arm trial after one weekly session for 8 weeks[25]. A 5-month non-RCT[21] reduced salt consumption by reducing high-salt foods, such as Japanese noodle soup. Significant results were observed not only from pre- to post-assessment in the intervention group, but also between the intervention and control groups. Finally, a reduction in alcohol consumption was reported in congregate meals group after a 2-year nutrition education and counselling intervention[23].

An 8-week RCT[15] using the SCT model as a behaviour change tool showed statistically significant improvements in psychosocial outcomes, demonstrating improvements in food enjoyment and self-efficacy. Meanwhile, a single-arm study[25] achieved significant improvements in knowledge about nutrition and health and confidence in cooking and healthy eating, providing a weak significant association between these two variables (knowledge and confidence), also finding that increased confidence in healthy eating was a predictor of desired dietary habits.

Of the seven trials[14,17–19,21,24,29] that reported statistically significant results for health outcomes, five[17,19,21,24,29] included at least two groups, and the duration of three trials[18,21,29] was 5 months or longer. In particular, two single-arm trials[14,18] showed statistically significant reductions in body mass index (BMI)[14,18] and fat and lean body mass[14] after CM intervention. In addition, a 6-month non-RCT[29] reported significant reductions in waist circumference and body weight for women in the intervention group. Five trials[17–19,21,29] reported statistically significant results for biochemical and physiological parameters, physical and mental status, and medical outcomes. Regarding biochemical parameters, a single-arm study[18] reported a significant reduction in total cholesterol after the intervention, and a 6-month non-RCT[29] reported a beneficial effect of the intervention on total cholesterol in men, while a 5-month non-RCT[21] observed a greater reduction in the sodium-to-potassium excretion ratio in the intervention group than in the control group after the intervention, also showing a significant reduction in low-density lipoprotein (LDL) cholesterol and blood pressure in the treatment group after the intervention. A 3-week RCT[19] reported a significant improvement in nutritional status, as assessed by the Mini Nutritional Assessment (MNA) form, in the group that received 3 d of free food samples per week, compared with the control group that received only 1 d of food samples per week. In terms of physical performance, changes in handgrip strength, a predictor of sarcopenia, and physical frailty were reported. A three-arm RCT[17] reported a significant improvement in handgrip strength in the exercise intervention group from baseline to post-intervention assessment, while the exercise nutrition group showed a significant reduction in this parameter from post-intervention to follow-up assessment. Physical frailty was assessed using the Fried Frailty Score, a five-question screening tool suitable for clinicians to identify frailty, with a reduction in the score indicating an improvement in the patient's physical status. A four-arm RCT[24] showed a significant reduction in the Fried Frailty Score in the exercise group at post-intervention follow-up. In addition, participants in the group that received both culinary-nutritional and exercise education were more likely to be robust at the end of the programme than those in the control group[24]. The three-arm study[17] reported significant changes in quality of life from baseline to post-intervention assessment: the exercise-nutrition group reported significant improvements in role physical, bodily pain, role emotional and physical components; and the exercise group reported significant improvements in mental health. Finally, a significant reduction in bodily pain was observed in all groups from post-intervention to follow-up assessment, while the exercise group also showed a significant reduction in physical functioning, role physical, vitality, role emotional, and physical and mental components.

In the studies with positive results, participants were recruited mainly through media campaigns[15,20,21], social/community centres[15,23,29] and health professionals or health organisations[14,15,17–19,21,24,25]. Regarding the retention methods used, most CM programmes analysed in this review did not report details about this. Some studies provided a close follow-up by contacting participants who missed a session to arrange a make-up session[20] or to encourage regular attendance[18]. In addition, the implementation of theoretical frameworks is likely to have worked as an undirected method of retaining participants in

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

three studies[14,15,20]. Specifically, Schneeberger and colleagues[14] included a health coach in all visits, Peters and colleagues[20] developed behavioural sessions to motivate participants, and Power and colleagues[15] used a trained volunteer to go to participants' homes for vicarious learning (learning by observing others). Other retention methods were the use of a trained facilitator[24], covering transport costs[24] or using a reinforcement method[29], although in the latter study[29] the authors did not specify the method of reinforcement used.

Discussion

This comprehensive review has analysed fourteen culinary-nutritional trials to promote healthy ageing (40–94 years old). Most of these trials found a significant outcome related to healthy ageing. Interestingly, longer intervention durations (5 months or more) and study designs involving two or more groups appeared to be critical factors associated with the observation of significant results. The classification of the studies according to the stages of prevention showed that although the prevalence of tertiary prevention in the studies analysed was high (eight out of fourteen), there were also a few studies (three out of fourteen) that included healthy participants without associated chronic diseases. This highlights the potential of CM in enhancing the wellbeing of participants through preventive interventions in addition to disease treatment. On the other hand, although few authors have identified theoretical frameworks as a success factor in healthy ageing interventions[27], most CM programmes did not refer to this issue as a factor influencing the effectiveness of the intervention.

The duration of most trials included in our review was less than 5 months. Interestingly, all CM interventions conducted for 5 months or more achieved statistically significant results in various outcomes, including dietary[20,21,23] and clinical outcomes[18,21,29]. This finding is consistent with the findings of Murimi and colleagues[26], who showed that an intervention of 5 months or more was an important factor associated with the effectiveness of dietary interventions after conducting a systematic review of forty-five studies that included dietary education interventions[11]. Of the eleven trials that reported statistically significant results, eight[15,17,19–21,23,24,29] included at least two groups. In these eight trials, participants made positive changes in their eating habits[15,20,21,23], and attitudes towards food[15], and reported improvements in some clinical outcomes[17,19,21,24,29], such as reductions in LDL-cholesterol[21]. In conclusion, the results observed in our review suggest that the inclusion of multiple arms and the duration of the intervention should be well defined in the design of future CM programmes.

In the studies included in our review, the culinary intervention was usually led by physicians, nutritionists, dietitians or other research staff members. A low presence of chefs as educators was stated. This finding contrasts with the fact that chefs are the professionals who have the knowledge and the skills to deliver culinary education[30]. In addition, we were not able to identify the person responsible for the culinary education in a large number of the studies analysed, as has been previously reported in adult cooking intervention studies[11]. These issues indicate that the culinary educator should be better justified in the CM programmes.

Evaluations of the type of culinary intervention showed a frequent use of cooking classes and hands-on cooking experience as educational components. Alpaugh and colleagues[31] reported similar effects when comparing an active (hands-on cooking) and passive (chef demonstrations) culinary intervention. The location of the cooking classes varied across the CM programmes. For example, three[14,20,25] out of the eleven trials with positive results delivered the cooking classes in a community kitchen, one culinary intervention[17] used a classroom in a research centre, and one[15] was delivered in participants' homes. In addition, one culinary intervention[19] provided cooking classes using a digital format. Similar to other aspects of culinary interventions, many studies did not specify the location of the cooking classes[18,21,23,24,29], and this lack of information limits the assessment of the importance of location on the effectiveness of these CM programmes. In this sense, the COVID-19 pandemic forced the delivery of virtual CM courses, but it also demonstrated the flexibility and viability of this approach for participants who would not have attended in person if they live far away[32]. Therefore, virtual delivery of cooking classes can be considered as an alternative or complementary activity to face-to-face interventions when designing CM programmes.

Several studies[13–17,19–25] included other educational components as an incentive to improve the effectiveness of the interventions. For example, the delivery of food may be an interesting method to improve the nutritional status of low-income communities and older adults living alone[15,19,23]. Specifically, in the studies by Power and colleagues[15] and Chung and colleagues[19], raw food was delivered to participants to be cooked, whereas in the studies by Wunderlich and colleagues[23] and Diallo and colleagues[13], participants were offered an already cooked meal. These CM programmes were successful in achieving significant reductions in energy intake[15] and alcohol consumption[23], as well as significant improvements in food enjoyment, self-efficacy[15] and nutritional status[19]. Another component used as an incentive was the provision of individualised advice to participants. This strategy has been used to improve health outcomes in nutritional education programmes[33], highlighting the power of personalisation as a teaching tool. In the study by Peters and colleagues[20], behavioural sessions were developed with individual goals and action plans. In the study by Kitaoka and colleagues[21], participants received individualised feedback, reinforcement and problem-solving strategies based on information obtained from monitoring their diet. Finally, in the study by Wunderlich and colleagues[23], participants were encouraged to call the dietitian for individual counselling. Despite the different ways in which individualised counselling was implemented[20,21,23], those interventions that provided personalised or tailored counselling were successful in changing participants' dietary behaviour and improving their adherence to healthy dietary patterns; and in some cases, these changes were translated into significant improvements in biochemical and physiological parameters[21]. In this sense, personalised advice could be an interesting educational tool in culinary interventions

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

and should therefore be considered in the design of future CM programmes.

The evaluation of the culinary training revealed a great variability in the frequency of classes taught during the interventions. For example, while Diallo and colleagues[14] included one weekly cooking session over 8 weeks, Wunderlich and colleagues[23] included four sessions per year. Interestingly, a review published by Owusu-Addo and colleagues[27] found an association between the number of sessions and improved intervention fidelity and programme impact on older adults[27]. In line with this, the follow-up by Peters and colleagues[20] found significant changes in the first four months of the intervention when the sessions' frequency was higher (one session per week) compared to the following months of the study (one or two sessions per month). However, only nine studies identified in our review[14,15,17,21–25,29] provided full details of the number, frequency and hours of classes offered. More information on culinary curricula is needed to adequately assess the effectiveness of CM interventions.

The CM programmes were more successful in achieving dietary and health outcomes than psychosocial outcomes. This could be explained by the findings previously demonstrated by Farmer and colleagues[34] that, although cooking interventions have a positive impact on psychosocial outcomes, the evidence is limited and scarce, partly due to the use of non-validated research instruments[34]. Furthermore, psychosocial outcomes were mostly related to dietary and health issues, such as dietary behaviour or perceived stress of participants, and only one[25] of the studies analysing psychosocial outcomes assessed culinary knowledge or behaviour related to cooking. In this context, there is a great opportunity to improve the methods used to assess psychosocial outcomes and support the need to develop a larger study that analyses the impact of a culinary intervention developed by a chef with a well-defined frequency of cooking classes on psychosocial outcomes. Although improving dietary habits should be one of the main objectives of culinary and nutritional interventions[35], only half of the studies analysed recorded dietary outcomes, which were then translated into small dietary changes. In this sense, Garcia and colleagues[36] showed that cooking interventions led to little change in fruit and vegetable consumption and had low effectiveness in modifying dietary behaviour[36]. On the other hand, health-related outcomes included changes in a wide range of parameters, including anthropometric measurements, physical activity and clinical outcomes. Although positive results were obtained, the changes achieved were small. In fact, none of the CM programmes achieved a significant improvement in physical activity, although this was the main outcome in two lifestyle interventions[18,22]. Culinary interventions remained successful in improving healthy dietary intake[35] and health-related outcomes[11], but one of the key points for achieving the greatest changes in dietary intake and health-related outcomes probably depends on improving the design of CM programmes. Furthermore, in the context of healthy ageing, the scientific literature has recently highlighted the need to assess the ageing process and how healthy ageing interventions modify the ageing process[37]. In particular, the measurement of biomarkers of ageing has been suggested as a promising strategy for evaluating healthy ageing interventions[37].

Limitations

Two major limitations of the present review should be mentioned. First, potential CM studies published before the last 11 years were not included in this review, although the concept of CM is new and we believe that the likelihood of excluding a relevant study is low. Second, we excluded seventy-four published studies where the participant profile was outside the scope of the review. Although the excluded studies described some positive effects on dietary, health or psychosocial outcomes[38–51], the participant profiles of these seventy-four studies included twenty-three trials with adult participants aged less than 40 years, six trials with children or adolescents, seven trials with parents or families, eight trials with health professionals, twenty-three trials with medical or health students, one trial with both doctors and patients, and six trials in which the age of participants was not well defined.

Conclusions

Our review has shown that CM intervention programmes can be a powerful tool to promote healthy ageing in the adult population. The duration of the intervention and the study design emerged as key determinants influencing the effectiveness of the interventions. Furthermore, other factors such as the inclusion of culinary outcomes, the optimisation of the culinary curriculum, the participation of a chef and adding several educational components (cooking classes, hands-on cooking, individual counselling, among others) could contribute to better health outcomes in ageing individuals. By considering these factors, CM programmes have the potential to significantly enhance the wellbeing and health status of ageing individuals, fostering a healthier and more vibrant ageing process.

Acknowledgements

We acknowledge the Basque Government for its support of the project and for providing Jara Domper with 'Ayudas de formación a personal investigador y tecnólogo en el entorno científico-tecnológico y empresarial del sector agropesquero y alimentario vasco'.

Conflict of interest

None.

Authorship

J.D. participated in the conception and design of the study, performed the critical review of the current literature and the assessment and wrote the first draft of the manuscript. M.R.C. and

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

U.E. developed the concept and design of this study and supervised the analysis of the results and the writing of the manuscript, Lu.G., Le.G. and V.D. contributed to the critical analysis of the results and to the writing of the manuscript. All included authors were involved in the review and subsequent approval of the final version of the manuscript.

References

1. World Health Organization (2015) *World Report on Ageing and Health*. Geneve: WHO.
2. Kisling LA & Das JM (2021) *Prevention Strategies*. In: StatPearls Publishing [Internet]. Treasure Island, FL: StatPearls Publishing.
3. Shlisky J, Bloom DE, Beaudreault AR, *et al.* (2017) Nutritional considerations for healthy aging and reduction in age-related chronic disease. *Adv Nutr* **8**, 17–26.
4. Román, GC, Jackson RE, Gadhi R, *et al.* (2019) Mediterranean diet: the role of long-chain ω-3 fatty acids in fish; polyphenols in fruits, vegetables, cereals, coffee, tea, cacao and wine; probiotics and vitamins in prevention of stroke, age-related cognitive decline, and Alzheimer disease. *Rev Neurol (Paris)* **175**, Suppl. 10, 724–41.
5. Rajaram S, Jones J & Lee GJ (2019) Plant-based dietary patterns, plant foods, and age-related cognitive decline. *Adv Nutr* **10**, 422–436.
6. Dominguez LJ, Di Bella G, Veronese N, *et al.* (2021) Impact of mediterranean diet on chronic non-communicable diseases and longevity. *Nutrients* **13**, Suppl. 6, 2028.
7. Mills S, White M, Brown H, *et al.* (2017) Health and social determinants and outcomes of home cooking: a systematic review of observational studies. *Appetite* **111**, 116–134.
8. Asher RC, Shrewsbury VA, Bucher T, *et al.* (2021) Culinary medicine and culinary nutrition education for individuals with the capacity to influence health related behaviour change: a scoping review. *J Hum Nutr Diet* **35**, Suppl. 2, 388–395.
9. La Puma J (2016) What is culinary medicine and what does it do? *Popul Health Manag* **19**, Suppl. 1, 1–3.
10. Mauriello LM & Artz K (2019) Culinary medicine: bringing healthcare into the kitchen. *Am J Health Promot* **33**, Suppl. 5, 825–829.
11. Reicks M, Kocher M & Reeder J (2018) Impact of cooking and home food preparation interventions among adults: a systematic review (2011–2016). *J Nutr Educ Behav* **50**, Suppl. 2, 148–172.
12. Teggart K, Ganann R, Sihota D, *et al.* (2022) Systematic review group-based nutrition interventions to promote healthy eating and mobility in community-dwelling older adults: a systematic review. *Public Health Nutr* **25**, Suppl. 10, 2920–2951.
13. Diallo AF, Falls K, Hicks K, *et al.* (2020) The healthy meal program: a food insecurity screening and referral program for urban dwelling older adults. *Public Health Nurs* **37**, Suppl. 5, 671–676.
14. Schneeberger D, Golubíc M, Moore HCF, *et al.* (2019) Lifestyle medicine-focused shared medical appointments to improve risk factors for chronic diseases and quality of life in breast cancer survivors. *J Altern Complement Med* **25**, Suppl. 1, 40–47.
15. Power JEMH, Lee O, Aspell N, *et al.* (2016) RelAte: pilot study of the effects of a mealtime intervention on social cognitive factors and energy intake among older adults living alone. *Br J Nutr* **116**, Suppl. 9, 1573–1581.
16. Delichatsios HK, Hauser ME, Burgess JD, *et al.* (2015) Shared medical appointments: a portal for nutrition and culinary education in primary care—a pilot feasibility project. *Glob Adv Health Med* **4**, Suppl. 6, 22–26.
17. Kwon J, Yoshida Y, Yoshida H, *et al.* (2015) Effects of a combined physical training and nutrition intervention on physical performance and health-related quality of life in prefrail older women living in the community: a randomized controlled trial. *J Am Med Dir Assoc* **16**, Suppl. 3, 263.
18. Villarini M, Lanari C, Barchiesi L, *et al.* (2015) Effects of the "PreveDi" lifestyle modification trial on metabolic syndrome. *Ann Ig* **27**, Suppl. 3, 595–606.
19. Chung LMY & Chung JWY (2014) Effectiveness of a food education program in improving appetite and nutritional status of elderly adults living at home. *Asia Pac J Clin Nutr* **23**, Suppl. 2, 315–320.
20. Peters NC, Contento IR, Kronenberg F, *et al.* (2014) Adherence in a 1-year whole foods eating pattern intervention with healthy postmenopausal women. *Public Health Nutr* **17**, Suppl. 12, 2806–2815.
21. Kitaoka K, Nagaoka J, Matsuoka T, *et al.* (2013) Dietary intervention with cooking instructions and self-monitoring of the diet in free-living hypertensive men. *Clin Exp Hypertens* **35**, Suppl. 2, 120–127.
22. Penn L, Ryan V & White M (2013) Feasibility, acceptability and outcomes at a 12-month follow-up of a novel community-based intervention to prevent type 2 diabetes in adults at high risk: mixed methods pilot study. *BMJ Open* **3**, Suppl. 11, 1–12.
23. Wunderlich S, Bai Y & Piemonte J (2011) Nutrition risk factors among home delivered and congregate meal participants: need for enhancement of nutrition education and counseling among home delivered meal participants. *J Nutr Health Aging* **15**, Suppl. 9, 768–773.
24. the R, Barnett D, Edlin R, *et al.* (2022) Effectiveness of a complex intervention of group-based nutrition and physical activity to prevent frailty in pre-frail older adults (SUPER): a randomised controlled trial. *Lancet Healthy Longev* **3**, Suppl. 8, 519–530.
25. Moreau M, Plourde H, Hendrickson-Nelson M, *et al.* (2015) Efficacy of nutrition education-based cooking workshops in community-dwelling adults aged 50 years and older. *J Nutr Gerontol Geriatr* **34**, Suppl. 4, 369–387.
26. Murimi MW, Kanyi M, Mupfudze T, *et al.* (2017) Factors influencing efficacy of nutrition education interventions: a systematic review. *J Nutr Educ Behav* **49**, Suppl. 2, 142–165.
27. Owusu-Addo E, Ofori-Asenso R, Batchelor F, *et al.* (2021) Effective implementation approaches for healthy ageing interventions for older people: a rapid review. *Arch Gerontol Geriatr* **92**, 1–9.
28. Bentzen N (2003) *Wonca International Dictionary for General/Family Practice*. Copenhagen: Niels Bentzen.
29. Shahar S, Adznam SNA, Lee LK, *et al.* (2013) A nutrition education intervention for anthropometric and biochemical profiles of rural older Malays with metabolic syndrome. *Public Health Nurs* **30**, Suppl. 2, 140–149.
30. Asher RC, Shrewsbury VA, Bucher T, *et al.* (2022) Culinary medicine and culinary nutrition education for individuals with the capacity to influence health related behaviour change: a scoping review. *J Hum Nutr Diet* **35**, Suppl. 2, 388–395.
31. Alpaugh M, Pope L, Trubek A, *et al.* (2020) Cooking as a health behavior: examining the role of cooking classes in a weight loss intervention. *Nutrients* **12**, 3669.
32. Newman C, Yan J, Messiah SE, *et al.* (2023) Culinary medicine as innovative nutrition education for medical students: a scoping review. *Acad Med* **98**, Suppl. 2, 274–286.
33. De Toro-Martín J, Arsenault BJ, Després J-P, *et al.* (2017) Precision nutrition: a review of personalized nutritional approaches for the prevention and management of metabolic syndrome. *Nutrients* **9**, 913.

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press

34. Farmer N, Touchton-Leonard K & Ross A (2018) Psychosocial benefits of cooking interventions: a systematic review. *Health Educ Behav* **45**, Suppl. 2, 167–180.
35. Hasan B, Thompson WG, Almasri J, *et al.* (2019) The effect of culinary interventions (cooking classes) on dietary intake and behavioral change: a systematic review and evidence map. *BMC Nutr* **5**, Suppl. 29, 1–9.
36. Garcia AL, Reardon R, Mcdonald M, *et al.* (2016) Community interventions to improve cooking skills and their effects on confidence and eating behaviour. *Curr Nutr Rep* **5**, 315–322.
37. Campisi J, Kapahi P, Lithgow GJ, *et al.* (2019) From discoveries in ageing research to therapeutics for healthy ageing. *Nature* **571**, 183–192.
38. Pritlove C, Capone G, Kita H, *et al.* (2020) Cooking for vitality: pilot study of an innovative culinary nutrition intervention for cancer-related fatigue in cancer survivors. *Nutrients* **12**, Suppl. 9, 1–21.
39. Buro AW, Gray HL, Kirby RS, *et al.* (2022) Pilot study of a virtual nutrition intervention for adolescents and young adults with autism spectrum disorder. *J Nutr Educ Behav* **54**, Suppl. 9, 853–862.
40. Kramer RF, Coutinho AJ, Vaeth E, *et al.* (2012) Healthier home food preparation methods and youth and caregiver psychosocial factors are associated with lower BMI in African American youth. *J Nutr* **142**, Suppl. 5, 948–954.
41. Silver JK, Finkelstein A, Minezaki K, *et al.* (2021) The impact of a culinary coaching telemedicine program on home cooking and emotional well-being during the covid-19 pandemic. *Nutrients* **13**, Suppl. 7, 1–11.
42. Sharma S V., McWhorter JW, Chow J, *et al.* (2021) Impact of a virtual culinary medicine curriculum on biometric outcomes, dietary habits, and related psychosocial factors among patients with diabetes participating in a food prescription program. *Nutrients* **13**, Suppl. 1, 1–18.
43. Wallace R, Lo J & Devine A (2016) Tailored nutrition education in the elderly can lead to sustained dietary behaviour change. *J Nutr Health Aging* **20**, Suppl. 1, 8–15.
44. Lavelle F, Hollywood L, Caraher M, *et al.* (2017) Increasing intention to cook from basic ingredients: A randomised controlled study. *Appetite* **116**, 502–510.
45. Eisenberg DM, Righter AC, Matthews B, *et al.* (2019) Feasibility pilot study of a teaching kitchen and self-care curriculum in a workplace setting. *Am J Lifestyle Med* **13**, Suppl. 3, 319–330.
46. Goh LML, Chow LM, Ng SY, *et al.* (2022) Impact of an interactive health corner using the culinary education approach in promoting long-term dietary changes among patients who seek public primary care services. *Int J Environ Res Public Health* **19**, Suppl. 18, 1–14.
47. Horning ML, Hill T, Martin CL, *et al.* (2021) The East Side Table Make-at-Home Meal-Kit Program is feasible and acceptable: a pilot study. *Appetite* **160**, 105087.
48. Jones M, Kimberlee R, Deave T, *et al.* (2013) The role of community centre-based arts, leisure and social activities in promoting adult well-being and healthy lifestyles. *Int J Environ Res Public Health* **10**, Suppl. 5, 1948–1962.
49. Monlezun DJ, Kasprowicz E, Tosh KW, *et al.* (2015) Medical school-based teaching kitchen improves HbA1c, blood pressure, and cholesterol for patients with type 2 diabetes: results from a novel randomized controlled trial. *Diabetes Res Clin Pract* **109**, Suppl. 2, 420–426.
50. Rees J, Fu SC, Lo J, *et al.* (2022) How a 7-week food literacy cooking program affects cooking confidence and mental health: findings of a quasi-experimental controlled intervention trial. *Front Nutr* **9**, 802940.
51. Adam M, Young-Wolff KC, Konar E, *et al.* (2015) Massive open online nutrition and cooking course for improved eating behaviors and meal composition. *Int J Behav Nutr Phys Act* **12**, 143.
52. Teh R, Kerse N, Waters DL, *et al.* (2019) Study protocol a randomised controlled trial to examine the impact of a complex intervention in pre-frail older adults. *Aging Clin Exp Res* **31**, Suppl. 10, 1407–1417.

Nutrition Research Reviews

https://doi.org/10.1017/S0954422423000148 Published online by Cambridge University Press