BMJ Open

Effect of nutrition interventions on diet-related and health outcomes of Aboriginal and Torres Strait Islander Australians: a systematic review

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To cite: Gwynn J, Sim K, Searle T, *et al*. Effect of nutrition interventions on diet-related and health outcomes of Aboriginal and Torres Strait Islander Australians: a systematic review. *BMJ Open* 2019;**9**:e025291. doi:10.1136/bmjopen-2018-025291

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-025291).

Received 11 July 2018
Revised 14 December 2018
Accepted 17 December 2018

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ABSTRACT

Objective To review the literature on nutrition interventions and identify which work to improve diet-related and health outcomes in Australian Aboriginal and Torres Strait Islander people.

Study design Systematic review of peer-reviewed literature.

Data sources MEDLINE, PubMed, Embase, Science Direct, CINAHL, Informit, PsychInfo and Cochrane Library, Australian Indigenous Health InfoNet.

Study selection Peer-reviewed article describing an original study; published in English prior to December 2017; inclusion of one or more of the following outcome measures: nutritional status, food/dietary/nutrient intake, diet-related biomedical markers, anthropometric or health measures; and conducted with Australian Aboriginal and Torres Strait Islander people.

Data extraction and synthesis Two independent reviewers extracted data and applied the Quality Assessment Tool for Quantitative Studies from the Effective Public Health Practice Project. A purpose designed tool assessed community engagement in research, and a framework was applied to interventions to report a score based on numbers of settings and strategies. Heterogeneity of studies precluded a meta-analysis. The effect size of health outcome results were estimated and presented as forest plots.

Results Thirty-five articles (26 studies) met inclusion criteria; two rated moderate in quality; 12 described cohort designs; 18 described interventions in remote/very remote communities; none focused solely on urban communities; and 11 reported moderate or strong community engagement. Six intervention types were identified. Statistically significant improvements were reported in 14 studies of which eight reported improvements in biochemical/haematological markers and either anthropometric and/or diet-related outcomes.

Conclusions Store-based intervention with community health promotion in very remote communities, fiscal strategies and nutrition education and promotion programmes show promise. Future dietary intervention studies must be rigorously evaluated, provide intervention implementation details explore scale up of programmes, include urban communities and consider a multisetting and strategy approach. Strong Aboriginal and Torres Strait Islander community engagement is essential for effective nutrition intervention research and evaluation.

Strengths and limitations of this study

- ► The first systematic review of dietary interventions for Australia's Aboriginal and Torres Strait Islander people.
- ► We provide a visual presentation of, and comparison among, the health outcome results of different studies by presenting these as forest plots.
- ► We developed and applied a novel method of assessing and reporting Aboriginal and Torres Strait Islander community engagement in research.
- ► Few appropriate quality assessment tools are available for assessment of public health interventions such as those reviewed in this paper.
- ► There is a potential for reporting bias where studies have been published in the grey literature or as reports and therefore not included according to our inclusion criteria.

PROSPERO registration number CRD42015029551.

INTRODUCTION

Indigenous people internationally frequently suffer greater early mortality rates and poorer health status when compared with non-Indigenous people.[1] In Australia, the difference in mortality rates is among the highest worldwide, with life expectancy being 10 years younger for Aboriginal and Torres Strait Islander people (Australia's Indigenous people).[1 2] Dietary factors alone contribute to overall disease burden at over three times the rate than non-Indigenous Australians.[1] Diet-related chronic diseases including diabetes and cardiovascular disease are the major contributors to the substantial 'gap' in health.[2] Aboriginal and Torres Strait Islander Australians are three and a half times more likely to suffer from diabetes and experience coronary heart disease (CHD) at younger ages and increased morbidity, with those in the age group of 35–44 years nearly five times

more likely to suffer from CHD than non-Indigenous Australians.[2] These and other significant and intransigent health issues requires more effective strategies, including dietary interventions, in order to reduce the health gap, yet the national 'Closing the Gap' strategy that aims to reduce the disadvantage experienced by Aboriginal and Torres Strait Islander Australians has been largely ineffective over a 10-year period[3] and does not include improved nutrition as a target. There have been calls for greater attention to nutrition and food security for Aboriginal and Torres Strait Islander Australians[4 5]; however, the 2018 Implementation Plan for the National Aboriginal and Torres Strait Islander Health Plan 2013–2023 includes few deliverables on nutrition.[6]

The causes of poor dietary intake among Aboriginal and Torres Strait Islander Australians are complex, have their origins in dispossession, marginalisation and extreme poverty and are compounded by ongoing socioeconomic, environmental and geographic factors.[7] In general, few Australians meet dietary recommendations for healthy foods,[8] and this is more pronounced among Aboriginal and Torres Strait Islander Australians with 41% of energy intake derived from discretionary foods and drinks (those high in saturated fat, added sugar and/or salt), compared with 35% of the energy intake of non-Indigenous Australians.[9] On average, Aboriginal and Torres Strait Islander Australians consume 25% more free sugar per day than non-Indigenous Australians, with more derived from sugary drinks (67% compared with 51%); this difference is more marked among children.[10]

The only systematic review investigating dietary interventions with Aboriginal and Torres Strait Islander Australians limited its focus to assessing the effectiveness of nutrition education programmes on non-communicable diseases[11] and included six studies, not all peer-reviewed. Other previous reviews (n=4) on dietary interventions have been narrative in approach and were not confined to the peer-reviewed literature.[5 12–14] All identified settings-based food supply policies and development of a dedicated Aboriginal and Torres Strait Islander nutrition workforce as effective strategies and most recommended a multistrategic approach to address broader determinants.[12–14]

We undertook a systematic review of the peer-reviewed literature that examined nutrition interventions aiming to improve diet-related and health outcomes in Australia's Aboriginal and Torres Strait Islander people.

METHODS

Study selection process and eligibility criteria

Articles were included in the review if they: described a nutrition intervention strategy and included one or more of the following outcome measures: nutritional status, food/dietary/nutrient intake, diet-related biochemical/haematological markers, anthropometric or health measures; were published in the peer-reviewed scientific literature, prior to/including December 2017 and in the English language; described an original study (not a review, report or study protocol); were conducted with Australian Aboriginal and Torres Strait Islander people; and included quantitative methods. Interventions that solely measured change in knowledge or attitudes, or reported on supplementation with nutrients, were excluded. The search strategy used is detailed in online supplementary table 1.

Electronic databases were searched, as was the Australian Indigenous HealthInfoNet,[15] and reference lists from assessed articles were hand-searched.

Articles were scanned and checked against the inclusion criteria, duplicate citations removed and those that met the inclusion criteria were read and assessed for inclusion, and their reference lists were manually checked for additional articles. Any disagreement about the eligibility of studies was resolved by consensus.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist of items to include when reporting a systematic review was followed, and this review was registered with the PROSPERO register.[16]

Quality assessment

Articles were assessed for their quality using the Quality Assessment Tool for Quantitative Studies from the McMaster University Effective Public Health Practice Project (EPHPP),[17] which includes six quality assessment components (selection bias, study design, confounders, blinding, data collection methods and withdrawals and dropouts). Each article was given a EPHPP Global Quality Assessment rating and rated weak if it scored two or more weak component ratings, moderate if it scored one weak rating or strong if it scored no weak ratings. The Australian National Health and Medical Research Council's evidence hierarchy for intervention research questions was also applied to each article.[18] This evidence hierarchy is widely accepted among the scientific community and includes five levels ranked according to rigour from level 1 (systematic review of level 2 studies) to level 4 (case series with either post-test or pretest/post-test outcomes).

Articles were allocated for review by one of the authors; no reviewer was allocated an article that they had coauthored. For each article, two reviewers independently assessed quality, and any discrepancies in component ratings were resolved through discussion between reviewers and then the expert opinion of the group if required.

Data extraction

General characteristics of the article, the population, outcomes and measures were extracted. We applied the Index of Relative Indigenous Socioeconomic Outcomes to classify socioeconomic disadvantage of the study target population.[19] Each study location was also assigned an Australian Standard Geographical Classification Remoteness Area classification.[20] All reviewers independently checked the extracted data. Discrepancies were resolved by consensus.

The principles of community engagement and governance as well as capacity building have been identified previously as critical to the conduct and outcomes of research with Aboriginal and Torres Strait Islander Australians[21 22] and were assessed in our review. Four key features that capture information about these principles were identified from key literature in this field by JB and JG,[13 21–26] applied to the final studies included in this review and referred to collectively as Community Engagement Intensity (CEI). Each study was assessed as either light (≤1 feature), moderate (2–3 features) or strong (four features). An 'ecological approach' (multisetting and multistrategic addressing several targets including the individual) is necessary when implementing community-based interventions addressing a complex behaviour such as dietary intake[27] is compatible with Aboriginal and Torres Strait Islander people's view of health and increasingly used in research and health policy work.[21 28 29] Each study was given an Ecological Approach Score[29] (EAS) to enhance understanding of the scope and impact of the interventions; a score of 4 representing at least two strategy types and ≥3 settings; lesser scores reflect fewer strategy types and settings.

Health outcomes

We quantitatively compared the results of health outcomes that were reported in four or more studies, these were: body mass index (BMI), blood glucose and triglycerides (TGs), total cholesterol (TC) and ratio of total to high-density lipoprotein cholesterol (TC:HDL-C). For outcomes of interest, we extracted the mean estimate before and after the intervention and associated SD and sample sizes. We calculated total TC:HDL-C ratios from reported mean values, with the SD for the ratio found by propagation assuming a weakly positive correlation (0.15) between HDL and TC at the individual level, as has been shown in the literature.[30]

For visual presentation of, and comparison among, the results of different studies, we estimated an effect size that corresponds to the change in the population mean biomarker following intervention. This was calculated as mean after intervention minus the mean at baseline; negative values correspond to the biomarker being lower after intervention. Many systematic reviews calculate effect sizes using a standardised mean difference such as Cohen's *d*; however, where data are reported in common and comparable units, as is the case here, it is preferable that differences are estimated on the raw scale, as they are easier to interpret.[31] We calculated the 95% CIs for each change as 1.96×SE of the difference. SEs of differences were found by propagation of error assuming a strong intraclass correlation (0.8), which is a strong correlation between repeated measures from the same individuals.[32 33]

Where studies reported data from multiple time points postintervention, we used data from the most recent time point recorded (ie, the longest follow-up period) to maximise inference about the long-term impacts of the intervention (follow-up periods are noted throughout). Where studies reported their results in a stratified way (eg, by age and/or gender), we estimated the overall mean, as the average of stratified means weighted by the sample size in each subgroup.

Patient and public involvement

This paper was reviewed by the Aboriginal Health and Medical Research Council of New South Wales [AHMRC NSW]) prior to publication. The AHMRC NSW is the peak body representing Aboriginal and Torres Strait Islander Community Controlled Health Organisations in the state of New South Wales. No patients were directly involved in the development and conduct of the review.

RESULTS

Study selection and characteristics

The initial search yielded 1101 records, duplicates were removed and 50 eligible articles remained of which 35 met the inclusion/exclusion criteria for this review. The first article was published in 1980[34] and the latest in 2017.[35] Figure 1 outlines the flow of included articles, table 1 summarises study characteristics and figure 2 presents health outcomes as forest plots. Online supplementary table 2 provides full details for each article.

The final 35 articles were derived from 26 studies and grouped according to their study of origin.

Quality assessment

Two[36 37] of the 26 studies in this review were assessed as moderate with the rest assessed as weak (online supplementary table 3). Six studies[38–43] included articles describing additional impact evaluations that were either 'nested'[44–49] or 'extensions'[50 51] of the original study, and two[44 50] of these were assessed as moderate.

EPHPP component ratings were largely strong for data collection and moderate for study design, however were weak for confounders and blinding and moderate to weak for selection bias. When studies (and articles that were 'nested' or 'extensions') were classified according to the NHRMC levels of evidence table for intervention research,[18] 11 were classified as level IV evidence, 21 as III-3, three as III-2 [34 38 46] and one as III-1.[36]

Nutrition intervention types

Six types of dietary intervention studies were identified: nutrition education and promotion programmes primarily aiming to improve nutrition and including a 'healthy lifestyle' programme component (n=8 studies); store-based intervention with community health promotion (n=5 studies); return to traditional diet (n=3 studies); fruit and vegetable subsidy (n=2 studies); store environment and/or policy (n=7 studies) that included store/organisation/government policy, food price discounts and the effect of store manager on diet; and preschool meal programme (n=1 study).

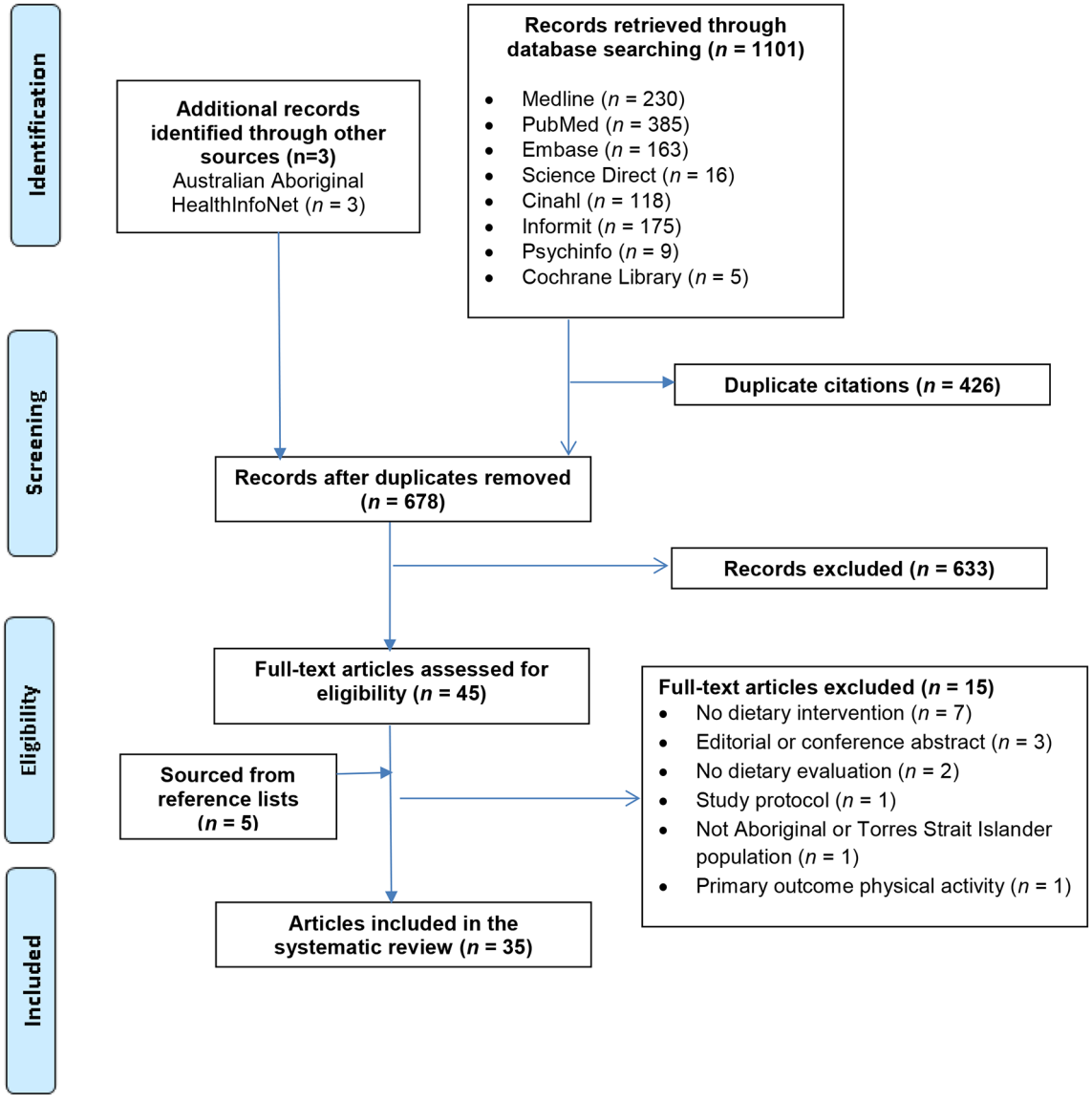

Figure 1 PRISMA flow chart of included and excluded articles. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Study locations

The majority of the studies (n=18) included Aboriginal and Torres Strait Islander communities from areas classified as 'very remote'.[20] Four studies included communities from areas classified as only 'inner' and/or' outer regional'. Only four studies[34 35 52 53] included participants from a major city and these studies also included other geographical locations.

Study design

This review includes 12 cohort studies, 1 cohort[39] with a 'nested' repeat cross-sectional study,[44] 2 repeat cross-sectional,[40 54] 2 interrupted time series,[55 56] four case series[53 57–59] and one each of retrospective pre–post study,[60] multisite case study,[61] non-randomised controlled study,[37] stepped-wedge randomised controlled trial[36] and an interrupted time series with a control group[38] and a 'nested' cohort.[45]

Health outcomes

Due to the relatively small number, and heterogeneity, of the studies, no meta-analysis was performed. There were insufficient common effect sizes to warrant aggregating the results. Outcomes reported in different articles arising from the one study were largely independent, other than in the Lee *et al*[38] study group (red blood cell folate at 12 months)[45] and the O'Dea and Sinclair[42] and O'Dea[43] study groups (changes in weight,[43] lipids ([42 43 47–49]] and diabetes markers[47]) where for completeness, we reported all results.

Outcome measures

Outcome measures of nutrition and health included the following categories: biochemical and/or haematological markers of dietary intake and/or health status (n=12 studies); food, diet and/or nutrient intake measures (24 hours recall, survey and store-turnover/point-of-sale

Table 1 Included intervention studies (n=26) summarised and described by: design, quality assessment rating, ecological approach, community engagement, intervention strategies, diet-related study outcomes, timeframe and geographical area. Refer to online supplementary table S2 for a full description of the interventions and study details. *Where a study has multiple manuscripts, these are cited according to outcomes reported; where differences in study design exist both are reported, where quality assessment rating differs, the higher rating is provided as this based on the most comprehensive methodology description in the literature.*

			Intervention strategies, ecological approach score and community engagement intensity			Diet-related study outcomes √=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. OR=OR ratio (shaded area not listed as an outcome).					
				Intervention strategies							
Study (other related articles)	**Study design**	**EPHPP Global Quality Assessment Rating[17]**	**EAS[29] (CEI)**	**Nutritional**	**Other**	**Anthropometry**	**Biochemical and /or haematological markers**	**Food/diet /nutrient Intake (outcome measure)**	**Other**	**Timeframe (intervention/ evaluation)**	**ASGC area[20]**
A. Nutrition education and promotion programmes (n=7 studies)											
Chan *et al*[52]	Cohort	Weak	2 (light)	Community lifestyle intervention programme aimed at improving diabetes and cardiovascular risk factors.	Included self-monitoring of fasting plasma glucose (those with T2DM) and PA strategy.	√ ↓ WC X_{nt} ↓ BMI	√ ↓ Lipids including HDL-C (Δ=−0.9 mmol/L [−0.05 to −0.13]). √ ↑ HbA1c (Δ=0.31% [0.18 to 0.44]).		√ ↓ BP	2 years/first 6 months only.	Inner regional, major city.
Egger *et al*[62]	Cohort	Weak	2 (moderate)	Group-based education sessions adapted for the community encouraging ↓ fat intake, ↑ dietary fibre and changing 'obesogenic' habits.	Health education and PA strategy.	√ ↓ Weight, WC, WHR, BMI and body fat.				5 weeks/1 year (at 2, 6 and 12 months).	Very remote.
Gracey *et al*[63]	Cohort	Weak	4 (strong)	Carer promotion of healthier living, including diet to minimise developing risk factors for obesity and diabetes. Group and individual level intervention.	Community awareness of NCDs, early detection/ treatment, compliance campaign and PA strategy.	X_{nt} ↓ weight for 49% of participants. X_{nt} ↓ BMI for 61% of participants.	X_{nt} ↓ HbA1c. X_{nt} ↓ TC (Δ=−0.134 mmol/L). X_{nt} ↑ HDL-C (Δ=0.09 mmol/L). X_{nt} ↓ LDL-C (Δ=−0.38 mmol/L).			Not specified (a few months–3 years)/ one community at 3 months; others not reported.	Very remote.
Longstreet *et al*[64]	Cohort	Weak	2 (light)	Dietary advice based on the Australian Guide to Healthy Eating modified as appropriate for identified comorbidities. Unclear whether individual or group intervention.	PA strategy.	X_{nt} ↓ weight.		√ ↓ Fats, energy, CHO, TC, Mg, P (24 hours recall). √ Differences in nutrient intake compared with national survey.		1 year/1 year.	Outer regional.
Pettigrew *et al*[53]	Case series	Weak	0 (light)	A single or multisession course (group) to improve knowledge and motivation relating to improving healthy food intake and food expenditure according to the healthy diet pyramid; included budgeting and cooking skills.	No.			√ ↑ f&v (self-report survey).		Single (1–2 hours) or multiple (≤8) sessions/ on completion of the intervention.	Inner and outer regional, major city.
Quinn *et al*[35]	Cohort	Weak	0 (light)	A free telephone-based service, 'enhanced' for Indigenous clients, supporting NSW adults to make sustained improvements in healthy eating. Available as a 3-month or a 6-month programme.	The telephone service also supports reducing alcohol intake and achieving or maintaining a healthy weight.	√ ↓ Between baseline and 3 months and baseline and 6 months in: weight, BMI and WC.		Between baseline and 3 months and baseline and 6 months: √ ↑ In daily serves of f&v. √ ↓ Daily serves of sweetened drinks and weekly serves of takeaway meals (self-report: mode not stated).		3 months or 6 months/3 months or 6 months.	Remote, inner and outer regional, major city.

Continued

Table 1 Continued

Study (other related articles)	Study design	EPHPP Global Quality Assessment Rating[17]	Intervention strategies, ecological approach score and community engagement intensity: EAS[29] (CEI)	Intervention strategies: Nutritional	Intervention strategies: Other	Diet-related study outcomes √=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. OR=OR ratio (shaded area not listed as an outcome): Anthropometry	Biochemical and /or haematological markers	Food/diet /nutrient Intake (outcome measure)	Other	Timeframe (intervention/ evaluation)	ASGC area[20]
Rowley *et al*[65]	Cohort	Weak	3 (strong)	Extensive health promotion messaging about diet, exercise and diabetes within clinical practice (individual education) and across a variety of community groups including family and local council. Widespread dissemination of messages by community members. Initiated by community.	PA strategy.	√ ↑ BMI, weight. √ BMI close to store >BMI far from store.	√ ↓ Lipids across age groups and gender including: HDL-C (Δ from 0.89 mmol/L to 0.83 mmol/L); LDL-C (Δ from 3.4 mmol/L to 3.3 mmol/L); HC prevalence (F) X_{ns} HC prevalence (M).		X_{ns} (no change) diabetes prevalence.	7 years/ 7 years.	Very remote.
B. Store-based intervention with concurrent community health promotion (n=5 studies)											
Brimblecombe *et al*[61]	Multisite case study	Moderate	4 (moderate)	Multisector intervention aimed at improving food security. Community level intervention.	No			X_{nt}: ↓ confectionary sales; ↑ water sales (store sales data).		5 years/5 years.	Very remote.
Lee *et al*[38 45] and Rowley *et al*[44]	Interrupted time series (Rowley *et al*[43]=cohort*)	Weak (Rowley *et al*[43]= moderate*)	3 (strong)	Provision and promotion of a wide variety of nutritious foods in the store and stickers (shelf-talkers) identifying 'key' foods.	PA strategy.	Slight increase in BMI however √ ↓ BMI when controlled for between subject differences (Lee *et al*[38] at 1 year) √ correlation between BMI and ↓ energy intake (Lee *et al*[38] at 1 year).	√ ↑ RBC folate, serum vitamin B6, serum vitamin C, √ ↓ lipids (not TG), √ ↓ 2-hour plasma glucose (F) (Lee *et al*[38] at 1 year). √ ↑ RBC folate (6 and 12 months). √ ↓ HCY (6 months). X_{ns} HCY (Rowley *et al*[44]).	X_{nt}: ↓ Saturated fat, sugar (↓ at 1 year then ↑ at 2 years), ↑ dietary fibre (store turnover) (Lee *et al*[38] at 1 year). X_{nt}: ↑ Fruit, vegetables, wholegrain bread, folate, vitamin C and thiamine (store turnover) (Lee *et al*[45] at 3 years).	√ ↓ BP √ correlation between store-turnover and related haematological markers of vitamins and minerals (Lee *et al*[38] at 1 year).	1 year/four × 3-month intervals during intervention; and 3 years.	Very remote.
McDonald [54]	Cross-sectional	Weak	3 (light)	Display of large healthy diet pyramid in the store wall, corresponding coloured labels on food items, a new store manager, policies that improved fresh fruit and vegetable supply at a price discount and the sale of 'health food packs'.	School-based health education programme.			X_{nt} (at 1 year) ↓ saturated fat, sugar; ↑ dietary fibre (household survey).		3 months/4 months.	Very remote.
Rowley *et al*[39] (Rowley *et al*[43]).	Cohort and cross-sectional (Rowley *et al*[43]=cross-sectional).	Weak	4 (strong)	Cooking classes and store tours, community member appointed by council as the store manager to improve the quality of the available food supply and increase fruit and vegetable consumption and informal education sessions about diabetes; weekly body weight and blood glucose checks were available.	Health education and PA strategy.	*High-risk cohort* at 6 months: √ ↓ BMI (Rowley *et al*[39]). *Community level* at 4 years: √ ↑ BMI 15–34 year olds at 4 years; X_{nt} no change in prevalence of obesity (Rowley *et al*[39]).	*High-risk cohort:* √ ↓ fasting plasma glucose at 6 month and fasting insulin concentrations at 18 months (>35 years old) with both returning to baseline at 24 months; TG and 2-hour fasting glucose at 24 months (Rowley *et al*[39]). *Community level at 4 years:* X_{ns} ↑ TG, plasma glucose. √ ↓ Fasting insulin (>35 years) (Rowley *et al*[39]). √ ↑ Nutritional markers of improved f&v intake. √ ↓ HC (prevalence), HCY X_{ns} retinol, lycopene (Rowley *et al*[43]).	*Community level at 4 years:* X_{nt} ↓ saturated fat and sugar; ↑ dietary fibre (self-report survey) (Rowley *et al*[39]).	*Community level at 4 years:* X_{ns} no change in diabetes prevalence (Rowley *et al*[39]).	4 years/6, 18 and 24 years (individual level [high-risk cohort]; 4 years [community level]).	Very remote.

Continued

Table 1 Continued

Study (other related articles)	Study design	EPHPP Global Quality Assessment Rating[17]	Intervention strategies, ecological approach score and community engagement intensity: EAS[29] (CEI)	Intervention strategies: Nutritional	Intervention strategies: Other	Diet-related study outcomes (√=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. OR=OR ratio (shaded area not listed as an outcome).): Anthropometry	Biochemical and /or haematological markers	Food/diet /nutrient Intake (outcome measure)	Other	Timeframe (intervention/ evaluation)	ASGC area[20]
Scrimgeour *et al*[40] (McDermott *et al*[50])	Cross-sectional	Weak (McDermott *et al*[50]=moderate)	3 (moderate)	Community store intervention and community-level nutrition programme promoting healthy food-buying habits and improving the quality of food purchased by the community store. Store managers improved the options for purchasing healthy foods and offered a range of alternative fast foods, a canteen supplying only healthy food was established at the school and nutrition education was provided in the school curriculum and at family-based workshops.	No.	↑ 'Obesity' (OR: 1.84). √↑ BMI and WC (F) (McDermott *et al*[50] at 8 years).	↑ Dyslipidaemia (OR: 4.54). ↓ HC (OR: 0.29) (McDermott *et al*[50] at 8 years). √↓ TC including HDL-C across age and gender (McDermott *et al*[50] at 8 years). √↑ TGs (McDermott *et al*[50] at 8 years).	Age ≥15 years: X_{nt} ↓ saturated fat and sugar; ↑ dietary fibre (store turnover) (McDermott *et al*[50] at 8 years). Age ≤15 years: X_{nt} ↓ pies, fried foods and sugary drinks; ↑ large bottles, fruit juice, diet drinks, f&v, sandwiches, 'healthy snacks' (store sales data) (Scirmgeour *et al*[40] at 2 years).	↑ T2DM (OR: 1.83). ↑ Diabetes prevalence 4–5 fold (F only) (McDermott *et al*[50] at 8 years).	2 years/2 years, and 8 years.	Very remote.
C. Return to traditional life (n=3 studies)											
O'Dea *et al*[66]	Cohort	Weak	2 (light)	Return to 'western' diet 3 months following 3 months of a traditional diet.	↑PA commensurate with return to traditional way of life.	X_{nt} ↓ Weight.	√↑ TGs X_{nt} (no change) TC, diabetes markers. Insulin-to-glucose ratios in response to oral starch load were greater among urban Aboriginal people than either traditional Aboriginal people or Caucasians.			3 months/3 months.	Very remote.
O'Dea and Sinclair[42] (O'Dea and Spargo[46])	Cohort	Weak	2 (light)	Return to traditional diet from a predominately 'western' diet of a small regional town.	↑PA commensurate with return to traditional way of life.	X_{nt} ↓ weight (O'Dea and Spargo[46] at 2 weeks.).	√↓ TGs, ω6 fatty acids. √↑ AA, ω3 PUFAs. X_{ns} ↓ TC (O'Dea and Sinclair[42] at 2 weeks). √↓ Lipids, diabetes markers. √↑ Glucose tolerance (O'Dea and Spargo[46] at 2 weeks).			2 weeks/2 weeks.	Very remote.
O'Dea[47]; (O'Dea and Sinclair[48]; O'Dea *et al*[49]	Cohort	Weak	2 (light)	Return to traditional diet from a predominately 'western' diet of a small regional town.	↑PA commensurate with return to traditional way of life.	X_{nt} ↓ weight (O'Dea[47] at 7 weeks).	√↓ Lipids, plasma glucose, diabetes markers (D only). √↑ Glucose tolerance (D and ND) (O'Dea[47] at 7 weeks). X_{nt} ↑ AA. X_{nt} ↓ lipids, LA (O'Dea and Sinclair[48] at 2 and 5 weeks). √↑ Folic acid. √↓ Vitamin A. X_{ns} ↑ Vitamin B12. (O'Dea *et al*[49] at 7 weeks).		√↑ Bleeding time (O'Dea and Sinclair[61] at 2 and 5 weeks). √↑ Hair zinc (O'Dea *et al*[59] at 7 weeks).	7 weeks/7 weeks (O'Dea[47]; O'Dea *et al*[49]; 5 weeks/2 and 5 weeks (O'Dea and Sinclair[48]).	Very remote.
D. Fruit and vegetable subsidy (n=2 studies)											

Continued

Table 1 Continued

Study (other related articles)	Study design	EPHPP Global Quality Assessment Rating[17]	Intervention strategies, ecological approach score and community engagement intensity: EAS[29] (CEI)	Intervention strategies: Nutritional	Intervention strategies: Other	Diet-related study outcomes (√=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. OR=OR ratio (shaded area not listed as an outcome).): Anthropometry	Biochemical and /or haematological markers	Food/diet /nutrient Intake (outcome measure)	Other	Timeframe (intervention/ evaluation)	ASGC area[20]
Black *et al*[67] (Black *et al*[68])	Cohort	Weak	2 (strong)	Fruit and vegetable subsidy programme with nutrition promotion across three communities. Aimed to improve children's health.	No.	X_{ns} (no change) in proportion of children overweight or obese (Black *et al*[68]).	√ ↑ Nutritional markers of f&v intake (Black *et al*[67]). √ ↑ Hb (Black *et al*[68]).	√ ↑ Fruit and sugar. √ ↓ Vegetables (24 hours recall) (Black *et al*[67]).	X_{ns} (no change) iron deficiency, anaemia (Black *et al*[67] 2013a) √ ↓ Mean annual numbers of illness related visits to health service or hospital and oral antibiotic prescriptions. X_{ns} ↓ Pyoderma (Black *et al*[68]).	1 year/ 1 year.	Inner and outer regional.
Jones and Smith[41] (Jones and Smith[51]).	Cohort	Weak	2 (light)	Provision of fresh fruit. Fruit and vegetable subsidy programme with a dietitian run cooking programme. Aimed to improve children's health.	No		X_{nt} ↑ (community 1) vitamin C (Jones and Smith[51] at 3 years).		X_{ns} ↑ hearing; ↓ antibiotic prescription (Jones and Smith[41] at 6 months). X_{ns} community 1: ↑ hearing; community 2: ↑ normal eardrums, ↓ skin infections (Jones and Smith[51] at 3 years).	6 months and 3 years/6 and 7 months and 3 years.	Inner and outer regional.
E. Store environment and/or policy (n=8 studies)											
Brimblecombe *et al*[55]	Interrupted time series	Weak	0 (light)	Commonwealth government implemented income management programme and 'stimulus payment'.	No			√ Soft drink sales (↓ 4–6 months then ↑). X_{nt} (no change) in f&v sales (store sales data).		18 months/3 years (including 18 months prior to the intervention).	Remote and very remote.
Brimblecombe *et al*[36]	Stepped-wedge randomised controlled trail	Weak	2 (moderate)	A 20% store-based discount on all fresh and frozen fruit and vegetables (not frozen potato products), bottled water and artificially sweetened soft drinks. Discount promoted in store.				√ ↑ 12.7% in purchases of f&v with price discount alone (grams; effect of 12 g per capita/day). X_{ns} increase of 7.6% when consumer education added (greatest for vege @ 13.6%). √ ↑ 19.8% in purchases of f&v postdiscount grams; effect of 18 g per capita/ day). X_{ns} decrease of −1% when consumer education added (though increased for vegetable @ 9.1%). √ ↑: 10.8% for healthy food purchases (postdiscount); 13.4% for less health food purchases (postpurchases); 17.6% in purchases of bottled water with price discount alone; ↑ sodium during (8.3%) and after (13.8%) discount; total energy during (6.7%) and after (13.8%) discount. Xns: ↑ diet and regular soft drinks (store sales data).		24 weeks/131 weeks.	Very remote.
Butler *et al*[56]	Interrupted time series	Weak	0 (moderate)	Community-developed store nutrition policy.	No			X_{nt} ↓ sugar, energy (store sales data).	X_{ns} ↓ sugar and kilojoules consumed when three top selling sugary drink items were withdrawn from sale.	1 year/2 years	Very remote.

Continued

Table 1 Continued

Study (other related articles)	Study design	EPHPP Global Quality Assessment Rating[17]	Intervention strategies, ecological approach score and community engagement intensity: EAS[29] (CEI)	Intervention strategies: Nutritional	Intervention strategies: Other	Diet-related study outcomes √=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. OR=OR ratio (shaded area not listed as an outcome): Anthropometry	Biochemical and /or haematological markers	Food/diet /nutrient Intake (outcome measure)	Other	Timeframe (intervention/ evaluation)	ASGC area[20]
Fergusson *et al*[60]	Retrospective pre post (quantitative component of a mixed methods study).	Weak	0 (light)	Food price discount (10%) applied to grocery items, fruit, vegetables and diet soft drinks.	No				No discernible effect was evident on the store sales of key food groups.	≤6 months/1 year.	Remote and very remote.
Lee *et al*[57]	Case series	Weak	0 (light)	Store manager and their influence on store healthy food availability and promotion.	No				√ Store manager influence on nutrient density>effect than community (store turnover).	16, 27 and 35 months/16, 27 and 35 months.	Very remote.
Lee *et al*[58]	Case series	Weak	3 (strong)	ALPA nutrition policy to increase the variety of healthy foods in community stores by providing healthier choices, employing 'good food people' in the store and subsidising fresh fruit and vegetable.	No				X_{ns} 'improvements' in the number of stores compliant with the policy. Description: compliance with the policy varied; promotion/education strategies not widely implemented. X_{ns} dietary improvements greater in compliant stores.	1 year/3 years.	Very remote.
McMahon *et al*[37]	Non-randomised controlled	Moderate	0 (light)	Stores receipt of 25% reduced salt bread (the brand being one of the top-selling brands in remote Indigenous communities) in 21 stores managed by OBS and 5 by ALPA.	No			X_{ns} difference in sales (percentage market share nor weekly average dollars) between control and intervention groups in the change from baseline to follow-up (store sales data).		18 weeks/1 year.	Remote and very remote.
Reilly *et al*[59]	Case series	Weak	4 (moderate)	Improving quality of foods provided through sports organisation.	Health education, women's meetings, health promotion educator workshops and PA strategy.			X_{nt} ↑ f&v, fresh meat, eggs, vitamin A, vitamin C and folate. X_{nt} ↓ discretionary foods (store turnover).		Two 6-month interventions over 2 years/1 year.	Inner and outer regional.
F. Preschool programme (n=1 study)											
Coyne *et al*[34]	Cohort	Weak	0 (light)	Preschool meal programme and multivitamin supplements (compared with control group of children who did not attend preschool).	No	√ ↑ Weight (F). √ ↑ Height (F).	√ ↑ Serum iron. √ ↓ Serum ferritin, Hb, HCT and vitamin C; √ negative correlation between gains in weight/ height and serum levels ferritin, Hb and vitamin C.			38 weeks/38 weeks.	Remote, inner and outer regional, major city.

√ =√=statistically significant. X_{ns}=not significant. X_{nt}=no test for difference applied. ↓=value decreased. ↑=value increased. ω3=omega 3; ω6=omega 6.
Diabetes markers=HbA1c, oral glucose or glucose, insulin.
*Nested evaluation; methods reported differently to original study.
†Extension of original study evaluation; methods reported differently to original study.
‡Two cross-sectional studies measuring before and after intervention potentially with some (number not specified) overlap in participants (stores sales indicative of community intake).
AA, arachidonic acid; ALPA, Arnhem Land Progress Association; ASGC, Australian Standard Geographical Classification; BMI, body mass index; BP, blood pressure; CEI, Community Engagement Intensity (light [≤1 feature], moderate [2–3 features] or strong [4 features]); CHO, carbohydrate; D, diabetic; EAS, Ecological Approach Score (4 represents an intervention with at least two strategy types [one of which is aimed directly at the individual] and ≥3 settings; lesser scores reflect the targeting of fewer strategy types and settings); EPHPP, Effective Public Health Practice Project; F, females; f&v, fruit and vegetables; Hb=haemoglobin; HbA1c, glycated haemoglobin; HC, hypercholesterolaemia; HCT, haematocrit; HCY, homocysteine; HDL-C, high-density lipoprotein cholesterol; LA, linoleic acid; Mg, magnesium; M, males; NCDs, non-communicable diseases; ND, non-diabetic; NSW, New South Wales; OBS, outback stores; P, phosphorus; PA, physical activity; PUFA, polyunsaturated fatty acid; RBC, red blood count; T2DM, type 2 diabetes mellitus; TC , total cholesterol; TG, triglyceride; Vege, vegetables; WC, waist circumference; WHR, waist-to-hip ratio.

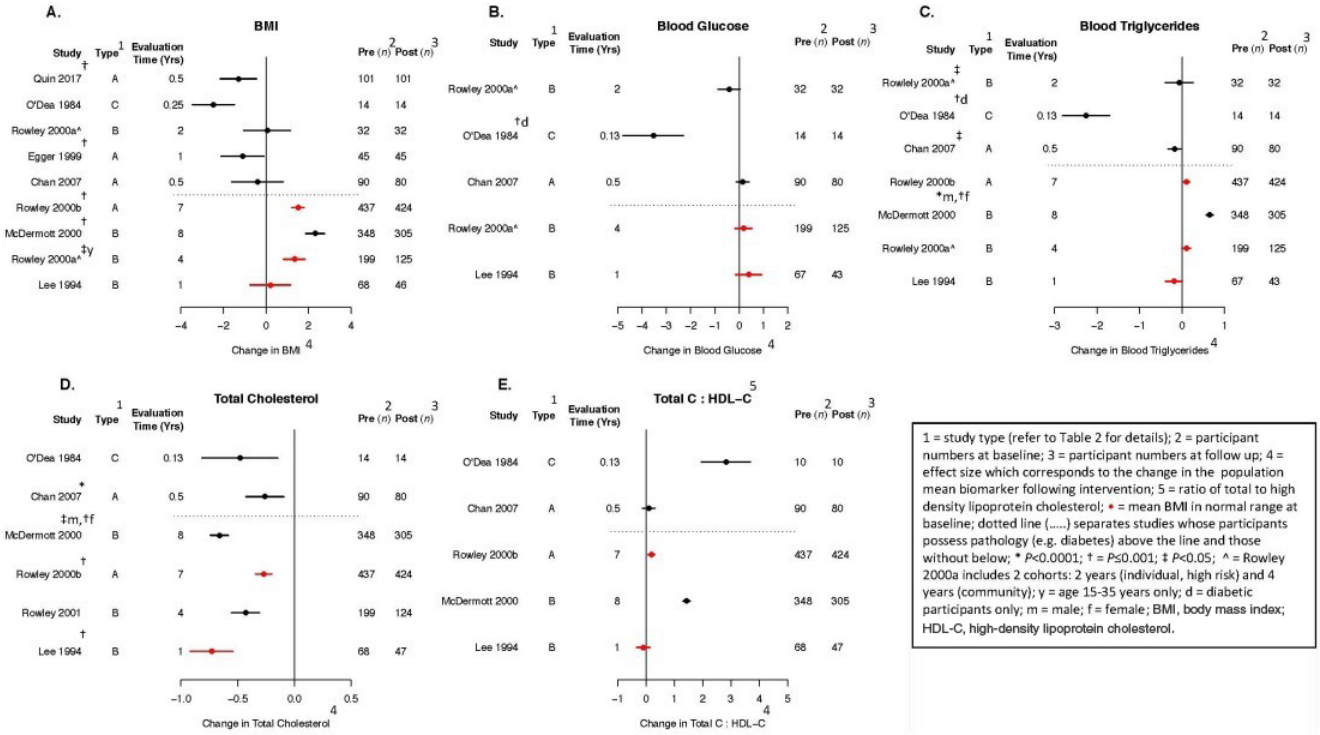

Figure 2 Forest plots of health outcome data. Study types[1]: nutrition education and promotion; store-based intervention with community health promotion; and return to traditional diet.

methods) (n=14 studies); anthropometric measures (n=14 studies) and other outcomes (n=12 studies). Fourteen studies included more than one outcome. We notate study outcomes in table 1 according to whether a test for significance was applied (and whether findings were significant), and if not, then all other findings (including descriptive) are reported.

Most of the studies that included a nutrition education and promotion component also included a physical activity component assessed as not being the primary focus of the study. Only two studies described a theoretical framework.[59 62]

Ecological approach and Aboriginal and Torres Strait Islander engagement and governance features

Nine of the 26 studies attained the higher EAS of 3 or 4, indicating two or more settings with at least one intervention strategy aimed at the individual level plus at least one other (see table 1), and eight studies attained a score of 0.

Aboriginal and Torres Strait Islander engagement and governance 'Key Features' are listed in online supplementary table 4, and studies reporting on these features were referenced. Around 50% of the studies attained moderate or strong CEI score. Sixty-eight per cent of studies reported including community governance though detail was scant. Fewer than 50% of studies did not report either providing results to the community (40%) nor whether the study had been initiated by the community (48%). Only 12% of studies reported providing a 'developmental pathway' to building Aboriginal and Torres Strait Islander research and programme delivery capacity, with most effort (50%) directed towards shorter term 'learning opportunity and skill development'.

Outcomes by intervention type

Nutrition education and promotion programmes

Seven studies described this type of intervention,[35 52 53 62–65] and all were assessed as weak in quality. Six were cohort studies, and another a case series.[53] Evaluation timeframes ranged from single education sessions to 2 years, and one at 7 years.[65] Studies that included a range of geographical locations were usually conducted in group or community settings and two included children.[63] CEI varied with two studies[63 65] rated as 'strong' and possessing an EAS of 3 and 4.

Six of the seven studies that tested for statistical significance showed positive outcomes for some measures,[35 52 53 62 64 65] including in two[52 65] of the three studies that measured biochemical/haematological plus anthropometric outcomes. Adverse outcomes were shown for mean glycated haemoglobin[52] and mean HDL-C,[52 65] and mean BMI increased in another at 7 years.[65]

Three studies reported on self-reported dietary intake and found associated statistically significant improvements in fruit and vegetable intake,[35 53] energy intake (decreased) and some macronutrients/micronutrients.[64]

Store-based intervention with concurrent community health promotion

Five studies (nine articles) described this intervention type.[38–40 44 45 45 50 54 61] Two studies were assessed as cross-sectional[40 50 54]; one an interrupted time series with

a control group[38] (included a 'nested' cohort design)[45]; one a multisite case study[61]; and one a cohort[39] (included a 'nested' cross-sectional design).[44] All were assessed as weak quality with two[38 40] including additional impact evaluations both assessed as moderate.[45 50] Evaluation timeframes were up to 8 years, CEI was moderate to strong in all but one study,[54] all attained an EAS of 3 or 4 and were conducted in very remote locations.

Three of the four studies tested for statistical significance and found associated positive outcomes,[38 39 44 45] including for biochemical/haematological and anthropometric outcomes. Mean lipids/diabetes-related markers,[38 39] markers of improved fruit and vegetable intake (eg, β-carotene)[44] and homocysteine (HCY)[44 45] showed associated improvements between 2 years and 4 years. HDL-C was only assessed in the study conducted over 8 years[50] and decreased. BMI significantly declined in the short term (6 months and 1 year)[38 39] and significantly increased over the longer term (4 and 8 years).[39 50] Improvements in diet-related outcomes were reported in all studies; however, statistical significance was not assessed.

Return to traditional way of life

These three cohort studies (six articles)[42 43 47–49 66] were conducted with remote Aboriginal and Torres Strait Islander adults (diabetic and non-diabetic) and published between 1980 and 1985. These were assessed as weak in quality, with light CEI, and reported on the impact of interventions of between 2 weeks and 3 months.

Five articles[42 43 47–49] reported on evaluations up to 7 weeks while living a traditional life and consuming a traditional diet. Statistically significant improvements in TGs, very low-density lipoprotein cholesterol (VLDL-C) and diabetes markers were reported, along with a significant drop in HDL-C, and in one article noted to be present among those with diabetes only.[49] Improvements were also reported for omega-3 and omega-6 fatty acids and nutritional markers. Three months after return to an 'urban' diet', a significant increase in TGs was found.[66] While improvements in anthropometric outcomes (weight) were reported, statistical significance was not assessed.

Fruit and vegetable subsidy

Two studies (four articles)[41 51 67 68] included this intervention type and were derived from the continuation and evolution of the one nutrition programme initiated in 2005.[41] Both were cohort design and participants were aged 17 years and under, and both were assessed as of weak quality. CEI was assessed as strong in the later study[67 68] and both attained an EAS of 2.

The earlier study[41 51] noted improvements in health (improvements in hearing); however, no tests for significance were applied. The later study[67 68] found statistically significant improvements in nutritional markers of fruit and vegetable intake and in fruit intake[67] and health (decrease in illness-related visits to health service or hospital and oral antibiotic prescriptions).[68] Adverse outcomes were that self-reported intakes of sugar increased and vegetables decreased.[67]

Store environment and/or policy

Eight studies described this intervention type[36 37 55–60]; all but one[59] were conducted in remote/very remote Aboriginal and Torres Strait Islander communities and included two studies assessed as moderate in quality. These studies differed in store environment strategy, and diverse study designs included: case series (n=3)[57–59]; interrupted time series (n=2)[55 56]; and one each of non-randomised controlled,[37] stepped wedge randomised controlled[36] and retrospective pre–post.[60] Four studies reported on the impact of the intervention at 2 years or more,[55–58] and all outcomes were assessed using the store turnover/point of sale methods. Participants included all members of the communities, three studies applied an ecological approach[36 56 58] and CEI varied.

Two studies found that a remote store manager supportive of healthy food provision[57] and a store discount of 20%[36] were associated with a positive impact on community-level dietary-related outcomes. The latter study found a statistically significant increase in purchases of key foods including fruit, vegetables and bottled water; however, no impact on the purchase of diet and regular soft drinks.[36]

The introduction of a nutrition policy was associated with improvements in dietary-related outcomes in very remote communities.[58] By contrast, a federal government-instigated income management strategy in very remote communities was associated with a statistically significant increase in soft drink sales and no change fruit and vegetables sales after 6 months.[55] A price discount of 10% was associated with no impact on sales of grocery products, fresh fruit and vegetables and diet soft drinks.[60]

Preschool meal programme

This one cohort study implemented a preschool meal programme, provided multivitamin supplements and was conducted at a time when undernutrition and poor growth among Aboriginal and Torres Strait Islander children were common. The study was implemented across a range of geographical areas and demonstrated improvements in the height and weight of children.[34]

Impact on health outcomes

Studies from three intervention types (nutritional education and promotion,[35 52 62 65] store-based nutrition intervention with community health promotion or environment/policy[38 39 50] and return to traditional diet[43]) were included in the forest plots (see figure 2). Decrease in BMI was only apparent in studies, which targeted those over the healthy weight range over a short time frame (ie, 3 months–1 year).[35 43 52 62] Small increases in BMI were apparent in four studies[38–40 65] conducted in remote communities with three[38 39 65] possessing a mean BMI at baseline within normal range and at follow-up within or

just over the normal range. Return to traditional diet over a short time frame demonstrated the most consistently positive impact on health outcomes, other than for TC:HDL-C,[43] where a large decline in VLDL-C relative to HDL-C (decreased) and LDL-C (increased) was reported by the authors as a contributing factor to the change in distribution of TC. There was little impact on blood glucose or TG levels reported in other studies. TC declined for all studies regardless of the timeframe and whether the study was a 'targeted' intervention. However, TC:HDL-C increased in two of these studies[43 50] with another three demonstrating little change in ratio.[38 52 65] The study conducted over the longest time frame (8 years)[50] noted a reversal of all positive health outcomes over time other than for TC.

DISCUSSION

This review of nutrition intervention studies that aimed to improve diet-related and health outcomes in Australian Aboriginal and Torres Strait Islander populations found statistically significant improvements in a range of outcomes across all intervention types and settings in the short to medium term. Store-based interventions, including a food price strategy,[36] combined with community health promotion demonstrated most promise in very remote locations,[36 38–40 42 44 46 50] with all describing improvements in diet-related outcomes, although only one tested for statistical significance.[36] Three of these six studies reported statistically significant improvements in some health outcome measures including BMI[38 39] and biochemical/haematological markers of good nutrition and health (TC[38 50] (over 8 years); folate[38]; plasma glucose[38 39]; HCY[38 39]; TG[38 39]). In a regional area, the fruit and vegetable subsidy programme showed encouraging results with statistically significant improvements in children's biochemical/haematological markers of nutrition and health outcomes.[67 68] 'Nutrition education and health promotion programmes', mostly targeting populations with pre-existing health conditions, showed potential at the group education level across geographically diverse groups.[52 53 62 64 65] Group nutrition education was also identified as a promising strategy in another review.[11]

Improvements reported in the store-based and community health promotion studies are likely related in part to their adoption of a strong ecological approach and moderate to strong community engagement in discrete communities, reflecting the strong evidence for approaches to addressing poor dietary intake which are both multisetting and multistrategy. We urge researchers to rigorously evaluate impact on diet-related outcomes to provide clear evidence of change. Store-based nutrition education (store tours and information labels on shelves) has also been identified as a promising strategy in another review.[11] Food subsidy and price discount strategies should be further investigated for effect, feasibility and viability across Aboriginal and Torres Strait Islander communities regardless of geographical area. Economic analyses of such strategies are also needed as is examination on how best to 'scale-up' promising interventions to ensure viability for business and of cost–benefit to government along with benefit for the consumer. Lower discounts have demonstrated no discernible impact,[60] and effect on the purchase of unhealthy foods with discount savings is yet to be fully understood as is the benefit of including an in-store strategy that seeks to deincentivise unhealthy food purchasing using retail marketing strategies.[69] A recent cost-effectiveness study has found that a single strategy price discount on healthy foods may have negative health effects and that combining discounts with a comprehensive range of other strategies may be preferable.[70] Income management strategies appear to have no positive effect on population level fruit, vegetables and soft drink sales.[55] It must be noted that large changes in dietary intake are required to significantly impact on health outcomes, and this necessitates that the underlying determinants of such changes are simultaneously addressed.

Return to a traditional diet and lifestyle showed improvements in key health indicators over a very short-time period[42 43 47–49]; however, these reversed once the participants returned to the less healthy 'urban' diet.[66] One study noted that physical activity was 'generally high' (p. 32),[66] and this may have also contributed to results, though not examined in the study. This seminal study demonstrated that Aboriginal and Torres Strait Islander Australians can experience dramatic health benefits from dietary improvement and in a very short time period and has inspired subsequent community-based studies. These studies have informed current dietary recommendations for Aboriginal and Torres Strait Islander Australians.[7]

The preschool meal programme conducted in 1980 found improvements among children who were underweight initially. Nutrition policies and programmes now exist in Australian preschool settings.[69] Only two studies examined change in health outcomes over the longer term (7–8 years),[50 65] and these were not sustained despite small decreases in TC thought to reflect a commensurate fall in HDL-C. While maintaining positive health outcomes is a challenge also in similar studies conducted in the general population,[71] additional barriers to healthy diet in Australian Aboriginal and Torres Strait Islander people exist[72] including lower gross weekly income,[73] the high cost and poor availability of healthy foods and increasing availability of unhealthy foods in many communities.[74] Food insecurity is higher among Aboriginal and Torres Strait Islander Australians (22%) than other Australians (4%).[8]

The majority of studies (n=17) scored the lower EAS of between 0 and 2 suggesting that multisetting and strategy interventions are yet to be fully embraced despite evidence to support this approach, possibly because of the significant resources and workforce capacity required to implement.[28] One study in this review[61] describes a 5-year project conducted with four remote communities and offers insights into establishing

a multisectoral, multisetting strategy systems approach to dietary improvement. Studies with strong Aboriginal and Torres Strait Islander community engagement generally reported a wider range of outcomes than others with less intense engagement and tended to be associated with more comprehensive evaluation. This is likely a result of the relevance of the study to the community and trust between partners, reflecting key Australian guidelines on the conduct of research with Aboriginal and Torres Strait Islander communities.[21] Building research capacity is recognised as an essential principle of research conducted with Aboriginal and Torres Strait Islander communities,[26] is a requirement of ethical research conducted with communities,[21] will help ensure high-quality research going forward and was not evident in most studies. The small proportion of studies reporting details of their community engagement and governance may be a factor of word limit restrictions imposed by journals and that these aspects of a study are yet to be accepted as integral to the report of methods.

The predominance of a weak overall quality rating for studies in this review is a result of generally weak scores for the assessment components of selection bias, presence of confounders and blinding. This may reflect brief or poor description of methods in the manuscripts and/or challenges around the suitability of empirical research (including randomised controlled trials) in the small discrete 'real-world' Aboriginal and Torres Strait Islander communities where most studies were located.

Implications and future directions

Multisetting and strategy approaches that support Aboriginal and Torres Strait Islander leadership and include addressing the underlying determinants of dietary intake are strongly recommended to intervene successfully in the complex systems that surround access to healthy foods in Aboriginal and Torres Strait Islander communities. Strong Aboriginal and Torres Strait Islander community engagement and governance is central to comprehensive implementation and evaluation of dietary intervention programmes and to embedding successful approaches and policies within communities. In remote and very remote Aboriginal and Torres Strait Islander communities, a suite of approaches including store-based strategies that address healthy food availability and consider price discounts, with community-wide nutrition education and promotion programmes, should continue to be delivered and evaluated. Future studies need to explore the long-term feasibility, viability and impact of fiscal (subsidy and discount) strategies on diet and markers of good health across Aboriginal and Torres Strait Islander communities including urban settings. Impact on less healthy food purchases should also continue to be investigated and addressed. Particularly in the absence of adequate legislative support to improve food supply, the engagement of retailers and community store owners in design, implementation and evaluation is essential for sustainability and scale-up of such strategies. Heterogeneity of the interventions, settings and methods of studies included in this review, along with at times unclear description of interventions and their implementation, limit the generalisability of results. These factors restrict the ability to identify specific intervention components that had a positive impact and thus limit opportunities to build evidence and inform future directions. Dietary intervention studies need to clearly describe the intervention trialled, implementation fidelity and process, along with primary and secondary outcome measures and standardised measures. This will then allow the replication and investigation of promising interventions across the diversity of Australian Aboriginal and Torres Strait Islander populations including regional and urban communities where the majority (80%) live[73] but where few studies have been conducted. There is a potential for reporting bias in this review where studies have been published in the grey literature or as reports or are currently under review and therefore not included.

National investment is required to prioritise dietary interventions in Australian Aboriginal and Torres Strait Islander communities given the prominence of poor diet as a risk factor for the health inequity suffered by Aboriginal and Torres Strait Islander Australians.[8 9 75] Improving nutrition is complex, given the extent of barriers to healthy intake in Aboriginal and Torres Strait Islander communities.[8 69 74] Future efforts should build capacity and evidence informed policy in all food environment settings to support healthy eating, include a focus on urban Aboriginal and Torres Strait Islander communities, ensure strong community engagement and leadership, and a trained and supported Aboriginal and Torres Strait Islander nutrition workforce. The results of this review provide guidance for the next steps to a healthy food future for Australia's first people.

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Acknowledgements The authors would like to thank Associate Professor Dr Michael Skilton (University of Sydney, Charles Perkins Centre) for his advice on health outcome data.

Contributors JG, TS, JB, AL and KS contributed to designing the search strategy. TS and KS conducted the searches. TS, KS and JG performed data extractions. JG, TS, JB, AL and KS contributed to quality assessment. AS quantitatively compared health outcome data. All authors contributed to drafting and revising the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The corresponding author has a data which supports Supplementary Table 4 which is not published. Plesae contact the corresponding author and this will be supplied.

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