Applied Physiology, Nutrition, and Metabolism

Healthy lifestyle initiatives for increasing fruit and vegetable intake among Aboriginal and Torres Strait Islander peoples: a rapid review

Journal:	<i>Applied Physiology, Nutrition, and Metabolism</i>
Manuscript ID	apnm-2021-0076.R3
Manuscript Type:	Systematic Review
Date Submitted by the Author:	08-Oct-2021
Complete List of Authors:	Blekkenhorst, Lauren; Edith Cowan University, Institute for Nutrition Research; The University of Western Australia, Medical School; Royal Perth Hospital Research Foundation Ride, Katherine; Edith Cowan University, School of Medical and Health Sciences Wallace, Ruth; Edith Cowan University, School of Medical and Health Sciences Eades, Sandra; Curtin University, Medical School McAullay, Daniel ; Edith Cowan University, Kurongkurl Katitjin Godrich, Stephanie; Edith Cowan University, School of Medical and Health Sciences
Novelty bullets: points that summarize the key findings in the work:	Five studies were undertaken in major cities and all reported positive findings; only one study was rated as good quality., Presented data supports the need for high-quality studies to be conducted among those residing in major cities.
Keyword:	Indigenous Populations, Fruits, Vegetables, Aboriginal and Torres Strait Islander, Major Cities, Urban, Metropolitan, Australian, Health Promotion, Public Health
Is the invited manuscript for consideration in a Special Issue? :	Indigenous Health and Well-Being

SCHOLARONE™
Manuscripts

**Healthy lifestyle initiatives for increasing fruit and vegetable intake among
Aboriginal and Torres Strait Islander peoples: a rapid review**

Lauren C Blekkenhorst^{1,2}, Katherine M Ride³, Ruth M Wallace³, Sandra J Eades⁴,
Daniel McAullay⁵, Stephanie L Godrich⁶

¹ Institute for Nutrition Research, School of Medical and Health Sciences, Edith
Cowan University, Joondalup, WA, Australia

² Medical School, The University of Western Australia, Perth, WA, Australia

³ School of Medical and Health Sciences, Edith Cowan University, Joondalup, WA,
Australia

⁴ Medical School, Curtin University, Perth, WA, Australia

⁵ Kurongkurl Katitjin, Edith Cowan University, Mount Lawley, WA, Australia

⁶ School of Medical and Health Sciences, Edith Cowan University, Bunbury, WA,
Australia

Corresponding author:

Dr Lauren Blekkenhorst

School of Medical and Health Sciences

Edith Cowan University

270 Joondalup Drive

Joondalup WA 6027 AUSTRALIA

Email: l.blekkenhorst@ecu.edu.au

ABSTRACT

Adequate fruit and vegetable intake is key to reducing chronic disease risk among Australian Aboriginal and Torres Strait Islander peoples. This rapid review collated evidence on healthy lifestyle initiatives that focused on increasing fruit and vegetable intake among Australian Aboriginal and Torres Strait Islander peoples residing in major cities. Due to limited studies conducted within major cities, we extended our inclusion criteria to regional and remote areas. Sixteen studies were included. Five (31%) studies were rated as good quality (least risk of bias), ten (63%) were rated as fair, and one (6%) was rated as poor (significant risk of bias). Five (31%) studies employed participatory research in the design and/or execution, and seven (44%) studies included minimal community involvement. Only five (31%) studies were undertaken in major cities; four of these combined major cities with regional and/or remote areas. All five studies reported positive findings, such as an increase in fresh fruit availability, usage of fresh vegetables, or self-reported fruit and vegetable intake. This review provides evidence confirming the need for high-quality healthy lifestyle initiatives to increase fruit and vegetable intake targeted at Aboriginal and Torres Strait Islander peoples living in major cities. This evidence will assist community organisations in designing effective health promotion interventions, providing insight into improving the structure and function of such programs.

PROSPERO registration number: CRD42020194522

Novelty

- **Five studies were undertaken in major cities and all reported positive findings; only one study was rated as good quality.**
- **Presented data supports the need for high-quality studies to be conducted among those residing in major cities.**

Keywords: Fruits; Vegetables; Indigenous Populations; Aboriginal and Torres Strait Islander; Major Cities; Urban; Metropolitan; Australian; Health Promotion; Public Health

49 INTRODUCTION

50 Fruits and vegetables are the most nutrient-dense foods available for human
51 consumption. Not only do they contain vital micronutrients and fibres, but they also
52 contain many antioxidants, polyphenols, and other plant chemicals, that have several
53 protective properties. These include, but are not limited to, reducing oxidative stress
54 and attenuating low-grade systemic inflammation; key mechanisms in the
55 foundations of lowering chronic disease risk (Liu 2003; Zhang et al. 2015).

56 One of the cornerstones for a healthy diet to reduce chronic disease risk is having an
57 adequate intake of fruits and vegetables. Increasing fruit and vegetable intake is
58 recommended in dietary guidelines worldwide (Herforth et al. 2019). According to
59 data from a 24-hour recall, in Australia, almost 40% of Aboriginal and Torres Strait
60 Islander peoples met fruit intake recommendations; however, only 8% met vegetable
61 recommended intakes (Australian Bureau of Statistics 2015; Lee and Ride 2018). In
62 the 24-hour recall, both fruit and vegetable consumption were higher in non-remote
63 areas than remote areas (47% of Aboriginal and Torres Strait Islander people
64 consumed fruit compared with 31% in remote areas, with 68% vs 54% for
65 vegetables, respectively). Among Aboriginal and Torres Strait Islander people
66 affordability, access, and availability are major contributing factors to purchasing
67 behaviours (Lee and Ride 2018). Remote community stores, regional and urban
68 supermarkets and fast-food outlets are where most foods and beverages are
69 accessed (Whalan et al. 2017).

70 More evidence is required regarding intervention attributes that are effective in
71 increasing fruit and vegetable intake among Australian Aboriginal and Torres Strait
72 Islander peoples and reducing their chronic disease risk. In many countries around
73 the world, culturally adapted interventions have been implemented to improve the
74 nutritional status of Indigenous peoples (Vincze et al. 2021). In Australia, there have
75 been several interventions that have focussed on increasing fruit and vegetable
76 intake among Aboriginal and Torres Strait Islander peoples across regional and
77 remote areas (Gwynn et al. 2019). The localised aspects of these interventions and
78 the paucity of information on the different cultural and dietary practices of these
79 study populations cast doubt on their generalisability to other locations. Furthermore,
80 it is unknown whether these interventions can be translated to effectively support the
81 health and wellbeing of Aboriginal and Torres Strait Islander peoples residing in

major cities. This is an important consideration as almost 40% of the total Aboriginal and Torres Strait Islander population lives in major cities (Australian Bureau of Statistics 2016b).

This rapid review aimed to collate available evidence using a systematic approach on healthy lifestyle initiatives that had a focus on increasing fruit and vegetable intake among Aboriginal and Torres Strait Islander peoples residing in major cities. This aim was to address the research question, '*Which health promotion activities are successful in increasing fruit and vegetable intake in Aboriginal and Torres Strait Islander peoples living in major cities of Australia?*'. This evidence should inform government and public health investment decisions regarding effective interventions to increase fruit and vegetable consumption among Aboriginal and Torres Strait Islander peoples residing in major cities. The evidence synthesised from this rapid review will also assist community organisations in designing effective health promotion interventions providing helpful insight into improving the structure and function of such programs.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement was adhered to (Liberati et al. 2009; Moher et al. 2009) and the review was prospectively registered with the PROSPERO register (CRD42020194522).

Study selection and eligibility criteria

Studies were included if they (1) were published from 2000 onwards; (2) involved Australian Aboriginal and Torres Strait Islander peoples; and (3) included healthy lifestyle initiatives with a focus on increasing intake of fruits and/or vegetables or enablers of fruit and/or vegetable intake. If both fruit and vegetable intake and enablers of fruit and vegetable intake were reported in the same study, only those results reported for actual intake were taken into consideration. This is because the provision of enablers increases the likelihood of increased fruit and/or vegetable intake but does not necessarily translate into action. The main focus of the review was to include studies conducted in major cities. However, given the small number of studies that were captured, the decision was made to extend the inclusion criteria to include those in regional and remote settings. Studies in regional and remote

settings were thought to be vastly different. Therefore, the discussion was centred around adapting those interventions to major cities. Healthy lifestyle initiatives included healthy food and/or nutrition interventions, programs or education with a focus to increase intake of fruits and/or vegetables or enablers of fruit and/or vegetable intake. Articles were excluded if they were (1) editorials; (2) conference abstracts; or (3) not published in English. There were no restrictions on age group and healthy/clinical populations.

Subject databases MEDLINE, CINAHL, Embase, and PsycINFO were searched for peer-reviewed journal articles, and the Australian Indigenous Health/*infoNet* was searched for grey literature. All documents were published from 1 January 2000 to 29 June 2020. The search strategy used for subject databases is detailed in **Supplementary Table S1**. The reference lists from all included articles were manually checked for additional relevant articles. Each database search was documented and all citations were imported and merged into an Endnote X9 library. Duplicates were removed, and citations were uploaded into Covidence systematic review software (<https://www.covidence.org/>) to identify relevant studies. Titles and abstracts were independently screened by two authors (RMW and KMR). If authors were unsure whether the article met inclusion criteria after the title and abstract review, articles were included for full-text retrieval. Full-text articles were retrieved and the same two authors independently screened all full-text articles. Reasons why articles were excluded were documented at this stage of the screening process. A third author (LCB) made final eligibility decisions for any discrepancies at both the title and abstract, and full-text review stages. Records identified at each stage and reasons for full-text article exclusions were documented using the PRISMA 2009 Flow Diagram (Moher et al. 2009).

Quality assessment

Each included article was critically appraised by LCB to determine the quality of results. A minimum of 10% of studies were assessed independently by two authors (RMW and SLG) and any discrepancies were resolved by discussion and consensus. The National Institute of Health (NIH) National Heart, Lung and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group (<https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>) was used to determine the quality of results. Each study was rated either 'good', 'fair', or

'poor' based on 12 criteria. The quality rating was scored by the number of criteria receiving a yes (i.e. 1-4 poor, 5-8 fair, 9-12 good). A study rated 'good' had the least risk of bias, a study rated 'fair' was susceptible to some bias but was not deemed sufficient to invalidate the results, and a study rated 'poor' indicated a significant risk of bias.

Data extraction

Information extracted from included articles comprised: title, author(s), date of publication, type of publication, study design, settings and population studied, interventions implemented, the methodology used, outcomes measured, results, and strengths and limitations of the study, and if relevant to the question, whether results differed among subgroups, such as by gender, socioeconomic status, etc. If the same results were found from different publications (i.e. thesis and journal article), the journal article was included. All data from included articles were extracted by LCB and checked by SLG. The 2016 Australian Statistical Geography Standard (ASGS) Remoteness Area classification was used to classify study locations (Australian Bureau of Statistics 2016a). If the exact location was reported this was entered into the Department of Health Health Workforce Locator (<https://www.health.gov.au/resources/apps-and-tools/health-workforce-locator/health-workforce-locator>) to obtain the ASGS Remoteness Area. If an area could not be determined, 'Not Reported' was entered. RMW assessed and LCB substantiated the ASGS Remoteness Area for each article.

Community involvement

The criteria for determining community involvement was based on the method described by Vincze et al. (2021). Community involvement was classified as minimal, maximal, no community involvement or not stated. Minimal involvement was defined when the intervention: gave the appearance of cultural appropriateness through the use of colours, images, fonts, music etc; used data on a given health issue within the population/community; used direct translations in the use of dominant or traditional languages; and/or was limited to testimonials or stories from members of the community. Community involvement was classified as maximal when the intervention: used community-based participatory research methods such as full translations with culturally relevant statements; was delivered by community

members; and/or recognised, reinforced and built upon the cultural values, beliefs and behaviours of the community or group.

RESULTS

Study selection and characteristics

Of the 2101 citations identified, 125 were selected for full-text review, 109 were excluded, and a total of 16 articles were included for data synthesis (**Figure 1**). Study characteristics of included articles are summarised in **Table 1**. Full details for each article can be found in **Supplementary Table S2**.

Quality assessment

Using the NIH National, Heart, Lung and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group, n=5/16 (31%) studies were rated as good (least risk of bias), n=10/16 (63%) studies were rated as fair (susceptible to some bias but not deemed sufficient to invalidate the results), and n=1/16 (6%) studies were rated as poor (significant risk of bias) (**Supplementary Table S3**). The majority of studies (n=12/16; 75%) did not report any justification of sample size and whether the sample size was large enough to provide confidence in findings. In addition, n=13/16 (81%) of studies did not report whether the assessor of study outcomes was blinded to the participants' exposures/interventions, n=15/16 (94%) did not report the percentage of participant loss to follow-up after baseline and did not report whether those lost to follow-up were accounted for in analyses, and n=13/16 (81%) did not measure outcomes of interest multiple times before the intervention and multiple times after the intervention. However, in some study designs, this would not have been feasible. Lastly, n=10/16 (63%) did not consider individual-level data to determine effects at the group level (**Supplementary Table S3**).

Program types and study locations

There were 14 different programs identified (**Table 1** and **Supplementary Table S2**). These included programs undertaken in a food store (shop) environment (n=4), healthy food subsidy programs (n=1), health promotion programs (n=4), healthy lifestyle challenges (n=1), nutrition education programs (n=3), and those related to policy (n=1). Limited studies included Aboriginal and/or Torres Strait Islander people from major cities (n=5). Most of these studies also included other geographical

areas; only one study included major cities without other geographical areas included. The majority of studies identified included Aboriginal and/or Torres Strait Islander people from inner and outer regional areas (n=7), or remote and very remote areas (n=7).

Fruit and vegetable-related outcomes

Outcome measures of fruit and vegetable intake or enablers of fruit and vegetable intake included store vouchers or discounts to promote fruit and vegetable purchasing (n=4); attitudes, behaviours, knowledge and/or environments associated with fruits and vegetables (n=4); store-turnover/point-of-sale methods (n=3); self-reported dietary assessment tools (n=3); receipt of free or subsidised fruits and/or vegetables (n=2); and biomarkers of fruit and vegetable intake (n=1) (Table 1 and Supplementary Table S2).

Fruit and vegetable-related outcomes by program type

Store environments

In total, there were five studies that included store environments (Table 1 and Supplementary Table S2). The most common measure of fruit and vegetable intake using store environment settings was to use store-turnover/point-of-sale methods (n=4) followed by self-reported intakes of fruits and vegetables (n=1). In general, non-significant increases and decreases in fruit and vegetable sales were reported.

Healthy food subsidy programs

Only one study was classified under healthy food subsidy programs, which used a store-turnover/point-of-sale method as a marker of fruit and vegetable intake (Table 1 and Supplementary Table S2). No change in self-reported fruit and vegetable intake was reported. However, biomarkers of fruit and vegetable intake were increased.

Health promotion programs

Four studies used health promotion programs to influence fruit and vegetable intake or to generate enablers of fruit and vegetable intake (Table 1 and Supplementary Table S2). All four studies used different methods for assessing change in fruit and vegetable intake or enablers of fruit and vegetable intake (e.g. semi-structured interviews, n=1; questionnaires related to attitudes, behaviours, knowledge, and

environments associated with fruits and vegetables, n=1; store-turnover/point-of-sale methods, n=2; and biomarkers of fruit and vegetable intake, n=1). Fruit and vegetable knowledge increased, such as types and recommended serves. Store turnover increases for fruit and vegetables and improvements in biomarkers of fruit and vegetable intake were also reported.

Healthy lifestyle challenges

Two studies were published using healthy lifestyle challenge methods; both reporting findings from the Knockout Health Challenge (Table 1 and Supplementary Table S2). Change in fruit and vegetable intake was assessed using self-reported dietary assessment tools, with increases in fruit and vegetable intake reported by both studies.

Nutrition education programs

Three education programs were captured (Table 1 and Supplementary Table S2). Two studies utilised questionnaires to assess knowledge and attitudes towards fruits and vegetables, whilst the other used semi-structured in-depth interviews to obtain information on dietary behaviours. Improvements in knowledge and attitudes to fruit and vegetables were reported, as was fruit and vegetable intake.

Policy

The Aboriginal Community Controlled Health Organisations (ACCHOs) Nutrition Policy Development pilot project was developed to strengthen nutrition policy development and implementation in Victorian ACCHOs. Policy clauses included increasing availability of fresh fruit to staff. Changes were measured by visible evidence of fresh fruit available to staff and captured via structured one-on-one interviews and focus groups and reported increases in visibility of fresh fruit in staff areas.

Fruit and vegetable outcomes by community involvement

Most programs included community involvement in the design, application and/or evaluation (n=10) (Table 1 and **Supplementary Table S4**). The degree of community involvement was not stated in three (n=3) programs and there was no community involvement in one program (n=1). Increases in fruit and vegetable consumption were observed in programs showing all levels of community

273 involvement (minimal involvement n=2; maximal involvement n=2; no involvement
274 n=1, not stated n=1).

275 **DISCUSSION**

276 The purpose of this rapid review was to collate available evidence on healthy lifestyle
277 initiatives that had a focus on increasing fruit and vegetable intake or enablers of fruit
278 and vegetable intake among Aboriginal and Torres Strait Islander peoples residing in
279 major cities. Using a rapid systematic approach, we found limited publications on
280 initiatives conducted in major cities and therefore extended our inclusion criteria to
281 include regional and remote settings. Since 2000, 16 studies have been published
282 evaluating change in fruit and/or vegetable intake or enablers of intake as a result of
283 a healthy lifestyle initiative (Abbott et al. 2010; Black et al. 2013; Brimblecombe et al.
284 2018; Brimblecombe et al. 2017; Brown et al. 2019; Ferguson et al. 2017; Grunseit
285 et al. 2019; MacDonald et al. 2016; Magarey et al. 2013; Mhrshahi et al. 2017;
286 Passmore et al. 2017; Pettigrew et al. 2015; Reilly et al. 2011; Ridge and Nimmo
287 2018; Rowley et al. 2001; Tyrrell et al. 2003).

288 Increasing consumption of fruits and vegetables is key to maintaining health and
289 wellbeing (Aune et al. 2017; Głabska et al. 2020). Increasing fruits and vegetables in
290 the diet not only delivers vital nutrients and other bioactive phytochemicals essential
291 for health but can displace consumption of energy-dense unhealthy discretionary
292 food items. Therefore, increasing fruits and vegetables in the diets of Aboriginal and
293 Torres Strait Islander people living in Australia is key to lowering the risk and
294 incidence of overweight and obesity, and subsequent lifestyle-related chronic
295 diseases, such as cardiovascular disease, diabetes, and chronic kidney disease;
296 major contributors to premature mortality in this population (Australian Indigenous
297 Health/InfoNet 2020).

298 Strong Aboriginal and Torres Strait Islander community involvement in the design,
299 implementation and evaluation of dietary intervention programs is recognised as a
300 positive influence on the outcomes of such interventions (Gwynn et al. 2019; Reilly et
301 al. 2011). Ten programs out of the 14 described here included community
302 involvement (i.e., community members were reported to have been consulted or
303 asked to provide feedback). Interestingly, of the six programs that reported an
304 increase in fruit and vegetable consumption (Abbott et al. 2010; Brimblecombe et al.

2017; Grunseit et al. 2019; Mahrshahi et al. 2017; Passmore et al. 2017; Pettigrew et al. 2015; Rowley et al. 2001) four of these involved the community, but only two had a high level of community involvement. This may be because other factors such as access and cost also play a major role in fruit and vegetable consumption.

Many published studies have been conducted in regional or remote areas despite almost 40% of the total Aboriginal and Torres Strait Islander population living in major cities (Australian Bureau of Statistics 2016b). There is no evidence to determine whether such healthy lifestyle initiatives are translatable to major cities, given the diversity in social, cultural, and economic conditions for people living in urban compared with regional or remote areas. Nor do these studies provide any indication of whether healthy lifestyle initiatives can be successful without parallel improvements to affordability, access, and availability of healthy foods.

It is essential that high-quality research is conducted to establish whether particular lifestyle initiatives can indeed increase fruit and vegetable intake, and therefore, subsequently improve overall diet quality and lower chronic disease risk in this population. Those initiatives undertaken in major cities included health promotion programs (e.g. Eat Well Be Active community programs) (Magarey et al. 2013), healthy lifestyle challenges (e.g. Knockout Health Challenge) (Grunseit et al. 2019; Passmore et al. 2017), nutrition education programs (e.g. cooking courses) (Abbott et al. 2010), and policy-related programs (e.g. Aboriginal Community Controlled Health Organisations Nutrition Policy Development) (MacDonald et al. 2016). Of those conducted in major cities, semi-structured and structured interviews, focus groups, and self-reported questionnaires were used to assess knowledge and behaviours relating to fruit and vegetable intake, and changes in fruit and vegetable intake and availability. All studies reported positive findings, including an increase in fresh fruit availability, increase in usage of fresh vegetables, and an increase in self-reported intake of fruits and vegetables. Two nutrition education programs did not report an ASGS Remoteness Area (e.g. FOODcents and the Good Start Program) (Mahrshahi et al. 2017; Pettigrew et al. 2015). Assuming these programs were undertaken in major cities, these initiatives would be considered successful. Nutrition education programs designed to provide participants with knowledge and motivation relating to increasing fruits and vegetables resulted in an increase in self-reported intakes of fruits and vegetables (Pettigrew et al. 2015). Class activities using cooking

338 sessions and cultural dance with an objective in promoting vegetables led to an
339 increase in knowledge and attitudes towards the health benefits of vegetables and
340 an increase in self-reported intake in vegetables (Mihirshahi et al. 2017).

341 Healthy lifestyle initiatives conducted in outer regional and remote areas have
342 generally been undertaken in store environments with food vouchers, discounts and
343 education as main methods for interventions to increase fruit and vegetable intake.
344 Store-turnover/point-of-sale methods are used as measures of change in fruit and
345 vegetable intake. Store-turnover/point-of-sale methods to assess population intake
346 have been shown to be more acceptable among community members in regional
347 and remote areas and have less bias compared to other dietary assessment
348 methods (e.g. weighed food records, 24-hour dietary recalls, diet histories and food
349 frequency questionnaires) (Whalan et al. 2017). Along with these strengths, store
350 environments are an appropriate method used in outer regional and remote areas as
351 there is usually only one food store available where most food is purchased.
352 Nevertheless, food store environments with store-turnover/point-of-sale methods are
353 limited to per capita consumption estimates rather than individual estimates
354 accompanied by age, gender and other variations that influence dietary intake
355 (Whalan et al. 2017). It is likely that price discount subsidies need to be increased in
356 order to demonstrate substantial increases in fruit and vegetable sales. However,
357 this may not be feasible in major cities as a high proportion of the uptake of price
358 discount subsidies in stores may be from non-Indigenous people living in major
359 cities.

360 As only five studies were conducted with Aboriginal and Torres Strait Islander people
361 residing in major cities, it is difficult to make recommendations on which initiatives
362 have been successful in increasing fruit and vegetable intake. However, programs
363 that showed promising results were (1) community programs promoting
364 environments for healthy eating particularly among children, which led to an increase
365 in knowledge of the benefits of consuming fruit, but may not be as effective for
366 vegetables; (2) community-led healthy lifestyle competitive challenges, which led to
367 increases in both fruit and vegetable intake; and (3) cooking courses incorporating
368 nutrition education and practical cooking lessons, which led to an increase in usage
369 of fresh vegetables.

370 *Strengths and limitations*

371 There are several strengths to this study. This is the first review that has
372 systematically collated evidence of initiatives over the last two decades that have
373 focused on increasing fruit and vegetable intake or creating enablers of fruit and
374 vegetable intake in Aboriginal and Torres Strait Islander people living in Australia. As
375 a large proportion of initiatives have been conducted in regional and remote areas,
376 our review has provided, for the first time, evidence confirming the need to test and
377 evaluate healthy lifestyle initiatives in Aboriginal and Torres Strait Islander peoples
378 residing in major cities. Several limitations need to be considered when interpreting
379 the findings from this rapid review. Firstly, heterogeneity in methodology makes a
380 comparison between studies difficult. Secondly, most studies did not use
381 assessment methods that have been specifically validated for Aboriginal and Torres
382 Strait Islander populations, or at least did not acknowledge this as a limitation.
383 Thirdly, most interventions reported in this rapid review did not have a control group
384 or were not randomised. Non-randomised intervention studies may overestimate the
385 advantages of one intervention over another. However, randomised controlled trials
386 are not always feasible in public health research (Sanson-Fisher et al. 2007).
387 Alternatives can include stepped wedge design, interrupted time series, multiple
388 baseline, and controlled pre-post designs (Sanson-Fisher et al. 2014). Lastly, none
389 of the interventions tried to increase consumption of traditional bush foods; however,
390 in the Looma Healthy Lifestyle Program it was noted that bush foods supplemented
391 the store foods purchased and hunting and fishing activities were encouraged.

392 *Implications for policy and practice*

393 In regional and remote settings, store-based strategies that include price discounts,
394 vouchers and increasing healthy food availability, coupled with nutrition education
395 and health promotion programs should continue to be delivered and evaluated.
396 However, price discount subsidies likely need to be increased in order to
397 demonstrate significant increases in fruit and vegetable sales. In major cities as well
398 as regional and remote areas, improving access to fruits and vegetables through
399 community settings, such as public swimming pools and schools, is an important
400 strategy to increase equitable access to healthy food, particularly for children.
401 Community-based programs with a focus on fun, such as a healthy lifestyle
402 competition, could be a successful approach in major cities. Longer-term nutrition
403 intervention programs are more likely to be successful in increasing fruit and

vegetable intake, in contrast to short term interventions. However, attrition rates in transient populations over lengthy follow-up periods need to be considered in regional and remote areas. In remote areas, the high cost of healthy foods in the context of low incomes remains an issue. Cultural awareness and developing meaningful relationships within the community are likely to positively impact intervention programs. Evidence suggests that community-initiated and managed healthy lifestyle programs for Aboriginal and Torres Strait Islander peoples are effective in changing behaviour. However, it is not known whether positive short-term effects are maintained in the longer term as very few programs continue to operate for 5 years or longer (Closing the Gap Clearinghouse 2012). Including Aboriginal and Torres Strait Islander peoples in the design and implementation of healthy lifestyle initiatives will improve attendance and adherence to the program, as well as the quality of research being published. The use of biomarkers for fruit and vegetable intake (e.g., plasma carotenoids) should be considered alongside self-reported fruit and vegetable intake data as individuals tend to overestimate consumption of healthy foods. Lastly, more emphasis is needed on recruiting men as studies have demonstrated an over-representation of female participants.

Conclusions

In summary, this rapid review used a systematic approach to collate evidence on healthy lifestyle initiatives that had a focus on increasing fruit and vegetable intake or enablers of fruit and vegetable intake among Aboriginal and Torres Strait Islander peoples living in major cities of Australia. We found limited studies conducted in major cities, and therefore, extended our inclusion criteria to regional and remote areas. Our review has provided, for the first time, evidence confirming the need to conduct and evaluate high-quality research into healthy lifestyle initiatives for Aboriginal and Torres Strait Islander people living in major cities to increase fruit and vegetable intakes. Potential outcomes include improved overall diet quality and a reduction in the substantial burden that lifestyle-related chronic disease has on this vulnerable population.

ACKNOWLEDGEMENTS

The authors would like to thank Professor Neil M Drew and Dr Natalie Strobel for providing guidance in the development of the protocol.

FUNDING

The salary of LCB is supported by a National Health and Medical Research Council of Australia Emerging Leadership Investigator Grant (ID: 1172987) and a National Heart Foundation of Australia Post-Doctoral Research Fellowship (ID: 102498).

AUTHOR CONTRIBUTION

LCB, KMR, RMW, DM, SLG contributed to the study design; LCB, KMR, RMW conducted the database searches and screening process; LCB performed and SLG substantiated data extraction; LCB conducted and RMW, SLG substantiated 10% of the quality assessments of included articles; RMW assessed and LCB substantiated the ASGS Remoteness Area for each included article; LCB drafted the initial manuscript with input from SLG; all authors contributed to the interpretation of the data and critically revised the manuscript. All authors read and approved the final version of the manuscript.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

REFERENCES

- Abbott, P., Davison, J., Moore, L., Rubinstein, R., Abbott, P., Davison, J., et al. 2010. Barriers and enhancers to dietary behaviour change for Aboriginal people attending a diabetes cooking course. *Health Promot. J. Austr.* **21**(1): 33-38.
- Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L.T., Keum, N., Norat, T., et al. 2017. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality: a systematic review and dose-response meta-analysis of prospective studies. *Int. J. Epidemiol.* **46**(3): 1029-1056.
- Australian Bureau of Statistics. 2015. Australian Aboriginal and Torres Strait Islander health survey: Consumption of food groups from the Australian Dietary Guidelines, 2012-2013. cat. no. 4727.0.55.008. ABS, Canberra.
- Australian Bureau of Statistics. 2016a. Australian Statistical Geography Standard (ASGS): Volume 1—Main Structure and Greater Capital City Statistical Areas, July 2016. cat. no. 1270.0. 55.001. ABS, Canberra.
- Australian Bureau of Statistics. 2016b. Census of Population and Housing - Counts of Aboriginal and Torres Strait Islander Australians. Available from <https://www.abs.gov.au/statistics/people/aboriginal-and-torres-strait-islander-peoples/census-population-and-housing-counts-aboriginal-and-torres-strait-islander-australians/2016> [accessed 12 December 2020].
- Australian Indigenous Health/InfoNet. 2020. Overview of Aboriginal and Torres Strait Islander health status 2019. Australian Indigenous Health/InfoNet, Perth, Western Australia. Available from <https://healthinonet.ecu.edu.au/learn/health-facts/overview-aboriginal-torres-strait-islander-health-status/39498/>.
- Black, A.P., Vally, H., Morris, P., Daniel, M., Esterman, A., Karschimkus, C.S., et al. 2013. Nutritional impacts of a fruit and vegetable subsidy programme for disadvantaged Australian Aboriginal children. *Br. J. Nutr.* **110**(12): 2309-2317.
- Brimblecombe, J., Ferguson, M., Barzi, F., Brown, C., and Ball, K. 2018. Mediators and moderators of nutrition intervention effects in remote Indigenous Australia. *Br. J. Nutr.* **119**(12): 1424-1433.
- Brimblecombe, J., Ferguson, M., Chatfield, M.D., Liberato, S.C., Gunther, A., Ball, K., et al. 2017. Effect of a price discount and consumer education strategy on food and beverage purchases in remote Indigenous Australia: a stepped-wedge randomised controlled trial. *The Lancet Public Health* **2**(2): e82-e95.
- Brown, C., Laws, C., Leonard, D., Campbell, S., Merone, L., Hammond, M., et al. 2019. Healthy Choice Rewards: A Feasibility Trial of Incentives to Influence Consumer Food Choices in a Remote Australian Aboriginal Community. *Int. J. Environ. Res. Public Health* **16**(112): 1-11.
- Closing the Gap Clearinghouse. 2012. Healthy lifestyle programs for physical activity and nutrition. Australian Institute of Health and Welfare, Canberra.
- Ferguson, M., O'Dea, K., Holden, S., Miles, E., and Brimblecombe, J. 2017. Food and beverage price discounts to improve health in remote Aboriginal communities: mixed method evaluation of a natural experiment. *Aust. N. Z. J. Public Health* **41**(1): 32-37.
- Głąbska, D., Guzek, D., Groele, B., and Gutkowska, K. 2020. Fruit and vegetable intake and mental health in adults: A systematic review. *Nutrients* **12**(115): 1-34.
- Grunseit, A.C., Bohn-Goldbaum, E., Crane, M., Milat, A., Cashmore, A., Fonua, R., et al. 2019. Participant profile and impacts of an Aboriginal healthy lifestyle and weight loss challenge over four years 2012–2015. *Aust. N. Z. J. Public Health* **43**(4): 328-333.
- Gwynn, J., Sim, K., Searle, T., Senior, A., Lee, A., and Brimblecombe, J. 2019. Effect of nutrition interventions on diet-related and health outcomes of Aboriginal and Torres Strait Islander Australians: a systematic review. *BMJ Open* **9**(4): e025291.
- Herforth, A., Arimond, M., Álvarez-Sánchez, C., Coates, J., Christianson, K., and Muehlhoff, E. 2019. A global review of food-based dietary guidelines. *Adv. Nutr.* **10**(4): 590-605.
- Lee, A., and Ride, K. 2018. Review of nutrition among Aboriginal and Torres Strait Islander people. Australian Indigenous Health/InfoNet, Perth, Western Australia. Available from <https://healthinonet.ecu.edu.au/learn/determinants-of-health/health-behaviours/nutrition/publications/34385/>.
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gotzsche, P.C., Ioannidis, J.P., et al. 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *Br. Med. J.* **339**: b2700. doi:10.1136/bmj.b2700.

- 509 Liu, R.H. 2003. Health benefits of fruit and vegetables are from additive and synergistic combinations
510 of phytochemicals. *Am. J. Clin. Nutr.* **78**(3): 517S-520S.
- 511 MacDonald, C., Genat, B., Thorpe, S., and Browne, J. 2016. Establishing health-promoting
512 workplaces in Aboriginal community organisations: healthy eating policies. *Australian Journal of*
513 *Primary Health* **22**(3): 239-243.
- 514 Magarey, A.M., Pettman, T.L., Wilson, A., and Mastersson, N. 2013. Changes in primary school
515 children's behaviour, knowledge, attitudes, and environments related to nutrition and physical
516 activity. *ISRN Obesity* **2013**(752081): 1-10.
- 517 Mhrshahi, S., Vaughan, L., Fa'avale, N., De Silva Weliange, S., Manu-Sione, I., and Schubert, L.
518 2017. Evaluation of the Good Start Program: a healthy eating and physical activity intervention
519 for Maori and Pacific Islander children living in Queensland, Australia. *BMC Public Health* **17**(77):
520 1-10.
- 521 Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., and The Prisma Group. 2009. Preferred reporting
522 items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med.* **6**(7): 1-6.
- 523 Passmore, E., Shepherd, B., Milat, A., Maher, L., Hennessey, K., Havrlant, R., et al. 2017. The impact
524 of a community-led program promoting weight loss and healthy living in Aboriginal communities:
525 the New South Wales Knockout Health Challenge. *BMC Public Health* **17**(951): 1-9.
- 526 Pettigrew, S., Jongenelis, M.I., Moore, S., and Pratt, I.S. 2015. A comparison of the effectiveness of
527 an adult nutrition education program for Aboriginal and non-Aboriginal Australians. *Soc. Sci.*
528 *Med.* **145**: 120-124.
- 529 Reilly, R.E., Cincotta, M., Doyle, J., Firebrace, B.R., Cargo, M., van den Tol, G., et al. 2011. A pilot
530 study of Aboriginal health promotion from an ecological perspective. *BMC Public Health* **11**(749):
531 1-9.
- 532 Ridge, A., and Nimmo, L. 2018. Swim for Fruit Evaluation. Royal Life Saving Society of Western
533 Australia, Western Australia. Available from [https://royallifesavingwa.com.au/your-safety/facts-](https://royallifesavingwa.com.au/your-safety/facts-and-figures/program-evaluations/swim-for-fruit)
534 [and-figures/program-evaluations/swim-for-fruit](https://royallifesavingwa.com.au/your-safety/facts-and-figures/program-evaluations/swim-for-fruit).
- 535 Rowley, K.G., Su, Q., Cincotta, M., Skinner, M., Skinner, K., Pindan, B., et al. 2001. Improvements in
536 circulating cholesterol, antioxidants, and homocysteine after dietary intervention in an Australian
537 Aboriginal community. *Am. J. Clin. Nutr.* **74**(4): 442-448.
- 538 Sanson-Fisher, R.W., Bonevski, B., Green, L.W., and D'Este, C. 2007. Limitations of the randomized
539 controlled trial in evaluating population-based health interventions. *Am. J. Prev. Med.* **33**(2): 155-
540 161.
- 541 Sanson-Fisher, R.W., D'Este, C.A., Carey, M.L., Noble, N., and Paul, C.L. 2014. Evaluation of
542 systems-oriented public health interventions: alternative research designs. *Annu. Rev. Public*
543 *Health* **35**: 9-27.
- 544 Tyrrell, M., Grundy, J., Lynch, P., and Wakerman, J. 2003. Laramba Diabetes Project: an evaluation
545 of a participatory project in a remote Northern Territory community. *Health Promot. J. Austr.*
546 **14**(1): 48-53.
- 547 Vincze, L., Barnes, K., Somerville, M., Littlewood, R., Atkins, H., Rogany, A., et al. 2021. Cultural
548 adaptation of health interventions including a nutrition component in Indigenous peoples: a
549 systematic scoping review. *International Journal for Equity in Health* **20**(125): 1-13.
- 550 Whalan, S., Farnbach, S., Volk, L., Gwynn, J., Lock, M., Trieu, K., et al. 2017. What do we know
551 about the diets of Aboriginal and Torres Strait Islander peoples in Australia? A systematic
552 literature review. *Aust. N. Z. J. Public Health* **41**(6): 579-584.
- 553 Zhang, Y.J., Gan, R.Y., Li, S., Zhou, Y., Li, A.N., Xu, D.P., et al. 2015. Antioxidant phytochemicals for
554 the prevention and treatment of chronic diseases. *Molecules* **20**(12): 21138-21156.

Table 1. Summary of study characteristics of included healthy lifestyle initiatives (n=16) with a focus on fruit and/or vegetable intake or enablers of increasing intake.

Authors (year)	Program name	Quality assessment	Intervention	Community involvement ¹	Study findings	Location	ASGS remoteness area classification
Store environment (n=5 studies)							
Brown et al. (2019)	Healthy Choice Rewards	Fair	Store vouchers to promote fruit and vegetable purchases.	Yes – minimal.	7% ↓ F sales; non-significant ↓ V sales	Queensland	Very Remote
Brimblecombe et al. (2018)	SHOP@RIC	Good	Combined price discount and consumer education strategy.	Yes – minimal.	Non-significant ↑ in FV intake	Northern Territory	Remote
Brimblecombe et al. (2017)	SHOP@RIC	Good	20% discount on fresh fruit and fresh and frozen vegetables with and without consumer education.	Yes – minimal.	Discount alone: 12.7% and 19.8% ↑ in FV sales during and post-intervention Discount with education: non-significant 7.6% ↑ and 1% ↓ in FV sales during and post-intervention	Northern Territory	Very Remote
Ferguson et al. (2017)	Outback Stores	Good	Discount strategies of approximately 10% to influence grocery, fruit, vegetables, and diet soft-drink sales.	Yes – minimal.	Non-significant 3% and 8% ↓ in F and V turnover	Northern Territory	Remote
Tyrrell et al. (2003)	Laramba Diabetes Project	Poor	Health education, improved access to health services, two-way learning and intersectoral health planning aimed to increase the knowledge of diabetes risk factors and consequences and to improve the management of diabetes in the community.	Yes – maximal.	175% ↑ in low-fat tinned meat and vegetable meal purchases; 81% ↑ in F purchases; 11% ↑ in V purchases	Northern Territory	Very Remote
Healthy food subsidy programs (n=1 study)							
Black et al. (2013)	Fruit and vegetable subsidy program	Good	Families received weekly boxes of subsidised fruit and vegetables. Each family paid \$5 for a box containing \$40 worth of fruit and vegetables (or \$60 if ≥5 children in the household). Seasonal recipes, practical	Not stated.	18% ↑ b-cryptoxanthin, 21% ↑ vitamin C, 11% ↑ lutein-zeaxanthin; no change in FV intake	New South Wales	Outer regional

			cooking and nutrition education sessions were also provided.				
Health promotion programs (n=4 studies)							
Ridge and Nimmo (2018)	Swim for Fruit program	Fair	Program introduced at swimming pools to increase physical activity, swimming skills and healthy eating through consumption of fruit. Targeted at Aboriginal participants.	Yes – minimal.	Most common reason for visiting the pool included receiving fruit as part of the program. Knowledge of different types of fruits was improved.	Western Australia	Very Remote
Magarey et al. (2013)	Eat Well Be Active community programs	Good	Promoting environments for healthy eating and physical activity in children's settings in two communities.	Yes – maximal.	Knowledge of F serves ↑ 9.4% for the intervention group and 8.1% for the comparison group, but not for V serves.	South Australia	Major Cities, Inner Regional
Reilly et al. (2011)	Health promotion program	Fair	Community-directed health promotion program with multiple activities/programs aimed at improving nutrition and physical activity.	Yes – maximal.	Store turnover ↑ 47g to 80g for fresh F and 1.1g to 2.0g for fresh V from 2005 to 2006.	Victoria	Inner Regional, Outer Regional
Rowley et al. (2001)	Community-directed intervention program	Fair	Store management policy changes, health promotion activities, and nutrition education aimed at high-risk individuals to reduce coronary heart disease risk through dietary modification.	Yes – maximal.	↑ biomarkers of FV intake including plasma levels of α-tocopherol, lutein and zeaxanthin, cryptoxanthin, and β-carotene; ↑ in fresh FV and dietary carotenoid intake.	Western Australia	Very Remote
Healthy lifestyle challenges (n=2 studies)							
Grunseit et al. (2019)	Knockout Health Challenge	Fair	Six team-based weight loss competitions based on physical activity and healthy eating.	Yes – minimal.	↑ FV intake	New South Wales	Major Cities, Inner Regional, Outer Regional, Remote, Very Remote

Passmore et al. (2017)	Knockout Health Challenge	Fair	Community-lead healthy lifestyle program for Aboriginal communities.	Yes – minimal.	FV intake ↑ at the end of the challenge compared to the start. F intake ↑ by 0.3 serves. V intake ↑ by 0.4 serves.	New South Wales	Major Cities, Inner Regional, Outer Regional
Nutrition education programs (n=3 studies)							
Mihrshahi et al. (2017)	Good Start Program	Fair	Class activities relating to healthy eating and physical activity, focusing on one message each term, using cooking sessions and cultural dance. Promotion of vegetables was a main objective.	Yes – maximal.	↑ in knowledge of correct serves of FV, and in attitudes to V. ↑ from 15% at beginning of term to 27% at end of term in reported intake of five serves of V daily. The proportion of children eating the recommended intake of two serves of F was already high pre-intervention (88%) and ↑ non-significantly to 92% after the intervention.	Queensland	Not reported
Pettigrew et al. (2015)	FOODcents	Fair	Nutrition education program designed to provide participants with knowledge and motivation relating to: (1) increasing consumption of fruit, vegetables, and cereals; (2) decreasing consumption of foods high in sugar, fat, and salt; and (3) improving food expenditure according to the healthy diet pyramid.	No.	↑ from pre to post intervention for F was 0.60 serves and for V was 1.14 serves.	Western Australia	Not reported
Abbott et al. (2010)	Community-based nutrition education program	Fair	Cooking courses. Each course consisted of 18 classes (4 hours each class). Practical cooking lessons incorporated nutrition education.	Not stated.	↑ in the use of fresh V	New South Wales	Major Cities
Policy (n=1 study)							
MacDonald et al. (2016)	Aboriginal Community	Fair	Pilot project to strengthen nutrition policy development and	Not stated.	↑ in visible evidence of 'Best Choice' foods and availability	Victoria	Major Cities, Inner

Controlled Health Organisations (ACCHOs)	implementation in Victorian ACCHOs.	of fresh F (e.g., in staff rooms and reception areas)	Regional, Outer Regional
---	--	--	--------------------------------

F, fruit; V, vegetable; ↑, increase; ↓ decrease
¹ Yes – minimal (community members were reported to have been consulted or asked to provide feedback); Yes – maximal (community-based participatory research was employed); No (there was no community involvement in the design of the intervention or program); Not stated (information not available)

556

Draft

557 **Figure caption**

558 **Figure 1.** PRISMA flow chart of articles identified, screened, and included. PRISMA,
559 Preferred Reporting Items for Systematic Reviews and Meta-analyses.

Draft