Effect of restricted retail merchandising of discretionary food and beverages on population diet: a pragmatic randomised controlled trial

Julie Brimblecombe, Emma McMahon*, Megan Ferguson, Khia De Silva, Anna Peeters, Edward Miles, Thomas Wycherley, Leia Minaker, Luke Greenacre, Anthony Gunther, Emma Chappell, Mark D Chatfield, Catherine L Mah*

Summary

Background The effectiveness of healthy food promotion on food and beverage sales in real-world food retail settings has been shown in randomised trials. The effectiveness of restrictions on the promotion of unhealthy food is, however, less clear. We aimed to assess the effect of restricted unhealthy food promotion, specifically those items contributing most to free sugar sales, on food and beverage sales.

Methods In this community-level pragmatic, partially randomised, parallel group trial, stores were randomly assigned by a statistician using a single sequence of random assignments to the intervention group, in which a co-designed strategy restricted merchandising of unhealthy food, or to a control group of usual retail practice. The trial was done in partnership with an organisation operating 25 stores in remote Australia. The primary analysis was based on difference in weekly sales with the strategy compared with no strategy in free sugar from all foods and beverages (g/total MJ; primary outcome), targeted food or beverages (weight and free sugars; g/total MJ), and gross profit (AU$) using mixed models. This trial is registered with the Australian New Zealand Clinical Trials Registry, ACTRN12618001588280.

Findings Between June 13 and Aug 15, 2018, 20 stores were recruited; ten stores were randomly assigned to the intervention group and ten stores to the control group. The trial was done between Sept 2 and Dec 2, 2018. The Healthy Stores 2020 strategy resulted in a reduction in sales of free sugar of 2·8% (95% CI –4·9 to –0·7). Targeted beverages were reduced by 8·4% (–12·3 to –4·3) and associated free sugar by 6·8% (–10·9 to –2·6), sugar-sweetened soft drinks by 13·2% (–18·5 to –7·6), and associated free sugar by 13·4% (–18·7 to –7·7). Reductions in sales of free sugar from confectionery of 7·5% (–14·3 to –0·2) and in weight sold (–4·6%, –11·1 to 2·3) resulted; however, the reduction in weight was not statistically significant. No differences in sales of table sugar and sweet biscuits were observed. Gross profit was not impacted adversely; a small increase resulted (5·3%, 0·3 to 10·5).

Interpretation Restricted merchandising of unhealthy foods and beverages, while allowing for complementary merchandising of healthier foods and beverages in a real-world store setting and co-designed with retailers, can achieve both public health and business relevant gains.

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*Contributed equally

Department of Nutrition, Dietetics and Food (J Brimblecombe PhD), **and Business School** (L Greenacre PhD), **Monash University, Melbourne, VIC, Australia; Menzies School of Health Research, Royal Darwin Hospital Campus, Darwin, NT, Australia** (J Brimblecombe, E McMahon PhD, M Ferguson PhD, E Miles, T Wycherley PhD, A Gunther DipProjMgt, M D Chatfield MSc); **School of Public Health, Faculty of Medicine, The University of Queensland, Brisbane, QLD, Australia** (M Ferguson, M D Chatfield); **Arnhem Land Progress Aboriginal Corporation, Darwin, NT, Australia** (K De Silva BNutDiet, E Chappell BNutDiet); **Institute for Health Transformation, Deakin University, Geelong, VIC, Australia** (Prof A Peeters PhD); **Alliance for Research in Exercise, Nutrition and Activity, University of South Australia, Adelaide, SA, Australia** (T Wycherley); **School of Planning, University of Waterloo, Waterloo, ON, Canada** (L Minaker PhD); **Faculty of Health, Dalhousie University, Halifax, NS, Canada** (C L Mah PhD); **Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada** (C L Mah)

Correspondence to:
Dr Julie Brimblecombe, Department of Nutrition, Dietetics and Food, Monash University, Melbourne, VIC 3168, Australia
julie.brimblecombe@monash.edu.au

Introduction

Diet-related risk factors are a major cause of death and disease worldwide.[1] Food retail stores, including grocery stores and supermarkets, provide for a high proportion of people's food and beverage needs, and are therefore a prime setting to implement change designed to increase purchase of healthy food and decrease purchase of unhealthy food so as to improve population diet and health.[2] Merchandising in food retail stores is highly effective in stimulating sales of a product.[3] Merchandising is initiated by manufacturers or retailers to position products at point of sale so as to stimulate customers' purchases (eg, price promotions, end-of-aisle displays, increased product facings, placement at eye level, and display of products in a secondary location).[3] Consumer behaviour theories indicate the effectiveness of merchandising techniques to be a consequence of their potential to capture consumers' attention and improve customer appraisal of the product, and thereby increase the chance of an unplanned or impulse purchase.[3–5]

Altering the characteristics of in-store environments with the intent to incentivise change in purchasing behaviour is gaining attention in research and public health policy.[6–13] Studies examining in-store strategies to improve health have, to date, focused on promoting healthier food, rather than discouraging the purchase of unhealthy food.[7–11,13] Many unhealthy foods and beverages (ie, those high in added sugar, fat, or salt, or all three; also known as discretionary products) have high hedonic appeal (ie, emotionally desirable or appealing), making

Research in context

Evidence before this study

Altering the characteristics of in-store environments to enable healthy behaviour is gaining attention in research and public health policy. A 2019 Cochrane review of interventions that altered the availability and proximity of snack food and beverages to the consumer reported an effect on selection and consumption; evidence was of low certainty and more high-quality studies in real-world settings were identified as needed. Five real-world randomised trials, identified through systematic literature review of grocery store interventions, altered the store environment (using signage, display, item placement, or taste testing, or all four). Two studies showed effects on purchasing in intervention stores compared with control stores. A cluster-controlled trial done with Native American Nation convenience stores used in-store signs, display, and price discounts, and increased the availability and self-reported purchasing of targeted healthy foods among high-frequency shoppers in intervention stores. These studies primarily focused on promoting healthier food. However, it is the unhealthy products that are typically more heavily merchandised (ie, made highly visible and attractive), and might provide a significant proportion of population diet. To the best of our knowledge, Healthy Stores 2020 is the first real-world in-store trial to partner with retailers to investigate the effect of modification of merchandising of unhealthy food and beverages on both public health and business outcomes.

Added value of this study

We provide robust evidence that optimising the store environment as a health-enabling setting, in partnership with retailers, offers a key opportunity to improve dietary quality and potentially reduce preventable chronic disease burden. We show that a strategy co-designed to restrict merchandising of target food and beverages can decrease purchasing of unhealthier products without damaging profits, representing a win–win strategy for retailers and public health. Our research with the Arnhem Land Progress Aboriginal Corporation, advances knowledge on the co-design, implementation and optimisation of pragmatic food retail strategies to enhance population-level diet and potentially health outcomes.

Implications of all the available evidence

Merchandising of food and beverage products is a key factor influencing consumer behaviour, and one that, with appropriate support, can be modified by retailers to positively impact population diet. Healthy Stores 2020 has demonstrated a real-world example of retailer contribution to enhanced societal health, and provides evidence for policy makers and communities on how food retail environments can be optimised to positively impact consumer purchasing.

them particularly attractive as impulse purchases triggered by merchandising techniques.[5,14] These products are often heavily merchandised and might comprise a substantial proportion of a population's dietary intake.[15,16] A 2019 Cochrane review[6] assessed the impact of altering the availability (ie, number of options and proportion of healthier options) or proximity to the consumer of snack food and beverages on selection and consumption, and found that microchanges can alter behaviour; however, evidence was of low certainty and more high-quality studies in real-world settings were needed.[15]

For more on **ALPA** see https://www.alpa.asn.au/

In First Nations communities in remote regions of Australia, in-store strategies show promise in promoting healthy food and beverage sales,[17–21] and community leaders and retailers support strategies to reduce sales of unhealthy food and beverages, particularly those high in sugar.[21,22] First Nations Peoples of Australia, due to colonisation and continued social injustices, have rates of diet-related disease (eg, type 2 diabetes, cardiovascular disease, kidney disease, and related conditions such as obesity) that exceed that of the general Australian population. Excessive intake of discretionary food is a major contributor to preventable chronic disease for all Australians. These products have been shown to provide 41% of total energy[23] and account for 53% of food and beverage expenditure in some remote First Nations communities.[21] Reducing discretionary product intake is imperative to improving health in this population group.

First Nations Peoples in remote Australia, in many instances, have sovereignty of their community store; thus, communities have the power to initiate and sustain store-level change.[24] Optimisation of the store environment as a health-enabling setting, in partnership with the community, is a key strategy and opportunity to improve dietary quality and reduce the high level of preventable chronic disease burden in this setting.

This Article reports on the impact on sales of the Healthy Stores 2020 trial that was co-designed and done in partnership with the Arnhem Land Progress Aboriginal Corporation (ALPA), an Australian First Nations Corporation that, at the time of the study, owned, managed, or both owned and managed, 25 stores in 24 community locations in remote Australia. The Healthy Stores 2020 strategy involved reversing commonly used merchandising techniques for discretionary or targeted high-sugar products (ie, price promotions; aesthetic display elements and signage; close proximity of the product to the customer at checkout; display in prime, high foot traffic locations; and area [facings] devoted to the product).[25] Theoretically, reducing merchandising should reduce purchases, because consumers tend to make choices after minimal search for products,[26] and the strategy was anticipated to be particularly effective at reducing unplanned and impulse purchases where visual presence is key and price comparison is not used.[27] We tested this novel strategy in a real-world setting using a pragmatic randomised trial

design to investigate the effect on customer purchasing and retail business performance. This study provides evidence from a real-world setting, in partnership with an Australian Indigenous retail organisation, that can inform health-enabling retail practice and policy.

Methods

Study design and participants

In this community-level pragmatic, partially randomised, parallel group trial, we aimed to evaluate the impact of a strategy co-designed with industry to reduce merchandising of discretionary products (targeting those high in free sugars; ie, added sugars to food and drinks and sugars naturally occurring in honey, fruit juice, and fruit juice concentrates) on customer purchasing and business performance. We hypothesised that the strategy would lead to reduced free sugars purchased (per total MJ energy) through reducing sales of the targeted products). Substudies on customer response and strategy feasibility from the retailer perspective will be reported separately.

ALPA owns, manages, or both owns and manages, stores in First Nations communities in the Northern Territory (NT) and Far North and Torres Strait Island regions of Queensland (QLD) in Australia (appendix p 5). These communities have limited access to services and by definition are geographically isolated from service centres.[28] Food is freighted by road transport, sea barge, small aircraft, or all three. Of the 25 stores ALPA serviced at the time of the design stage of this study (2017), six were ALPA-owned stores in the NT, each represented by a community-elected ALPA board director. 13 stores in the NT (n=12) and QLD (n=1) were managed by ALPA on behalf of Indigenous corporations and their community-elected directors. Island and Cape stores (n=6), all in QLD, were governed by an ALPA-company board. All stores owned, managed, or both owned and managed by ALPA were invited to participate (n=25).

This research was granted ethical approval by the NT Top End (HREC-2018–3048) and Far North Queensland (HREC-18-QCH-23–1211) Human Research Ethics Committees and was done in line with the Australian Code for the Responsible Conduct of Research[29] and guidelines on the ethical conduct in research with Aboriginal and Torres Strait Islander Peoples and communities.[30] We applied the He Pikinga Waiora framework[31] to describe our consideration of culture and community engagement in the conduct of this trial (appendix p 3).

Information on the study was presented to the respective boards and store directors by an ALPA staff member (nutritionist or area manager) alone or with a member or members of the research team. Consent was sought from store directors.

Randomisation

Stores were randomly allocated (1:1) to intervention (Healthy Stores 2020 strategy for 12 weeks) or control (usual store practice). Usual practice involved endeavour to align retail practice with the ALPA nutrition policy. We assessed treatment effect as the difference in outcomes with the strategy compared with no strategy. Full study design details are reported in the study protocol.[17] We anticipated an immediate strategy effect on sales. A 12-week strategy period was therefore considered ideal to ensure there was enough time to determine if there was an effect.

Randomisation was done by a statistician after recruitment was complete, using a computer-generated randomisation list. The randomisation was based on a single sequence of random assignments. Allocation was concealed. Partial randomisation occurred because two of the stores, which were in the same community, were allocated together.

Procedures

The strategy (Healthy Stores 2020) was co-designed with ALPA (appendix p 4) and included seven components to be implemented simultaneously (panel). Of these, four components were related to reduced merchandising of all discretionary food and beverage products (strategy components 1–4), and three (strategy components 5–7) targeted the biggest contributors to free sugars: table sugar, sugar-sweetened beverages, confectionery, and sweet biscuits. Together, these targeted product types contributed 64% of the energy from discretionary product purchases and 87% of free sugars (ie, all sugars added to products plus sugars naturally present in honey, syrups,

See Online for appendix

Panel: **The complete Healthy Stores 2020 strategy***

- No promotional activity on discretionary food and beverages, including no price promotions or discounts, volume promotions, posters, shelf stripping, or fridge branding
- No misleading promotional activity on food and beverages (eg, fruit and vegetable fridge branding on a fridge containing confectionery, or sugar-free stripping in front of sugar-sweetened beverages in fridges)
- No visible availability of discretionary food and beverages at counter, ends of aisles, and other high-traffic areas (eg, front and end-of-aisle displays) with substitute availability of healthier products
- Reduced facings of table sugar, confectionery, and sweet biscuits with substitute facings of healthier products or non-food products, aiming for (1) table sugar facings reduced to one bay, no multipacks displayed, smaller units at eye level; (2) sweet biscuit products with multiple facings reduced by half† and no increase in variety; and (3) confectionery products with multiple facings reduced by half† and no increase in variety
- Reduced refrigerator facings for targeted beverages, substituting with healthier beverages
- Soft drink beverage units of more than 600 mL not permitted in fridges (only in stores with no competitor retail outlet; n=6), but still available for sale not chilled
- Floor sticker (showing amount of sugar per 1·25 L soft drink), shelf stripping (giving a warning of high sugar), and floor sticker promoting water as the healthiest choice

*Discretionary food and beverage products were those classified as red according to the Arnhem Land Progress Aboriginal Corporation nutrition policy, as detailed in the appendix (p 6). Detailed information on each of the Healthy Stores 2020 strategies is provided in the appendix (p 8). †If three facings of same product, reduced to two facings.

and fruit juices), using purchasing data from 20 remote community stores.[17]

Due to ALPA and store directors' concerns about a potential adverse impact on business outcomes, the strategy was modified for stores with food retail competition within or in close proximity to the community (one in the NT; three in QLD). These stores did not implement the component of the strategy where soft drink units of more than 600 mL were removed from refrigerators (modified six-point strategy).

To aid strategy implementation, we identified and listed the changes needed in each of the intervention stores. Store staff and research team members then retrofitted each of the intervention stores according to the Healthy Stores 2020 strategy protocol in the ten intervention stores (four stores in week ending Sept 2, 2018; six stores in week ending Sept 9, 2018). Store managers and their staff maintained the strategy thereafter, until Dec 2, 2018 (12–13 full weeks after strategy set-up). Control stores continued usual business practice.

We collected weekly sales data, including unit quantity, dollar value (AU$), and gross profit for each product sold in each store during baseline (June–September, 2018) and follow-up (12–13 weeks each, depending on strategy set-up week; total 25 weeks per store; appendix p 9). Product categorisation, sourcing of unit weight per volume, and linkage to nutrient composition information is described in the appendix (p 10).

Store managers in intervention and control stores were interviewed by a research assistant using a merchandising checklist every 2 weeks via telephone (appendix p 11), and were requested to provide photographs of specified store areas. Where non-adherence with the strategy was identified, further information was sought and action taken to rectify the issue (eg, removing a promotion on a discretionary product). Photographic data were also collected in all stores by public health nutritionists or members of the research team at the end of the baseline and follow-up periods, according to a purpose-built photographic checklist (appendix p 11). Adherence to each strategy component was assessed using these photographic and merchandising checklist data.

Outcomes

The outcomes provided a standardised measure of free sugar and weight of discretionary food and beverages, and targeted product (table sugar, sugar-sweetened beverages, sweet biscuits, and confectionery) purchases in addition to total and non-targeted discretionary and non-targeted products to assess substitution effect. Business outcomes of importance to ALPA were included. Free sugar was selected as the primary outcome because of the ALPA board's concern regarding high sugar consumption in association with the high burden of chronic disease experienced by First Nations Peoples in the communities they served. The primary outcome was therefore difference in change in free sugars purchased relative to energy purchased (total g/MJ total energy) with the strategy compared with no strategy. Weight was included as a unit of measure to provide a meaningful outcome for store owners, retailers, and other end-users who could influence evidence uptake into practice and policy.

Secondary outcomes were free sugars relative to energy purchased (free sugars g/total MJ); weight relative to energy purchased (g/total MJ); and dollar value relative to total dollars (% total $) for discretionary food and beverages, targeted food and beverages, targeted beverages, targeted soft drinks, targeted table sugar, targeted confectionery, targeted sweet biscuits, non-targeted beverages, and non-targeted soft drinks. Business outcomes were gross profit (product sell price minus cost) of all food and beverages and basket size (number of items per transaction). Outcome definitions are provided in the appendix (p 12).

Statistical analysis

We anticipated a difference in total free sugar (g/total MJ) and in targeted products with the strategy versus no strategy of approximately –8% to –9%, and –10%, respectively.[17] The estimated effect sizes were based on Batis and colleagues'[32] reported effect of an 8% tax applied by the Mexican Government on non-essential energy-dense foods, where low socioeconomic status households purchased, on average, 10·2% less taxed foods than expected (–44 g [–72 to –16] per capita per month). Using 20 weeks of data for 20 remote stores (ie, from Stores Healthy Options Project in Remote Indigenous Communities[17]), we found a 95% CI with a width of 3·6 for the difference in free sugars for two randomly chosen groups of ten stores. A corresponding power calculation was not necessary;[33] however, the proposed study would likely have approximately 90% power to detect a treatment effect of a 6% reduction in the primary outcome (free sugars g/total MJ), as described in our protocol.[17]

All analyses of treatment effect used longitudinal data analysis models via Stata, version 16, on weekly outcomes with fixed effects for week and intervention (as a time-varying covariate), random effects for the stores, and autoregressive structure of order 1. Outcomes were log-transformed before analysis because variables were not normally distributed. Treatment effect is expressed as a relative percentage difference (95% CIs). Residuals were checked for normality.

Analyses were done according to the intention-to-treat principle, with the one deviation from the study protocol,[17] where weekly rather than 2-weekly data were used to account for staggering of strategy implementation over 2 weeks. Details on statistical analysis are provided in the appendix (pp 13–15).

We did a secondary analysis by subgroup of complete (seven-point) versus modified (six-point) strategy.

We did sensitivity analyses for the main outcomes (total free sugars g/total MJ; targeted and non-targeted

food relative weight g/total MJ; total gross profit) with stores that were allocated together combined (ie, n=19); outliers excluded; removing each store one at a time; including a longer (1 year) baseline period of store sales data; adjusting the study periods (11 weeks baseline and 12 weeks follow-up, where the 2 weeks of strategy set-up were excluded); and a simple ANCOVA analysis (appendix pp 14–15). We did additional sensitivity analyses for gross profit by including gross profit from non-food products and food and beverage products, and accounting for losses from product write-offs (where products were coded as out of date, close to date, or damaged) occurring in that week for targeted food and beverages only, and all food and beverages.

Role of the funding source

The funder did not have any role in the study design; collection, analysis, and interpretation of data; writing the report; or the decision to submit the report for publication. EMc, JB, and MDC had access to the data. All authors made the decision to submit the Article for publication.

Results

Between June 13 and Aug 15, 2018, 20 (80%) of the 25 stores invited consented to participate; ten stores were randomly assigned to intervention and ten to control (figure 1). The participating stores serviced 19 communities with a combined population of 16 070 people.[34] The ten intervention stores serviced communities (n=10) with a median population per community of 578 (range 223–2560; IQR 368–947), and a median of 94% (range 73–97; IQR 91–95) of the population identifying as Aboriginal, or Torres Strait Islander, or both.[35] The ten control stores serviced communities (n=9) with a median population per community of 814 (range 378–2087; IQR 507–974), and a median of 92% (range 69–94; IQR 86–94) of the population identifying as Aboriginal, or Torres Strait Islander, or both.[34] Store characteristics are shown in table 1. A descriptive analysis of baseline and follow-up values for control and intervention stores, and percentage change from baseline to follow-up are shown in table 2.

At baseline, some stores already adhered to elements of the strategy (appendix pp 16–17), including no promotional activity on discretionary products (intervention n=3; control n=3), no misleading promotional activity on discretionary products (intervention n=0, control n=2), and table sugar stocked to one bay or less (intervention n=6; control n=4). Full strategy implementation required strict adherence to all strategy components for all relevant products at all checkpoints. Median adherence score across intervention stores was 67% (IQR 52–71; appendix p 18). The few occurrences of non-adherence detected for the strategy components—no promotional activity, no misleading promotional activity, and no display in high-traffic areas—were when one to three product types only were detected as promoted at least once or misleading stripping, for example, was returned to the drink refrigerators by the supplier. All stores reduced sugar shelf space to one bay or less. Substantial reductions in facings of beverages, sweet biscuits, and confectionery were achieved from baseline to follow-up in intervention stores overall. Six stores, as intended, had not refrigerated more than 600 mL targeted beverages and nine stores fully implemented the shelf stripping and floor stickers. Seven of ten stores achieved a reduction in percentage of targeted beverages. Eight of ten stores achieved a reduction in sweet biscuits facings, and nine of ten stores achieved a reduction in confectionery facings. In control stores, the percentage of targeted beverage facings increased or stayed the same in six stores, facings of

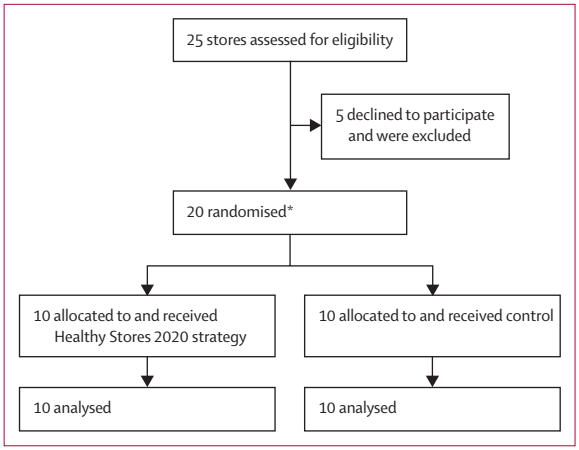

Figure 1: **Trial profile**
*Two stores in the same community were allocated together, therefore n=19 by unit of allocation. The two stores grouped together received control.

	All stores (n=20)	Intervention (n=10)	Control (n=10)
Location			
Northern Territory	14 (70%)	7 (70%)	7 (70%)
Queensland	6 (30%)	3 (30%)	3 (30%)
Nearest food retail outlet outside of community			
By air or sea	8 (40%)	5 (50%)	3 (30%)
By road	12 (60%)	5 (50%)	7 (70%)
Distance, km	103 (48–119)	77 (32–107)	106 (65–171)
Competitor store			
Yes	9 (45%)	4 (40%)	5 (50%)
No	11 (55%)	6 (60%)	5 (50%)
Alternate food outlets in community			
Yes	8 (40%)	4 (40%)	4 (40%)
No	9 (45%)	5 (50%)	4 (40%)
Unsure	3 (15%)	1 (10%)	2 (20%)
ALPA owned			
Yes	12 (60%)	6 (60%)	6 (60%)
No	8 (40%)	4 (40%)	4 (40%)

Data are n (%) or median (IQR). ALPA=Arnhem Land Progress Aboriginal Corporation.

Table 1: **Store characteristics**

	Baseline		Follow-up		Change	
	Control	Intervention	Control	Intervention	Control	Intervention
Free sugars, g/MJ						
Food and beverages, total*	14·3 (1·3)	14·7 (1·2)	14·8 (1·3)	14·8 (1·2)	3·5% (3·5)	0·7% (2·2)
Food and beverages, discretionary	14·0 (1·3)	14·4 (1·2)	14·5 (1·3)	14·5 (1·2)	3·8% (3·8)	0·7% (2·5)
Food and beverages, targeted	12·6 (1·4)	13·0 (1·2)	13·2 (1·4)	13·2 (1·3)	4·4% (4·1)	1·1% (2·1)
Food, discretionary non-targeted	1·3 (1·2)	1·3 (1·2)	1·3 (1·2)	1·2 (1·2)	–2·1% (6·2)	–2·1% (10·1)
Beverages, targeted	5·0 (1·3)	5·6 (1·4)	5·7 (1·3)	6·1 (1·5)	14·0% (9·4)	7·6% (6·2)
Soft drinks, targeted	3·0 (1·6)	3·5 (1·5)	3·2 (1·6)	3·2 (1·7)	6·8% (9·3)	–8·8% (13·7)
Table sugar, targeted	6·1 (1·7)	4·7 (2·2)	6·1 (1·7)	4·5 (2·4)	–0·2% (3·4)	–2·6% (10·6)
Confectionery, targeted	0·8 (1·3)	1·0 (1·3)	0·6 (1·3)	0·7 (1·3)	–17·2% (9·1)	–24·4% (6·1)
Sweet biscuits, targeted	0·3 (1·3)	0·3 (1·7)	0·3 (1·2)	0·3 (1·8)	–13·4% (5·5)	–9·8% (11·8)
Weight, g/MJ						
Food and beverages, total	153·4 (1·1)	166·3 (1·3)	158·3 (1·1)	173·5 (1·3)	3·2% (1·7)	4·4% (5·0)
Food and beverages, discretionary	70·6 (1·3)	79·8 (1·3)	73·4 (1·3)	78·6 (1·3)	4·0% (3·6)	–1·4% (4·3)
Food and beverages, targeted	55·0 (1·4)	63·4 (1·3)	58·2 (1·4)	62·6 (1·4)	5·9% (4·8)	–1·3% (5·1)
Food, discretionary non-targeted	14·5 (1·4)	15·8 (1·3)	14·1 (1·4)	15·5 (1·3)	–2·7% (3·8)	–1·8% (4·4)
Beverages, targeted	45·3 (1·4)	53·1 (1·5)	48·9 (1·4)	52·7 (1·5)	8·1% (6·0)	–0·6% (6·9)
Soft drinks, targeted	30·1 (1·6)	35·8 (1·5)	32·0 (1·6)	32·3 (1·7)	6·7% (9·6)	–8·8% (13·8)
Table sugar, targeted	6·1 (1·7)	4·7 (2·2)	6·1 (1·7)	4·5 (2·4)	–0·2% (3·4)	–2·6% (10·6)
Confectionery, targeted	1·5 (1·3)	1·9 (1·3)	1·3 (1·3)	1·5 (1·2)	–16·8% (7·2)	–21·5% (7·3)
Sweet biscuits, targeted	1·3 (1·3)	1·3 (1·7)	1·1 (1·2)	1·2 (1·8)	–12·8% (5·2)	–10·4% (12·3)
Beverages, non-targeted	25·8 (1·4)	30·8 (1·9)	27·7 (1·4)	37·3 (2·0)	7·7% (5·0)	22·0% (12·6)
Soft drinks, non-targeted	3·4 (1·9)	5·6 (1·7)	3·5 (1·9)	7·2 (1·8)	2·1% (12·4)	31·3% (27·1)
Dollars (AU$), % total						
Food and beverages, discretionary	0·4% (1·2)	0·5% (1·2)	0·4% (1·2)	0·5% (1·2)	–4·4% (3·9)	–5·0% (5·1)
Food and beverages, targeted	0·2% (1·3)	0·3% (1·2)	0·2% (1·3)	0·3% (1·3)	–2·7% (5·3)	–4·4% (7·3)
Food, discretionary non-targeted	0·2% (1·2)	0·2% (1·2)	0·2% (1·2)	0·2% (1·2)	–6·4% (3·5)	–6·3% (4·5)
Beverages, targeted	0·2% (1·4)	0·2% (1·2)	0·2% (1·4)	0·2% (1·3)	3·9% (6·2)	2·2% (8·1)
Soft drinks, targeted	0·1% (1·5)	0·1% (1·3)	0·1% (1·5)	0·1% (1·4)	4·7% (9·1)	–0·5% (6·4)
Table sugar, targeted	0·0% (2·0)	0·0% (3·2)	0·0% (2·0)	0·0% (3·6)	–6·2% (4·5)	–9·6% (12·5)
Confectionery, targeted	0·0% (1·3)	0·1% (1·3)	0·0% (1·3)	0·0% (1·3)	–19·6% (6·6)	–21·0% (11·2)
Sweet biscuits, targeted	0·0% (1·5)	0·0% (2·5)	0·0% (1·4)	0·0% (2·7)	–15·9% (6·2)	–16·1% (9·2)
Beverages, non-targeted	0·1% (1·2)	0·1% (1·2)	0·1% (1·2)	0·1% (1·3)	–5·0% (5·9)	8·7% (8·6)
Soft drinks, non-targeted	0·0% (1·8)	0·0% (1·7)	0·0% (1·8)	0·0% (1·8)	–1·3% (12·5)	20·8% (22·1)
Absolute variables, weekly means						
Food and beverages, total energy, MJ	38 599·7 (1·7)	20 101·6 (2·3)	35 858·3 (1·8)	19 108·4 (2·4)	–7·0% (4·4)	–4·4% (9·9)
Food and beverages, total amount, AU$	53 399·8 (1·6)	30 531·0 (2·2)	48 866·6 (1·7)	29 329·1 (2·2)	–8·4% (4·7)	–3·5% (9·7)
Food and beverages, total weight, kg	5919·7 (1·6)	3342·8 (2·0)	5675·0 (1·7)	3315·2 (2·1)	–4·1% (4·1)	–0·3% (10·3)

Data are geometric mean (SD) at baseline and follow-up periods, and mean (SD) of percentage change from baseline to follow-up periods. Analysis done on summarised dataset (weekly values summed to baseline and follow-up level for each store; relative outcomes calculated using the summed values; absolute values calculated as weekly means to account for different number of weeks at baseline and follow-up). n=10 each for control and intervention. Discretionary food and beverage products were those classified as red according to the Arnhem Land Progress Aboriginal Corporation nutrition policy, as detailed in the appendix (p 6). *Primary outcome.

Table 2: **Descriptive analysis of baseline and follow-up values, and percentage change from baseline to follow-up period**

sweet biscuits increased or stayed the same in six stores, and seven stores had an increase or no change in confectionery facings (appendix pp 16–17).

The Healthy Stores 2020 strategy reduced sales of total free sugars (–2·8% relative percentage change g/total MJ, 95% CI –4·9 to –0·7; table 3).

There was a statistically significant reduction in sales of free sugar from targeted beverages (–6·8%, –10·9 to –2·6) and a reduction in sales of free sugar from confectionery (–7·5%, –14·3 to –0·2), but no statistically significant difference in free sugar from targeted table sugar (–2·3%, –8·6 to 4·5), and sweet biscuits (4·7%, –3·0 to 12·5). The reduction in free sugar was greatest for targeted soft drinks (–13·4%, –18·7 to –7·7). In terms of effect on weight sold relative to total energy, targeted beverages were reduced by 8·4% (–12·3 to –4·3), and targeted soft drinks were reduced by 13·2% (–18·5 to –7·6). Non-targeted beverages were increased by

	Free sugars (g/total MJ)	Weight, relative (g/total MJ)	Dollars (AU$; % total)
Food and beverages, total	−2·8% (−4·9 to −0·7)*	0·5% (−1·9 to 2·9)	NA
Food and beverages, discretionary†	−3·1% (−5·2 to −0·9)	−5·4% (−8·1 to −2·6)	−1·8% (−3·6 to 0·0)
Food and beverages, targeted	−3·4% (−5·7 to −1·0)	−7·0% (−10·2 to −3·6)	−3·1% (−5·7 to −0·5)
Food, discretionary non-targeted	0·3% (−4·2 to 5·0)	0·9% (−2·0 to 3·9)	−1·0% (−3·3 to 1·4)
Beverages, targeted	−6·8% (−10·9 to −2·6)	−8·4% (−12·3 to −4·3)	−3·4% (−6·7 to −0·1)
Soft drinks, targeted	−13·4% (−18·7 to −7·7)	−13·2% (−18·5 to −7·6)	−5·7% (−10·0 to −1·3)
Table sugar, targeted	−2·3% (−8·6 to 4·5)	−2·3% (−8·6 to 4·4)	−4·9% (−11·7 to 2·4)
Confectionery, targeted	−7·5% (−14·3 to −0·2)	−4·6% (−11·1 to 2·3)	−2·2% (−8·8 to 4·8)
Sweet biscuits, targeted	4·7% (−3·0 to 12·5)	3·2% (−4·3 to 11·0)	0·9% (−5·8 to 7·9)
Beverages, non-targeted	NA	10·1% (4·2 to 16·4)	10·9% (6·8 to 15·2)
Soft drinks, non-targeted	NA	23·5% (10·2 to 38·5)	17·4% (6·0 to 30·1)

Data are relative percentage change (95% CI) derived from mixed model coefficients for treatment effect (vs no strategy). NA=not applicable. *Primary outcome. †Discretionary food and beverage products were those classified as red according to the Arnhem Land Progress Aboriginal Corporation nutrition policy, as detailed in the appendix (p 6).

Table 3: **Effect on sales of targeted and non-targeted outcomes**

10·1% g/total MJ (4·2 to 16·4), and non-targeted soft drinks by 23·5% (10·2 to 38·5; table 3). Difference in relative weight (g/total MJ) of confectionery, sweet biscuits, and table sugar did not reach statistical significance (table 3). Changes in other nutrients, food groups, and units were consistent with these results (appendix p 19).

There was an increase in total dollar spend of 3·3% (95% CI −1·4 to 8·3), but this was not statistically significant. The percentage of dollar spend on targeted food (combined or by product type) reduced, except for sweet biscuits, and the percentage of dollar spend on non-targeted beverages and non-targeted soft drinks increased (table 3).

There was a statistically significant increase in gross profit from food and beverage products (5·3%, 95% CI 0·3 to 10·5). No statistically significant difference in basket size was observed (1·4%, −2·1 to 4·9).

As shown in figure 1, the effect on the primary outcome of free sugar (g/total MJ) was similar with the complete strategy (seven-point strategy; n=6 stores) and modified strategy (six-point strategy; n=4 stores). The effect on free sugars from targeted beverages (and targeted soft drinks) was larger with the complete strategy (including removal of sugar-sweetened soft drinks of more than 600 mL from refrigerators) than with the modified strategy, and the effect on free sugars from table sugar and confectionery was larger with the modified strategy than the complete strategy (figure 2; appendix p 20). In the complete strategy (appendix p 21), quantity sales of 1·25 L targeted beverages decreased, whereas the quantity of sales of 600 mL targeted beverages and 1·25 L non-targeted beverages increased. The same pattern was not evident with the modified strategy (appendix p 21). The direction of the treatment effect for all outcome measures remained consistent in sensitivity analyses, except that reductions in free sugar from confectionery were no longer significant when the stores that were allocated together were pooled for analysis (nine *vs* ten), with an extended baseline period, and when analysed using the simple ANCOVA (appendix p 22), and gross profit was no longer significantly increased when some stores were removed in the analyses where each store was dropped one at a time (appendix pp 24–25).

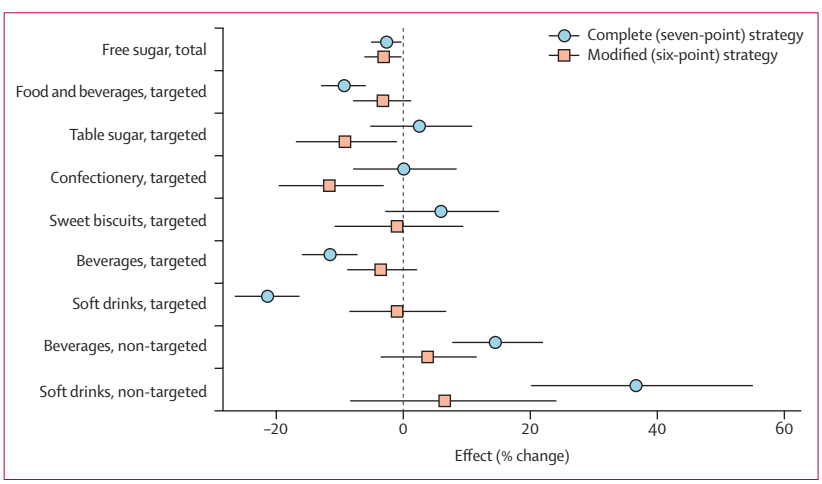

Figure 2: **Effect sizes for Healthy Stores 2020 complete (seven-point) strategy and modified (six-point) strategy versus no strategy**
Values are modelled effect and 95% CIs. Free sugars, total includes free sugars from all foods and beverages (free sugars g total/MJ). Targeted and non-targeted outcomes are expressed as relative weight (g/total MJ).

The treatment effect on gross profit remained consistent when examining total gross profit, including non-food and food and beverage items (5·7%, 95% CI 0·4 to 11·2), and when accounting for losses due to write-offs (where products were coded as out of date, close to date, or damaged) of targeted products (4·9%, −0·2 to 10·3) or for all food and beverage products (6·7%, 1·2 to 12·5).

Discussion

The Healthy Stores 2020 strategy was successful in achieving a significant overall reduction in free sugar with no adverse impact on gross profit. A large reduction of −13·4% in targeted soft drink free sugar was observed alongside a large increase of 23·5% in non-targeted soft

drink weight sold. Targeted confectionery free sugar was significantly reduced (–7·5%). No overall statistically significant impact on free sugar sales from table sugar or sweet biscuits was observed.

The absence of a statistically significant treatment effect for table sugar is not surprising because many stores were already meeting the strategy at baseline. In addition, we anticipated that the Healthy Stores 2020 strategy might work best on products susceptible to impulse or unplanned purchases. Staple items such as table sugar might be less likely to attract an impulse purchase than the other targeted products, confectionery, and beverages. A different strategy approach, alongside restricted merchandising, might be required to stimulate change in purchasing behaviour of staple items. The absence of treatment effect was also shown for sweet biscuits. Sweet biscuits, because of their hedonic characteristics, might trigger an impulse purchase; however, in ALPA stores they are less likely than confectionery to be displayed in prime placement locations at the front of counter or in multiple locations, meaning there is less opportunity for an impulse purchase, and therefore less opportunity for Healthy Stores 2020 to have had an impact.

The difference in effect between the complete and modified strategies, compared with no strategy, reveals that the large overall reduction in targeted soft drink sales and concomitant large increase in non-targeted soft drink sales can near fully be attributed to the removal of larger unit soft drinks from refrigeration and a switch by customers in these stores to refrigerated smaller unit sugar-sweetened soft drink or other healthier beverages, or both. Three of the four stores that received the modified strategy did not reduce targeted beverage facings. Substantial reductions in facings of confectionery, however, were achieved in three of these four stores. Overall reductions in free sugars from confectionery and table sugar with the modified strategy compared with no strategy probably explain the overall reduction in free sugars observed in this group.

A number of studies, including a study[35] done in partnership with Native American Nation-owned convenience stores, have co-designed retail strategies aimed at affecting healthy food sales with retailers.[36] Few studies globally have assessed the effectiveness of strategies aimed at restricted merchandising for unhealthy food and beverages to improve population health. A study targeting unhealthy food substituted confectionery with fruit and healthy snacks at supermarket checkouts.[37] The strategy was received positively by customers, but had no effect on confectionery sales. Another study found that more shelf space for healthy snacks in a checkout display led to higher sales of healthy snacks.[38] One of the only studies we know of to have used merchandising techniques to promote healthier beverages in-store (ie, substituted facings of regular-sugar soft drink with healthier alternatives in-aisle and at checkout, with signage) had a positive effect on water sales, but no effect on regular-sugar beverage sales, which the authors attributed to low levels of implementation.[39] Removal of sugar-sweetened soft drink from sight of customers in a hospital cafe, was shown to substantially reduce the proportion of sales to total drink sales.[40] Healthy Stores 2020 is not the first time First Nations leaders in remote Australia have supported in-store strategies to reduce sugar-sweetened soft drink sales. The Amata Community Council in the Anangu Pitjantjatjara Yankunytjatjara Lands reduced availability of sugar-sweetened beverages in the community store by not stocking the three top-selling items. Over a 12-month period, a 28% reduction in total sugar purchased was reported.[19]

The reduction in free sugars we have shown with the Healthy Stores 2020 strategy has important health implications. Free sugars per MJ total energy at baseline was 2·6 times the WHO recommendation of 10% for the prevention of dental disease and overweight and obesity.[41] Because of the high percentage of free sugars to energy in our study context, even a modest reduction, as achieved by the Healthy Stores 2020 strategy, can have substantive health implications at the population level, assuming sales is a proxy for intake. The relative reduction in free sugars observed is equivalent to approximately a 1 percentage point reduction in free sugars to energy. According to Yang and colleagues,[42] people consuming 25% energy from free sugars have an approximate 10% lower adjusted hazard ratio for cardiovascular disease mortality than people consuming 26% energy from free sugars (2·0 *vs* 2·25 adjusted hazard ratio compared with the lowest quintile of 7·4% energy from free sugars). We achieved a reduction in soft drink equivalent to 440 mL per person per week in the communities that removed the larger-sized beverages from refrigeration (based on an average intake of 8·9 MJ) and an approximate 1·8 t removal of sugar overall in intervention stores from purchased food and beverages. The impact on free sugar was less than the 8–9% reduction anticipated. The observed reduction of 7·0% (95% CI –10·2 to –3·6) in relative weight of targeted products purchases is closer to the 10·2% reduction in non-essential energy-dense foods shown among low-income households with the Mexican Government's 8% tax.[32] Although taxes are an important public health instrument to help counter obesity and related disease through reduced purchasing of discretionary products, our study shows restricted in-store merchandising of discretionary products to also be worthy of public health attention.

To the best of our knowledge, this study is the first real-world in-store trial to report treatment effects on profitability.[43] Profitability accounts for changes in the product sales mix relative to individual product profit margins, and is an important indicator for retailers. Although margins are sometimes viewed as proprietary industry information, in this study, gross profit data were made available to the research team by ALPA, enabling

our analysis of this outcome measure. Sustained profitability is often a critical factor in retailer uptake of a strategy. In the co-design stage, ALPA also indicated they would cease the trial if customer satisfaction was adversely affected. ALPA internally monitored the impact of Healthy Stores 2020 on customer satisfaction and store management satisfaction, in addition to profitability. ALPA reported that Healthy Stores 2020 was acceptable and feasible on these dimensions.

How the Healthy Stores 2020 strategy worked might have depended on a number of contextual factors, which are important to consider in making inferences from a pragmatic trial. These factors included the characteristics of the strategy co-design, target population, delivery mechanisms, and implementation.[44] The majority of the study population live in close proximity to the community store and are likely to make multiple shops in one day rather than occasional shops. Household infrastructure, such as refrigeration, can also be limited in First Nations communities in remote Australia. These factors might have influenced the likelihood of a customer choosing a smaller-sized refrigerated drink, rather than an off-the-shelf larger sized drink to refrigerate at home. Customers, in general, have been shown to make in-store decisions relatively quickly with minimal product search,[26] so the reduction in targeted soft drink sales might have occurred regardless of access to a household refrigerator. However, little is known about the shopping behaviour of customers in First Nations communities in remote Australia.[45] Children are afforded agency at a young age and can be seen making purchases within stores.[46,47] Because children are susceptible to marketing activity,[46,47] this characteristic might result in a larger Healthy Stores 2020 effect than might be possible in different supermarket contexts. Our baseline data, on the other hand, indicate lower levels of merchandising of discretionary food and beverages in stores in remote Australia than those observed in non-remote supermarkets,[15,16] suggesting a lot more room for improvement in those mainstream supermarkets.

ALPA's long commitment to advancing nutrition goals for the communities they serve, and their leadership and whole-of-organisation approach to implementation were important to the success of Healthy Stores 2020. ALPA board and management support for Healthy Stores 2020 was communicated across the whole of the organisation, and all departments (from retail store staff to head office operations) aligned their practice to the Healthy Stores 2020 goals. Setting up the strategy in-store for store management to then maintain, and regular communication with store managers to check implementation were also key to sustained implementation.

Strengths of our trial included the collaboration between the researchers and ALPA, and the communities more broadly, and the co-design of a strategy that was relevant to ALPA's business practice and policy. ALPA championed the implementation, enabling the collection of high-quality data, their meaningful interpretation, and their translation to ongoing practice. In a complex environment such as retail, a further strength of our strategy was that it modified different aspects of merchandising together, rather than singling out one component.[43] All targeted products were still made available to customers—ie, preserving choice, with only the merchandising of them being restricted. The controlled study design allowed for temporal variation to be accounted for, such as seasonal effects, which have been shown to be particularly strong for bottled water sales.[21] Randomisation helped to reduce potential confounders. Within-store comparisons, an important part of the mixed models, meant that unchanging store-level factors were accounted for and differences at baseline were adjusted for. Although masking was not possible, the use of objective sales and photographic data to assess impact and implementation fidelity minimised risk of bias.[48] Outcome measures were those both important to public health and business goals, and included targeted and non-targeted products to allow for assessment of substitution effect. Multiple statistical comparisons were made, thereby increasing the chance of statistically significant results. Results remained consistent with sensitivity analyses. We were likely underpowered to detect effects by subgroup (complete *vs* modified strategy stores).

The success of Healthy Stores 2020 provides ALPA with the business confidence to maintain the restrictions on merchandising of unhealthy food and beverages so as to support the health of the community as a whole. The customer-level data will enable an examination of how the strategy might impact differently on customer subgroups, and the association of customer characteristics and purchasing of discretionary food and beverages. The generalisability of our study findings to other populations needs consideration. Although customers in remote Australia are more likely than the general population to not have a refrigerator to cool ambient temperature drinks, make multiple daily shops, and highly value children's agency, the Healthy Stores 2020 strategy is also relevant to non-remote store settings. However, retailers in more competitive settings might not be prepared to take the economic risk in restricting merchandising. On the other hand, the Healthy Stores 2020 strategy demonstrates that with co-design to ensure contextual relevance, a strategy that aims to restrict merchandising of discretionary food and beverages can be a win–win strategy for retailers and customers.[37] There is societal support for legislative and corporate restrictions in the merchandising of unhealthy food and beverages, especially when targeting children.[49,50] Similarly to that suggested by Winkler and colleagues in a study on customer attitude and sales effect of substituting confectionery with fruit at shop counters,[37] Healthy Stores 2020 offers a way for stores to position themselves as responsible retailers, which could potentially strengthen customer loyalty without necessarily damaging profits.

More empirical studies that examine the long-term sales and health implications of strategies such as Healthy Stores 2020 are needed to provide the know-how and confidence for retailers and governments to enact policy in this area. Once we showed effectiveness of Healthy Stores 2020, the ALPA board and their management approved its implementation in all their stores and have incorporated it into their nutrition policy. This study adds to the growing literature on health retail strategies for First Nations communities in remote Australia and might inform future policy for the near 200 stores across remote Australia. We will continue to evaluate scale of Healthy Stores 2020 with ALPA.

Our study, done in partnership with a First Nations food retail organisation in Australia, shows that restricted merchandising of unhealthy food and beverages, while allowing for merchandising of healthier food and beverages in a real-world store setting, can achieve both public health and business relevant goals. We have shown that food retailers are willing to engage in health-enabling strategies that consider public health and business goals, as well as accommodate the needs of community in their design. Healthy Stores 2020 in the remote Australian context is a win–win strategy for customers, retailers, and public health. More research is needed to determine the long-term impact on health and business outcomes, with scale of Healthy Stores 2020, and how transferable our findings are to non-remote store settings.

Contributors

All authors contributed to study design, strategy components, interpretation and manuscript writing. JB and CLM conceived the study with Arnhem Land Progress Aboriginal Corporation (ALPA). JB led the study and drafted the Article. EMc analysed sales data and prepared results. MDC advised on statistical analysis and interpretation. EMi advised on cultural protocols. AG managed study execution. EC collected and analysed adherence data. KDS led the study within ALPA. All authors revised the Article and approved the final version.

Declaration of interests

We declare no competing interests.

Data sharing

Data sharing will be considered on contact with the corresponding author.

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References

1 Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet* 2006; **367:** 1747–57.

2 Glanz K, Bader MD, Iyer S. Retail grocery store marketing strategies and obesity: an integrative review. *Am J Prev Med* 2012; **42:** 503–12.

3 Garrido-Morgado A, Gonzalez-Benito O. Merchandizing at the point of sale: differential effect of end of aisle and islands. *Bus Res Q* 2013; **18:** 57–67.

4 Inman J, Winer R, Ferraro R. The interplay among category characteristics, customer characteristics, and customer activities on in-store decision making. *J Mark* 2009; **73:** 19–29.

5 Kacen J, Hess J, Walker D. Spontaneous selection: the influence of product and retailing factors on consumer impulse purchases. *J Retailing Consum Serv* 2012; **19:** 578–88.

6 Hollands GJ, Carter P, Anwer S, et al. Altering the availability or proximity of food, alcohol, and tobacco products to change their selection and consumption. *Cochrane Database Syst Rev* 2019; **9:** CD012573.

7 Cameron AJ, Charlton E, Ngan W, Sacks G. A systematic review of the effectiveness of supermarket-based interventions involving product, promotion, or place on the healthiness of consumer purchases. *Curr Nutr Rep* 2016; **5:** 129–38.

8 Castro IA, Majmundar A, Williams CB, Baquero B. Customer purchase intentions and choice in food retail environments: a scoping review. *Int J Environ Res Public Health* 2018; **15:** e2493.

9 Escaron AL, Meinen AM, Nitzke SA, Martinez-Donate AP. Supermarket and grocery store-based interventions to promote healthful food choices and eating practices: a systematic review. *Prev Chronic Dis* 2013; **10:** e50.

10 Gittelsohn J, Rowan M, Gadhoke P. Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. *Prev Chronic Dis* 2012; **9:** e59.

11 Liberato SC, Bailie R, Brimblecombe J. Nutrition interventions at point-of-sale to encourage healthier food purchasing: a systematic review. *BMC Public Health* 2014; **14:** 919.

12 Hollands GJ, Shemilt I, Marteau TM, et al. Altering micro-environments to change population health behaviour: towards an evidence base for choice architecture interventions. *BMC Public Health* 2013; **13:** 1218.

13 Hartmann-Boyce J, Bianchi F, Piernas C, et al. Grocery store interventions to change food purchasing behaviors: a systematic review of randomized controlled trials. *Am J Clin Nutr* 2018; **107:** 1004–16.

14 Thornton LE, Cameron AJ, McNaughton SA, Worsley A, Crawford DA. The availability of snack food displays that may trigger impulse purchases in Melbourne supermarkets. *BMC Public Health* 2012; **12:** 194.

15 Cameron AJ. The shelf space and strategic placement of healthy and discretionary foods in urban, urban-fringe and rural/non-metropolitan Australian supermarkets. *Public Health Nutr* 2018; **21:** 593–600.

16 Zorbas C, Gilham B, Boelsen-Robinson T, et al. The frequency and magnitude of price-promoted beverages available for sale in Australian supermarkets. *Aust NZ J Public Health* 2019; **43:** 346–51.

17 Brimblecombe J, Ferguson M, McMahon E, et al. Reducing retail merchandising of discretionary food and beverages in remote indigenous community stores: protocol for a randomized controlled trial. *JMIR Res Protoc* 2019; **8:** e12646.

18 Lee A, Rainow S, Tregenza J, et al. Nutrition in remote Aboriginal communities: lessons from Mai Wiru and the Anangu Pitjantjatjara Yankunytjatjara Lands. *Aust NZ J Public Health* 2016; **40** (suppl 1)**:** S81–88.

19 Butler R, Tapsell L, Lyons-Wall P. Trends in purchasing patterns of sugar-sweetened water-based beverages in a remote Aboriginal community store following the implementation of a community-developed store nutrition policy. *Nutr Diet* 2011; **68:** 115–19.

20 Gwynn J, Sim K, Searle T, Senior A, Lee A, Brimblecombe J. 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.

21 Brimblecombe J, Ferguson M, Chatfield MD, et al. Effect of a price discount and consumer education strategy on food and beverage purchases in remote Indigenous Australia: a stepped-wedge randomised controlled trial. *Lancet Public Health* 2017; **2:** e82–95.

22 Brimblecombe J, Bailie R, van den Boogaard C, et al. Feasibility of a novel participatory multi-sector continuous improvement approach to enhance food security in remote Indigenous Australian communities. *SSM Popul Health* 2017; **3:** 566–76.

23 Australian Bureau of Statistics. 4727·0.55·008—Australian Aboriginal and Torres Strait Islander Health survey: consumption of food groups from the Australian dietary guidelines, 2012–13. 2016. https://www.abs.gov.au/ausstats/abs@.nsf/lookup/4727.0.55.008main+features12012-13 (accessed June 12, 2020).

24 Ferguson M, Brimblecombe J. Use of evidence by Aboriginal leaders to inform local food supply policy. 15th World Congress Public Health; Melbourne; April 3–7, 2017.

25 Dreze X, Hoch S, Purk M. Shelf management and space elasticity. *J Retailing* 1994; **70:** 301–26.

26 Hoyer WD. An examination of consumer decision making for a common repeat purchase product. *J Consum Res* 1984; **11:** 822–29.

27 Dickson PR, Sawyer AG. The price knowledge and search of supermarket shoppers. *J Mark* 1990; **54:** 42–53.

28 Australian Bureau of Statistics. 1270.0.55.005–Australian Statistical Geography Standard (ASGS): volume 5–remoteness structure, July 2016. 2018. http://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005?OpenDocument (accessed June 11, 2020).

29 National Health and Medical Research Council. Australian Code for the responsible conduct of research. Canberra, 2018. https://www.nhmrc.gov.au/sites/default/files/documents/attachments/grant%20documents/The-australian-code-for-the-responsible-conduct-of-research-2018.pdf (accessed Sept 15, 2020).

30 National Health and Medical Research Council. Ethical conduct in research with Aboriginal and Torres Strait Islander Peoples and communities: guidelines for researchers and stakeholders. Canberra, 2018. https://www.nhmrc.gov.au/about-us/resources/ethical-conduct-research-aboriginal-and-torres-strait-islander-peoples-and-communities (accessed Sept 15, 2020).

31 Oetzel J, Scott N, Hudson M, et al. Implementation framework for chronic disease intervention effectiveness in Māori and other indigenous communities. *Global Health* 2017; **13:** 69.

32 Batis C, Rivera JA, Popkin BM, Taillie LS. First-year evaluation of Mexico's tax on nonessential energy-dense foods: an observational study. *PLoS Med* 2016; **13:** e1002057.

33 Bland JM. The tyranny of power: is there a better way to calculate sample size? *BMJ* 2009; **339:** b3985.

34 Australian Bureau of Statistics. 3238·0.55·0–1—Estimates of Aboriginal and Torres Strait Islander Australians, June 2016. 2016. https://www.abs.gov.au/ausstats/abs@.nsf/mf/3238.0.55.001 (accessed June 12, 2020).

35 Bird Jernigan VB, Salvatore AL, Williams M, et al. A healthy retail intervention in Native American convenience stores: the THRIVE community-based participatory research study. *Am J Public Health* 2019; **109:** 132–39.

36 Middel CNH, Schuitmaker-Warnaar TJ, Mackenbach JD, Broerse JEW. Systematic review: a systems innovation perspective on barriers and facilitators for the implementation of healthy food-store interventions. *Int J Behav Nutr Phys Act* 2019; **16:** 108.

37 Winkler LL, Christensen U, Glümer C, et al. Substituting sugar confectionery with fruit and healthy snacks at checkout—a win-win strategy for consumers and food stores? a study on consumer attitudes and sales effects of a healthy supermarket intervention. *BMC Public Health* 2016; **16:** 1184.

38 van Kleef E, Otten K, van Trijp HC. Healthy snacks at the checkout counter: a lab and field study on the impact of shelf arrangement and assortment structure on consumer choices. *BMC Public Health* 2012; **12:** 1072.

39 Foster GD, Karpyn A, Wojtanowski AC, et al. Placement and promotion strategies to increase sales of healthier products in supermarkets in low-income, ethnically diverse neighborhoods: a randomized controlled trial. *Am J Clin Nutr* 2014; **99:** 1359–68.

40 Huse O, Blake MR, Brooks R, Corben K, Peeters A. The effect on drink sales of removal of unhealthy drinks from display in a self-service café. *Public Health Nutr* 2016; **19:** 3142–45.

41 WHO. Guideline: sugars intake for adults and children. Geneva: World Health Organization, 2015. https://www.who.int/publications/i/item/9789241549028 (accessed Sept 15, 2020).

42 Yang Q, Zhang Z, Gregg EW, Flanders WD, Merritt R, Hu FB. Added sugar intake and cardiovascular diseases mortality among US adults. *JAMA Intern Med* 2014; **174:** 516–24.

43 Blake MR, Backholer K, Lancsar E, et al. Investigating business outcomes of healthy food retail strategies: a systematic scoping review. *Obes Rev* 2019; **20:** 1384–99.

44 Rutter H, Savona N, Glonti K, et al. The need for a complex systems model of evidence for public health. *Lancet* 2017; **390:** 2602–04.

45 Henryks J, Brimblecombe J. Mapping point-of purchase influencers of food choice in Australian remote Indigenous communities. *SAGE Open* 2016; published online Feb 15. https://doi.org/10.1177/2158244016629183.

46 Kruske S, Belton S, Wardaguga M, Narjic C. Growing up our way: the first year of life in remote Aboriginal Australia. *Qual Health Res* 2012; **22:** 777–87.

47 Cairns G, Angus K, Hastings G. The extent, nature and effects of food promotion to children: a review of the evidence to December 2008. Geneva: World Health Organisation, 2009. https://www.who.int/dietphysicalactivity/publications/Hastings_paper_marketing.pdf (accessed June 12, 2020).

48 Brimblecombe J, Liddle R, O'Dea K. Use of point-of-sale data to assess food and nutrient quality in remote stores. *Public Health Nutr* 2013; **16:** 1159–67.

49 Campbell S, James EL, Stacey FG, Bowman J, Chapman K, Kelly B. A mixed-method examination of food marketing directed towards children in Australian supermarkets. *Health Promot Int* 2014; **29:** 267–77.

50 Kelly B, Chapman K, Hardy LL, King L, Farrell L. Parental awareness and attitudes of food marketing to children: a community attitudes survey of parents in New South Wales, Australia. *J Paediatr Child Health* 2009; **45:** 493–97.