***Special Article***

**A systematic review of the influences of food store product placement on dietary related outcomes**

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# Abstract

**Context**  
Product placement strategies have been used to influence customers’ food purchases in food stores for some time, however, assessment of the evidence that these techniques can limit unhealthy, and promote healthy, food choices has not been completed.   
**Objective**  
This systematic review aimed to determine how product placement strategies, availability and positioning, in physical retail food stores located in high-income countries influence dietary-related behaviours.

**Data Sources**From a search of nine databases, thirty-eight articles, 17 observational studies and 22 intervention studies, met the study inclusion criteria.

**Data Extraction**

Two reviewers independently extracted data relating to study design, study population, exposures, outcomes and key results. Each study was also assessed for risk of bias in relation to the research question.  
**Data Analysis**  
Meta-analysis was not possible due to heterogeneous study designs and outcomes. As recommended by Cochrane, results were synthesised in effect direction plots using a vote counting technique which recorded the direction of effect and significance level according to the expected relationship for health improvement.

**Results and Conclusions**  
The majority of studies showed that greater availability and more prominent positioning of healthy foods, or reduced availability and less prominent positioning of unhealthy foods, related to better dietary-related behaviours. A large number of results, however, were non-significant which likely reflects the methodological difficulties for this research field. Adequately powered intervention studies that test both the independent and additive effects of availability and positioning strategies are needed.

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# Introduction

The current food environment is obesogenic and encourages individuals to habitually overconsume foods inconsistent with dietary recommendations.1 It was identified that modern food environments heavily promote the sale and intake of energy-dense, nutrient-poor foods and beverages in the late 1990’s.2 It took until 2007 for the first significant government document, the Foresight report, to highlight the key role of food environments in fuelling obesity.3,4 Although published in the UK, this report has had international impact. Yet now, more than a decade later, food environments remain obesogenic and obesity levels continue to rise worldwide.5

Human behaviour can be reliant on environmental stimuli in settings frequently visited.6 Food stores, such as supermarkets and corner stores, are the main sources of food for many people living in high-income countries; they are likely having a significant influence on the food choices of their consumers.7 Marketing strategies are used extensively in food stores and are commonly composed of the 4P’s of marketing: product, price, promotion and placement.8 Product placement strategies have been used to influence customers’ purchases in these stores for some time, and their successful effects have been documented in the marketing literature.9,10 Assessment of the evidence that these techniques can be successfully used to limit unhealthy and promote healthy food choices has not yet been completed. Grey literature suggests that two thirds of placement strategies are used to promote unhealthy food and beverages in supermarkets.11 Comprehensive assessment of academic research examining the health-related effects of placement strategies on store-level food sales, household-level food purchasing or individual-level dietary outcomes would help guide future government intervention across the world. Some governments are already taking, or considering, legislative actions on food and beverage placement promotions. For example, Chapter 2 of the UK Government’s Childhood Obesity Plan, released in 2018, included a population-level proposal to ban marketing strategies used in food outlets that promote the overconsumption of unhealthy foods and beverages.12

A number of systematic reviews have narratively summarised the influence of supermarket interventions on diet-related outcomes. Existing reviews have largely examined the evidence for intervention strategies related to product price and healthier product promotion including swaps, signage and product labelling.13-18 Only a very small number of studies included in these reviews assessed the role product placement has on dietary and food purchasing behaviours, and no quantitative evidence synthesis has been conducted. Reviews of observational research investigating the association between in-store food retail environments and dietary-related outcomes have not exhaustively examined product placement either; primarily because the literature in this area has grown rapidly since 2012 when two critical reviews on this topic were published.19,20 Policy makers would benefit from a systematic review of recent observational and intervention research investigating the role product placement strategies in retail food stores have on outcomes related to health such as sales, purchasing, diet or BMI.

According to the Typology of Interventions in Proximal Physical Micro-Environments (TIPPME), product placement contains two distinct intervention types: availability and position.21 Availability describes the addition or removal of products to increase or decrease their variety, number or range. Position refers to altering the position, proximity or accessibility of products, making them easier or harder to engage with.

There is some evidence to indicate that public health strategies that alter environmental influences on health behaviours may be more equal in their effectiveness across socioeconomic groups than those requiring conscious or reflective engagement which appear most beneficial for more advantaged groups.22 Assessing whether product placement strategies in retail food stores has a differential effect on dietary-related behaviours could provide important evidence to help address dietary inequalities. Thus, this systematic review aims to adopt a quantitative approach to answer the following questions:

1. Is greater availability of healthier and/or unhealthy food products in retail food stores associated with BMI, dietary behaviours, purchasing and sales of these foods?
2. Is more prominent positioning of healthier and/or unhealthy food products in retail food stores associated with BMI, dietary behaviours, purchasing and sales of these foods?
3. Do these relationships differ according to socioeconomic position?

# Methods

Recommendations made by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) group were followed throughout this review.23 Supplementary Materials show the PRISMA checklist for the review. This systematic review was registered with the Prospective Register for Systematic Reviews (PROSPERO) CRD: 42016048826

## Data Sources

Nine electronic databases were searched (Medline, DARE, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, EbscoHosT, PsychINFO, Science Direct, Econlit and Scopus). A combination of medical subject headings (MeSH) and free-text terms relating to ‘diet’, ‘feeding behaviour’, ‘food’, ‘beverages’, ‘food supply’, and ‘food industry’ were used to ﬁnd publications relating to the association between in-store food environments and diet, sales, purchasing and BMI outcomes in adults that were published in the English-language between January 2005 and February 2019. A landmark paper describing different types of food environments in relation to diet and health was published in 2005, prior to this date little research was published in this area.24 The inclusion of this timeframe captures the most recent literature in the research field, reflects current food store layouts and provides useful and applicable evidence for policy makers. The complete search strategy and list of search terms can be found in Supplementary Materials*.* All titles and abstracts were screened by one author (SS) against the study PICOS criteria to ensure eligibility for inclusion (Table 1). Observational and intervention studies were included if they involved adult participants (aged 18 years and older), were conducted in high-income countries, included an exposure/intervention which investigate either the positioning or availability of food items in physical food stores and had an outcome relating to food sales, purchasing, dietary intake or BMI. If it was unclear from the abstract alone if an article was eligible, the full text was reviewed. The bibliographies of included studies were also screened for additional articles.

## Data Extraction and Risk of Bias Assessment

Data were extracted to capture the relevant information for the research questions. Separate data extraction forms were created for observational and intervention studies. The full text for each article was assessed independently by two reviewers (SS, CV). Details about the study characteristics (study design, setting, participant details, exposures, outcomes, results and funding sources) were extracted.

Concurrent with data extraction, risk of bias assessment was conducted for each eligible article to assess the risk of bias in relation to the research questions. This process was conducted using pre-defined assessment criteria based on those described by the NHS Centre for Reviews and Dissemination.25 Separate risk of bias assessment criteria were used for observational and intervention studies. Thirteen domains in observational studies and 18 domains in intervention studies assessed elements of study design, participant selections, attrition, assessment methodologies, statistical analyses and handling of confounding (Supplementary Table 3 and 4). A risk of bias score of +1 (low risk of bias), 0 (medium risk of bias), or (-1) (high risk of bias) was allocated for each domain. If, for any reason, an element of the assessment criteria was not applicable a score of 0 was applied for that domain. For example, a 0 rating was applied for the ‘cohort follow-up percentage’ domain if the study was cross-sectional. The reviewers (SS, CV) compared the risk of bias assessment ratings for consistency. Any discrepancies were discussed in depth until a quality score was agreed. An overall risk of bias score was given to each study based on the number of ‘-1’ ratings a study received. Intervention studies with 6 or more, and observational studies with 5 or more, ‘-1’ ratings were classed as having a high risk of bias overall. If the number of ‘-1’ scores was 2 or less for intervention studies and 1 or less for observational studies the overall risk of bias score was classified as low. Intermediate ratings were allocated a moderate overall risk of bias score.

## Data Synthesis

Separate summary tables were produced for observational and intervention studies (Supplementary Tables 5 and 6). Each study was categorised according to the placement strategy (availability or positioning) of the exposure or intervention. Availability and positioning were defined according the TIPPME recommendations.21

Studies were further classified to reflect if the exposure/intervention focused on the “placement of healthy foods” or “placement of unhealthy foods”. These categorisations were based on the UK Eatwell Guide.26 Foods that had inadequate description or did not clearly align with this Guide were excluded from this review. For example, popcorn, vegetarian pepperoni and wheat-square cereal covered in the study by Holmes et al27 were not included in the quantitative assessment as an expected direction for health outcomes could not be determined. Exposures/interventions that considered both healthy and unhealthy food items together were categorised under “placement of healthy and unhealthy food”.

Meta-analysis was not possible due to the heterogeneity of study design, exposures/interventions and outcomes. Vote counting synthesis was therefore used to summarise the findings of this review. Cochrane’s advice for accurate vote counting was followed throughout this review and requires that each studies’ effect estimates are categorised according to their direction in showing benefit or harm for health in order to produce a standardised binary metric.28 This systematic review hypothesised that greater availability and/or more prominent positioning of healthy foods resulted in a benefit for health through greater sales/purchasing/consumption of the healthy food, reduced sales/ purchasing/consumption of unhealthy food items or lower BMI. In addition, this review also hypothesised that reduced availability and/or no prominent positioning of unhealthy foods resulted in a benefit for health through lower sales/purchasing/consumption of the unhealthy foods, greater sales/purchasing/consumption of healthy foods or lower BMI. Each outcome result from an article was classified as either positive (supports hypothesis) or negative (rejects hypothesis). In cases where the direction of the outcome result could not be determined, results were categorised as inconclusive. Each article’s results were further classified according to the significance level (significant p≤0.05 or non-significant p>0.05). Only results that were deemed to be relevant to the research question were extracted during the data synthesis procedure. The vote counting results were summarised visually using bar charts and in detail using effect direction plots, as recommended by Cochrane.28 Effect direction plots indicate studies that report on more than one similar outcome (diet, sales, purchasing, BMI) in a way that was not captured in the bar chart. Arrows were used in effect direction plots to represent the combined direction and significance level of outcomes for each study. The method of combining results was based on previous criteria for variation in effect and significance:29

If ≥70% of outcomes report similar direction use the arrow ( (positive) or (negative)) to represent the direction

* If <70% of outcomes report similar direction use a diamond () to represent inconsistent results
* If effect direction similar AND > 60% outcomes are statistically significant, use a solid arrow () to represent a significant result
* If effect direction similar AND <60% of outcomes are statistically significant, use a hollow arrow () to represent a non- significant result

# Results

## Search Results

Figure 1 is a PRISMA diagram presenting the process of study selection. After removing duplicates, 16,342 references were identified from the nine databases searched. A further two articles were included from bibliographic review. All titles and abstracts were screened and 69 full-text articles were reviewed for eligibility. A total of 31 articles were excluded because of insufficient detail or inappropriate population, exposure/intervention or outcome. Overall, 38 articles were deemed appropriate for inclusion. These articles described 17 observational studies, and 22 intervention studies. Two of the intervention studies were reported in the same article but used different data sources and addressed different research questions. This article has therefore been treated as 2 separate studies in this review.30

## Study Characteristics

### Observational studies

Publication dates of the included observational studies ranged from 2008 to 2017. In total, 13,769 participants and over 1,487 food stores were studied in the included observational literature. All but one of the observational studies had a cross-sectional design (n=16, 94%). Supplementary Material provides a detailed summary of the study design, study setting, participant demographics, key findings and quality for all observational studies.

### Intervention studies

The intervention studies were published between 2009 and 2019. In total, over 40,571 participants and 289 food stores were included. The study designs varied greatly between the intervention studies; four (18%) studies described randomised control trials,31-34 four (18%) quasi-experimental design,35-38 seven (32%) repeated cross-sectional design,30,39-45 four (18%) alternating treatment designs,46-49 two (9%) used time-series analyses,27,30 and one (5%) was a natural experiment.30

Supplementary Material provides a detailed summary of the study design, study setting, participant demographics, key findings and quality for all intervention studies.

## Exposures/Interventions and Outcomes

### Observational Studies

Of the 17 observational studies, nine (53%) focused on supermarkets,50-58 six (35%) convenience stores59-64 and two (12%) considered both supermarkets and convenience stores.65,66 Fourteen (82%) observational articles assessed availability.50,52-54,57-66 While heterogeneous measures were used, all observational studies conducted in-store audits to assess food placement strategies. Five (29%) studies assessed availability by measuring the shelf-space dedicated to specific food items.50,59,60,64,66 Length of shelf space (metres) was the most common measurement of shelf space but total shelf space (length X depth, metres2) was also used in two (n=2/5, 40%) studies.50,64 Eight (47%) observational studies used cumulative scoring techniques to assess in-store availability.52-54,60-62,64,65 Five (n=5/8, 75%) studies used modified versions of the Nutrition Environment Measures Survey in Stores (NEMS-S).52-54,62,65 NEMS-S assesses availability, price and quality of healthy food items within stores. The modifications varied greatly between studies, each assessing different items, and none reported validity testing on these modified NEMS-S tools. The Health Food Supply (HFS) Score was used in two (n=2/8, 25%) articles.60,61 The HFS score is similar in structure to the NEMS-S tool, assessing availability, variety, price and quality, but focuses on subsidised items approved for the US Women, Infants and Children (WIC) program. Six (n=6/14, 43%) studies assessed product variety as a measure of availability;50,57,59,60,62,63 five (n=5/6, 83%) tallied the number of different varieties of fruit and vegetables available 50,59,60,62,63 and one (n=1/6, 17%) assessed the number of different varieties of chocolate and confectionery available.57

Five (29%) observational studies reported that they examined food positioning strategies.51,55,56,60,63 Of these, all five (100%) measured store positioning, namely checkout areas (n=3/5, 60%),51,55,60 store entrances (n=2/5, 40%),60,63 special floor displays (n=1/5, 20%),51 and end of aisle displays (n=3/5, 60%).51,55,56 One (n=1/5, 20%) of these studies additionally measured shelf positioning by assessing whether water was present at eye-level.63 One study described the development, reliability and validity of the GroPromo tool.55 This tool assesses the presence of food items in nine locations within food stores which vary in their level of prominence. It was the only validated tool identified in this review to assess positioning. Four (n=4/5, 80%) other studies used dichotomised variables (Yes/No) to record if specific types of food items were positioned in prominent store or shelf locations.51,56,60,63

Sales-related outcome measures were used in six (35%) observational studies,55-57,60,62-64 eight (47%) assessed dietary related outcomes,50,52,53,58,59,61,65 and four (24%) used BMI.51,53,54,66 For those assessing sales and purchasing, objective store-level sales data was the outcome in only one (n=1/7, 14%) study.56 The remainder (n=6/7, 86%) recorded individual-level purchases via store exit interviews and shopping bag audits. Self-reported dietary data were collected using a number of different dietary tools. The majority (n=6/7, 86%) of studies which reported dietary data used fruit and vegetable measures as the primary outcome.50,52,53,58,59,61 Other dietary measures included sugar sweetened beverages (n=3/7, 43%),51,52,61 chocolate and confectionery (n=1/7, 14%),58 and biscuits and cakes (n=1/7, 14%).52 One (n=1/7, 14%) study reported a 120-item food frequency questionnaire used to produce two dietary pattern scores; one score described a high quality diet (high intakes of whole grains and fruits), other described a low quality diet (high intakes of high fat foods and processed meats).65 One (n=1/7, 14%) study used a novel measure, reflection spectroscopy, to objectively assess skin carotenoids as a marker of fruit and vegetable consumption in addition to self-reported fruit and vegetable consumption.61 Four studies considered BMI as an outcome. 51,53,54,66

### Intervention studies

In accordance with this review’s inclusion criteria, all interventions were conducted in physical food retail stores; 13 (n=13/22, 59%) articles reported interventions taking place in supermarkets,27,30,32,35,38,39,42,45-49 eight (n=8/22, 36%) in convenience stores,31,34,37,40,41,43,44 and one (n=1/22, 5%) in both supermarkets and convenience stores.36 Across the 22 intervention studies, 243 were intervention stores and 43 control stores. Eight (n=8/22, 36%) studies did not include a control group.27,41,44-49 None of the intervention studies mentioned sample size calculations. Of the 14 (n=14/22, 64%) studies that did include a comparator group, one (n=1/14, 7%) study had one control checkout per store to act as a comparison,39 another (n=1/14, 7%) included delayed treatment controls,31 four (n=4/14, 29%) used unmatched control stores34,36-38, and eight (n=8/14, 57%) used matched control stores based on store characteristics, geographic location and food product sales.30,32,33,35,40,42,43 Nine (n=9/22, 41%) intervention studies incorporated availability in the treatment condition,31,32,36-38,41,43,44,49 and 18 (n=18/22, 82%) included positioning components.27,30-35,38-42,45-49 Thirteen (n=13/22, 59%) articles were not solely placement interventions and contained additional intervention features such as social marketing campaigns, staff training, shelf labelling, food demonstrations, signage and financial incentives.27,31-34,36-38,40,41,44,47

The majority (n=7/9, 78%) of intervention studies examining availability focused on increasing the availability of healthy foods.31,36,37,41,43,44 One study (n=1/9, 11%) increased the availability of crisps 49 and two studies (n=2/9, 22%) manipulated the availability of both healthy and unhealthy items.32,38 Of the 18 studies that focused on positioning, four (n=4/18, 22%) studies manipulated shelf positioning, particularly the role of positioning food at eye-level.32,35,46,49 The majority (n=13/18, 72%), however, focused on product position within the store.27,30,31,33,38-40,42,45,47-49 The most common store position tested was the checkout, investigated in seven (n=7/13, 54%) studies,30,38,39,42,45,47,48 three (n=3/13, 23%) examined front of store positioning,33,38,40 and four (n=4/13, 29%) investigated island displays.27,31,38,49 One study assessed both shelf and store positioning.34

The majority of intervention (n=20/22, 91%) studies used sales-related outcomes.27,30,32-35,37-49 Only four (n=4/22, 18%) studies measured diet related outcomes,31,36,40,43 and one (n=1/22, 5%) assessed BMI.43 Most (n=15/20, 75%) studies that used sales-related outcomes collected data at the store level. Of these, nine (n=9/15, 60%) used objective store sales data,27,32,35,38,45-49 three (n=3/15, 20%) studies conducted bag checks and checkout observations,39,43,44 two (n=2/15, 13%) relied on store manager reported sales,34,37 and one (n=1/15, 7%) study used WIC store sales provided by the state department.33 Self-reported household-level purchasing data from Kantar Worldpanel were applied in three studies (n=3/20, 15%).30,42 Another three studies (n=3/20, 15%) relied on self-reported purchases of food items.33,40,41

Of the four studies that assessed dietary outcomes, one (n=1/4, 25%) used a “healthy food getting” variable which assessed self-reported consumption of 26 healthy foods over the past 30-days.36 The three (n=3/4, 75%) remaining studies assessed self-reported fruit and vegetable consumption,31,40,43 with one also including self-reported sugar-sweetened beverage consumption.43 A validated questionnaire was used in only one study,31 however, another used reflection spectroscopy to objectively assess skin carotenoids as a marker of fruit and vegetable consumption.43

## Key Findings

Figure 2 visually presents the quantitative vote counting results, incorporating 76 diet, sales and BMI outcomes from 17 observational studies, and 89 outcomes from 22 intervention studies. More than three quarters (76%) of the observational outcomes showed positive findings supporting the review hypotheses; approximately one quarter (24%) showed negative findings that did not support the review hypotheses. Of all observational findings, 66% were non-significant (59% of positive and 89% of negative). Almost three quarters (72%) of the intervention outcomes showed positive findings supporting the review hypotheses; approximately one quarter (28%) of intervention outcomes showed negative findings that did not support the study hypotheses. A large proportion of the intervention outcomes (74%), however, were non-significant (67% of positive outcomes and 92% of negative outcomes).

## Research Question 1 - Is greater availability of healthier and/or unhealthy food products in retail food stores associated with BMI, dietary behaviours and sales/purchasing of these foods?

### Observational studies

As shown by the effect direction plot in Table 2, 14 (82%) observational studies assessed food availability,50-55,57-66 of which, over half (n=8/14, 57%)50,52,59-64 found that product availability in retail food outlets was associated with outcomes that supported the review hypotheses and showed health benefits (3 positive significant (+s), 5 positive non-significant (+ns). Two studies reported results that did not support the hypotheses (2 negative non-significant (-ns)) and four reported inconsistent (ic) results.

Of the 13 studies (n=13/14, 93%) that assessed availability of healthy food products 50,52-54,58-66, 57% (n=8/14) showing results in the expected direction for health (5 +ns, 3 +s). 50,52,59-64 In addition, one (n=1/14, 7%) of these studies assessed the availability of healthy food items separately to unhealthy items. Results showed a non-significant positive relationship between unhealthy food availability and BMI, but inconsistent findings for the availability of healthy foods and BMI.66 One study showed that having a ratio of greater shelf space of fruit and vegetables, compared to unhealthy drinks and snacks was associated with healthier purchases (+ns).60 One study assessed the availability of chocolate and confectionary, finding an overall inconsistent relationship with the consumption of these items, specifically a non-significant positive association for confectionary exposure and confectionary consumption but no clear trend between chocolate exposure and chocolate consumption.57

The four studies that considered purchasing outcomes demonstrated the most consistent support of the review hypotheses; 80% (n=3/4) found significant positive associations 62-64 and 20% (n=1/4) non-significant positive associations.60 Half (n=4/8, 50%) of the studies with diet outcomes indicated a relationship with food availability in the expected direction for health benefit; however, none were statistically significant.50,52,59,61 BMI showed no clear relationship with food availability; two of the three studies showed inconsistent results,54,66 and one identified a non-significant relationship between greater healthy food availability and higher BMI.53

### Intervention studies

Table 3 shows the effect direction plot for intervention studies. Four (n=4/22, 18%) intervention studies described food availability manipulation.36,37,43,44 Of these, none showed results in the expected direction for health benefit. One study had results in the unexpected direction (-ns) 36 and three showed inconsistent results.37,44,61 All four of these studies targeted the availability of healthy foods, with none reducing the availability of unhealthy food items; additionally all four were implemented as part multicomponent interventions. 36,37,43,44

For the studies assessing sales/purchasing (n=3/4, 75%), inconsistent results were observed in two studies,37,44 and one study showed that increasing the availability of healthy food items resulted in reduced sales of these items (-ns).43 In the two studies assessing dietary outcomes (n=2/4, 50%), one found results in the unexpected direction (-ns), 36 and the other showed inconsistent results.43 The one study (n=1/4, 25%) that assessed BMI found that improving the availability of fruit, vegetables, low-fat milk and wholegrain products in convenience stores resulted in a non-significant increase in BMI among intervention customers compared to control customers.43

## Research Question 2 - Is more prominent positioning of healthier and/or unhealthy food products in retail food stores associated with BMI, dietary behaviours and sales/purchasing of these foods?

### Observational studies

Of the five (n=5/17, 29%) observational studies that assessed food positioning (Table 2),51,55,56,60,63 three (60%) showed that positioning strategies were consistently associated with outcomes beneficial to health (2 +s, 1 -ns).55,56,60 One of these studies assessed shelf positioning combined with store positioning, and found results in the unexpected direction for shelf positioning (2 –ns) and inconsistent results for store positioning strategies (1+ns, 1-ns; separate results not shown).63

Of the four (n=4/5, 80%) studies that assessed the positioning of healthy food products,51,56,60,63 two showed results in the expected direction (1 +s, 1+ns)56,60 and two showed results in the unexpected direction (2-ns).51,63 Additionally, two of these studies also assessed the positioning of unhealthy food items, with both showing results in the expected direction: positioning unhealthy drinks and snacks at the end-of-aisle, checkouts and islands was associated with greater sales of these unhealthy items and increased BMI (1+s, 1+ns).51,56 Another study assessed only unhealthy food positioning and found significant results in the expected direction (+s).55

Sales and purchasing outcomes were reported in four (n=4/5, 80%)55,56,60,63 of the studies that examined the positioning of food products, one study reported BMI51 but no studies measured dietary outcomes. Three quarters (n=3/4, 75%) of studies reporting sales/purchasing outcomes showed that positioning healthy and unhealthy food products in prominent in-store locations was associated with greater sales of these products (2 +s, 1 +ns, 1 -ns).55,56,60 The single study that reported BMI revealed inconsistent results with prominent positioning of both healthy and unhealthy foods showing associations with higher BMI.51

### Intervention studies

Twelve (n=12/22, 55%) intervention studies 30,33-35,39,40,42,45-48 described the effects of manipulating the positioning of food products, four (n=4/12,33%) of these included additional intervention components such as signage, social media campaign and staff training.33,40,47,48 Of the eight (n=8/12, 75%) studies 30,34,35,39,42,45,46 that tested only product positioning, four showed results in the expected direction for health (3+s, 1+ns)30,35,39 and four showed inconsistent or unexpected results.34,42,45,46 Two studies tested alternating treatment and control conditions. Treatment conditions included prominent positioning of healthy products alone or prominent positioning alongside point-of-purchase signage. The results were inconsistent for the positioning alone strategies but consistent positive results (2 +ns) were observed for the multicomponent condition.47,48 Of the studies describing the effects of prominent store positioning (n=11/12, 92%),30,33,34,39,40,42,45-48 the majority (n=6/11, 55%) showed these interventions have positive effects for health (3 +s, 3+ns). 30,33,39,40,48 The two (n=2/12, 17%) studies that investigated the effects of shelf positioning, however, had inconsistent results (1+ns, 1 -ns).34,35

Most (n=5/9, 56%) studies that concurrently positioned healthy foods in prominent locations and unhealthy foods in less prominent locations showed results in the expected direction for health (2+s, 3+ns). 30,33,40,48 Positioning healthy foods in more prominent locations led to healthier dietary-related outcomes in the majority (n=3/5, 60%) of studies (2+s, 1+ns, 1-ns, 1 ic).34,35,39,47,48 The single study that altered the positioning of unhealthy food, found that locating high fat dairy products in a less prominent shelf position resulted in a non-significant decrease in sales of these items.35

Most studies (n=7/12, 58%) reporting sales/purchasing outcomes showed that positioning products in prominent locations increased sales/purchases of these products (3 +s, 4 +ns) 30,33,35,39,40,48. One study showed a decrease in WIC eligible food sales after these products were positioned in prominent store and shelf locations.34 The single (n= 1/12, 8%) study measuring dietary outcomes showed that simultaneously placing fruit and vegetables at the front of the store and crisps at the back, resulted in a non-significant increase in daily fruit and vegetable intake among intervention store customers compared to control customers.40

Availability and positioning were combined in six intervention studies.27,31,32,38,41,49 The vast majority (n=5/6, 83%) of these studies showed results in the expected direction for health (5+ns, 1 ic).31,32,38,41,49 These results were consistent regardless of whether the intervention targeted healthy, unhealthy or both types of products, or measured sales/purchases or dietary outcomes. Five studies reported findings from multicomponent interventions incorporating other strategies such as shelf labels, food demonstrations and promotional events. The majority (n=4/5, 80%) of these multicomponent intervention studies showed results in the expected direction for health (4+ns, 1ic).27,31,32,38,41

## Research Question 3 - Do these relationships differ according to store type or socioeconomic position?

### Observational studies

Seven (41%) observational studies provided no description of the socioeconomic backgrounds of the study area or study participants. Of the 10 (59%) that reported socioeconomic data, five were conducted in study areas with varying levels of socio-economic position (SEP),55,57,58,63,65 and five were conducted with participants of lower SEP or in areas of lower SEP.51,53,59,62,64 Only one study had an inclusion criterion that specifically targeted low-income participants.53 No observational studies explicitly examined the interaction between SEP and food placement strategies. However, from the studies conducted amongst predominantly disadvantaged groups (i.e. low income, high prevalence of government assistance or deprived area) findings showed consistently that healthier placement strategies were associated with better diet and sales outcomes, but the association with BMI outcomes was inconsistent.

### Intervention studies

Fifteen (71%) intervention studies described the socio-economic backgrounds of the study area or study participants. Twelve (n=12/15, 80%) of the studies reporting socioeconomic data were conducted in deprived neighbourhoods and three (n=3/15, 20%) among populations of varying SEP. Only one study specifically analysed the differential intervention effects according to household social class (occupation of highest earner) and found no clear trend across social class quintiles.42 In the 12 studies which focused on populations of lower SEP, half showed results indicating that the intervention was beneficial for health. The other half of the studies, however, showed inconsistent results.

## Risk of Bias

Supplementary Material presents the risk of bias assessment results for each article.

### Observational studies

Nine (59%) observational studies were found to have a low risk of bias in relation to the research questions.52,53,59-63,65,66 Six (35%) were classified as having moderate risk of bias51,55-58,64 and two (12%) as high risk of bias.50,54 Of the nine classified as having a low risk of bias, five showed positive results (4+ns,52,59-61 1+s62), 3 ic63,65,66 and 1 negative (-ns).53

### Intervention studies

Twenty (91%) intervention studies were classified as having a high risk of bias in relation to the research question27,30,31,34-36,38-49and two (9%) had moderate risk of bias.32,33 The two studies with moderate risk of bias both showed results indicating that health product placement interventions can be beneficial for health, however, the results from these studies did not reach statistical significance.32,33

# Discussion

## Summary of Findings

This systematic review is the first to consider the overall direction of effect for food placement strategies on healthy eating behaviours. Considering the need for action on the complex public health concerns of poor diet and obesity, and the difficulties in conducting randomised controlled trials in this research field, this systematic review finds moderate evidence using a practice-based evidence perspective67, from both observational and intervention studies, for food placement strategies in food retail stores positively influencing healthy eating behaviours. This review indicates weaker but still meaningful evidence of an effect when adopting the more traditional evidence-based practice approach. Although the majority of findings showed that greater availability and more prominent positioning of healthy foods, or reduced availability and less prominent positioning of unhealthy foods, related to better dietary behaviours, a large number were not statistically significant. The small sample size and lack of power demonstrated in many of the studies, particularly the intervention studies, may be contributing to the high number of non-significant results, and likely indicates the difficulties in conducting these types of field studies with a high quality scientific design.

Analysing the results with greater granularity, according to placement type, the literature reveals moderate observational evidence for an association between product availability and dietary-related outcomes in the expected direction for health; evidence from intervention research was more limited and equivocal. A large proportion of both observational and intervention literature focused on improving the availability of healthy foods, hence drawing conclusions on the effectiveness of solely limiting the availability of unhealthy foods is not yet possible. Both observational and intervention literature indicated moderate evidence for product positioning strategies in food stores effecting dietary-related health outcomes; most intervention studies indicated that more prominent positioning of healthy, and less prominent positioning of unhealthy foods, results in better dietary or healthier sales behaviours. Good evidence from the intervention studies included in this review exists to support strategies that combine the availability and positioning of both healthy and unhealthy foods to provide benefit for health. A number of interventions were multicomponent which does somewhat weaken the conclusions we can draw about the effect of availability and positioning measures alone, however, the majority (80%) of the multicomponent interventions in this study showed findings in the expected direction for health. Sales outcomes, which were assessed in the majority of intervention studies and in almost half of the observational studies, provided the most consistent results in the expected direction for health benefit. The least abundant and least consistent evidence was found for BMI outcomes; this is perhaps not surprising given the multiple determinants of body weight and the challenges of assessing BMI in large-scale studies.

Observational studies suggested that strategies to improve the placement of healthy foods, and limit the placement of unhealthy foods, could have a positive impact on diet and sales in populations of low socio-economic status. However, these results were not replicated among intervention literature which showed inconsistent findings in populations of low socio-economic position.

## Policy implications

The results from this review provide policy makers with evidence to justify the implementation of population level policies incorporating placement strategies in food retail stores to improve dietary-related behaviours. Although more research is needed to quantify the magnitude of effect of availability and positioning strategies, this review’s findings suggests that placement strategies combining both availability and positioning have the greatest potential to improve the healthfulness of sales and dietary patterns.

The evidence that is currently available, summarised in this review and the 2016 systematic review by Bucher et al, which found that manipulating the order and proximity of food in eateries and food service outlets influenced food choice,68 support the UK government’s intention to ban the positioning of unhealthy food items in prominent locations in food retail stores and food service outlets.69 Other governments could also consider introducing similar policies to improve dietary quality across high-income countries. Even though the current research findings do not meet the ‘gold-standard’ level of evidence that is usually required for the scientific community to provide certainty of effect, these reviews provide a sufficient body of evidence to recommend government action. The introduction of government policies to promote healthy food retail establishments would lead to a ‘level playing field’ between retailers. If such placement strategies are only implemented on a voluntary basis the high level of competition within this setting may result some businesses not implementing such strategies and that would likely limit the positive impact on public health.70

## Next steps for the research field

Although this review indicates moderate evidence for food placement strategies in retail food stores influencing purchasing and dietary behaviours, there are a number of ways in which the body of evidence can be strengthened. The lack of power calculations described in intervention research in particular, is an issue that needs addressing to optimise external validity of the evidence. No intervention articles in this review described their power calculations or justified the study’s sample size. Placement studies require power calculations that take account of clustering at the store level because the intervention is store-based. In a cluster designed study, it is the number of clusters, rather than the number of individuals within each cluster which is most potent in determining statistical power.71 The need for a large number of stores and opportunistic nature of many interventions studies is a key reason why there is no high quality intervention research in this field. Considerable commitment is required from commercial collaborators to allow for the required number of stores, however, mounting societal and political pressure for food retailers to engage in healthy eating strategies could enhance future prospects of adequately powered studies being conducted.

Improving the design of future food placement research, particularly considering novel trial designs and longitudinal observational studies, would further improve the evidence base. Less than two thirds of the intervention articles in this review included a comparison group, and only four were randomised controlled trials. This finding indicates that store-based placement interventions do not easily conform to scientific gold standards. Researching in real-world settings, however, provides valuable knowledge to policy makers of intervention effectiveness in complex social contexts, particularly when studies are rigorously designed. Parallel designs with control groups matched on area characteristics and store sales (plus adjustment for confounders) offer a robust design and were used in approximately one third of the current intervention evidence, all published in the last five years. Alternative designs including natural experiments, stepped-wedge designs, synthetic controls and propensity scores could be further explored for use in future food placement intervention or policy evaluation studies.72-75

There is a gap in the evidence to describe how reducing the availability of unhealthy foods in food retail stores effects diet-related outcomes as most of the literature investigating placement strategies has focused on healthy foods. Although more challenging commercially than the ‘win-win’ of targeting healthy foods in placement interventions,45 future research should focus on limiting the availability and prominent positioning of unhealthy foods; perhaps by replacing them with non-food items in an attempt to reduce overall food intake. Compensation to food retail chains for any loss in revenue may need to be considered. As highlighted in a recent scoping review, business outcomes of food retail strategies to improve health should be consistently reported in academic literature.76

There is also a need for greater harmonisation of in-store assessment measures that act as exposures in observational research or fidelity assessments in intervention studies. Currently three categories of availability measures are used: shelf space, variety and composite scores. Considerable within-category variation exists and the composite scores typically measure in-store factors such as price and quality in addition to availability. Positioning measures have focused almost entirely on prominent store locations such as checkouts, end-of-aisle and front of store; only one observational article measured shelf placement in this review. An in-store assessment tool that expands the existing validated GroPromo tool55 to include measures of availability and shelf-placement would help to harmonise data in this field. Intervention research should include measures of both availability and positioning in their fidelity assessments because these two placement strategies are often intertwined. Positioning products at the checkouts or end-of-aisle typically extends the availability of those products as they are located both in the aisle and in the prominent location. Only one intervention article in this review specifically identified considering both these aspects of placement in their evaluation.47

Consistent with the findings of previous reviews of supermarket interventions,15,16 many of the studies in this review contained multiple intervention components. Food placement strategies were a core component of these interventions. It was not possible, however, to decipher the isolated effects of changing product availability or positioning because additional strategies such as signage or staff training were employed at the same time. Future research wishing to test multiple intervention components, such as the 4P’s of marketing, should consider the work by Wensel et al.34 which tested both the independent and additive effects of four intervention elements. This type of research, combined with studies that test single-component placement interventions, will be scientifically advantageous and ensure efficient and cost-effective packaging of interventions.

While sales outcomes were most frequently used and showed greatest consistency of effect in this review, loyalty card data were not used in any of the observational or intervention studies. Loyalty card data are a form of ‘big data’ that offer a potentially economical method of analysing how in-store determinants affect household purchasing.16,77 Little is known from the available literature about the populations who are most effected by placement strategies in food stores. This gap could be addressed by measuring intervention effects at the household or individual level, rather than the store level. Despite existing evidence suggesting that the diets of those from disadvantaged backgrounds are more susceptible to unhealthy in-store environments than those of more affluent groups,78 it is currently unclear whether placement strategies exacerbate or reduce dietary inequalities. Further evidence from adequately powered studies is needed to determine differential effects by SEP. Moreover, assessments of dietary outcomes, nutritional biomarkers or metabolites, and food waste are needed alongside loyalty card data to provide intelligence on the accuracy of this big data source, and the correlation between purchasing and intake patterns. It would be particularly useful if future research included dietary assessments from more than one household member to understand more clearly who in the household placement strategies are affecting. Finally, as outcome measures with frequent time points (weekly sales or purchasing data) become commonplace in this research field, more advanced statistical methods such as time-series analyses used by Ejlerskov et al,30 and appropriate adjustment for clustering and confounding, should be more consistently applied.

## Strengths and limitations

This review is strengthened by the adherence to PRISMA guidelines throughout. Two reviewers independently conducted a risk of bias assessment and data extraction from each of the included studies to ensure consistency and rigor. In addition, the inclusion of both observational and intervention studies is a strength of this study as it has allowed for a more thorough assessment of the overall relationship between placement strategies in food store settings and diet-related outcomes. Product availability has been researched most extensively in the observational literature, while product positioning has been the focus of many intervention studies. However, including both types of literature presents some challenges with interpreting the quality of the evidence and summarising overall results. Separate risk of bias assessment criteria were used for observational and intervention studies meaning the final quality scores cannot be compared. Intervention research is considered a higher grade of evidence and should be treated as such when drawing conclusions. This review also only included studies that assessed physical in-store environments, excluding virtual and online settings. This approach allows for the assessment of strategies that have greater external validity and the ability to be implemented in real-life settings. The findings of this review, however, are not applicable to the growing online grocery sales market.

The search strategy for this review did not include literature published prior to 2005 or forward searching for identified articles through citations. It is therefore possible that some articles of interest may have been excluded. However, 2005 was the year a landmark paper in the field of food environment research was published.24 This paper, along with the Foresight obesity report,3 were among the first to highlight the importance of understanding the role food environments have on population health. Another limitation of this systematic review was the exclusion of grey literature or unpublished data in this topic area. Consequently, there is a possibility that the results of this review are subject to publication bias. Studies showing positive and significant effects may have a greater chance of publication and there is a potential that are findings are skewed as a result of this bias. In addition, due to the heterogeneous nature of the study exposures, interventions and outcomes, it is difficult to draw definitive conclusions from the available evidence. Meta-analysis was not possible, however, a quantitative summary of the evidence was achieved by using a direction-based vote counting technique or effect direction plot, as is recommended by Cochrane when meta-analysis is not feasible.28 This technique, however, is limited by its lack of consideration of the magnitude of effects and differences in study size.28

# Conclusions

Drawing on recent evidence from observational and intervention research across high-income countries, this review suggests that more prominent placement strategies are associated with higher sales and consumption of both healthy and unhealthy foods but not weight status. Even though further high-quality research is required in this area, the balance of evidence suggests that the introduction of government interventions could be beneficial by providing a ‘level playing field’ between retailers and to increase the availability and prominence of healthy foods and reduce the availability and prominent positioning of unhealthy foods. Future research priorities should focus on designing adequately powered intervention studies that test both the independent and additive effects of reducing the availability and limiting the prominent positioning of unhealthy foods. A greater understanding of who is most effected by placement strategies is required; this could be achieved through the use of loyalty card data as the primary outcome holds potential, alongside dietary assessments from more than one household member.

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# Author contributions

Overall integrity of the work from inception to publication: SS, JB and CV. Design, acquisition of data, or analysis and interpretation of data: SS and CV. Preparation and review of the manuscript for important intellectual content: SS, GN, JB and CV. Final approval of the version to be published: SS, GN, JB and CV.

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# Supporting Information

Table S1: PRISMA Checklist

Table S2: Search Strategy

Table S3: Quality Assessment Grading for Observational Studies

Table S4: Quality Assessment Grading for Intervention Studies

Table S5: Summary Table of Observational Studies

Table S6: Summary Table of Intervention Studies

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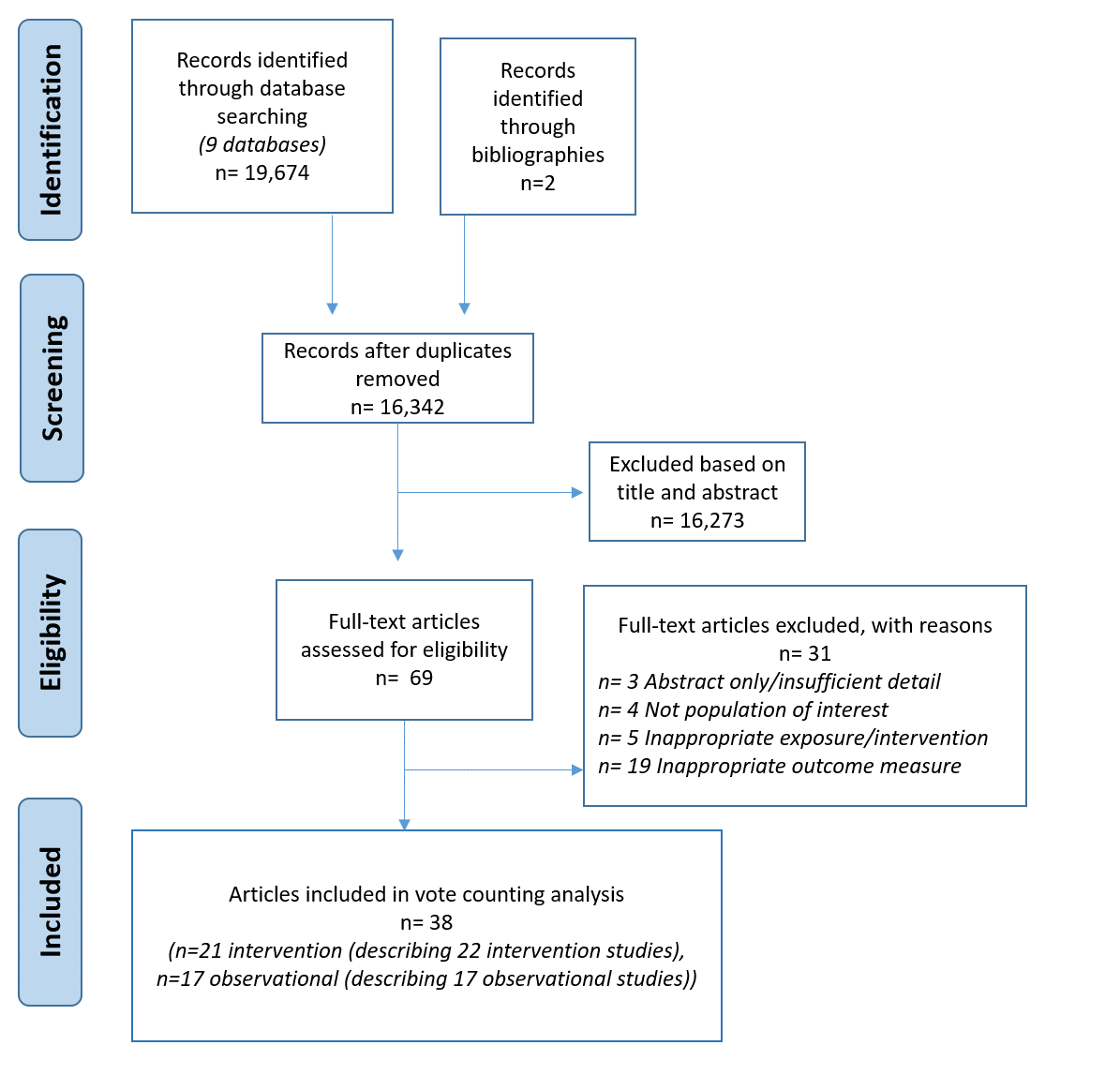
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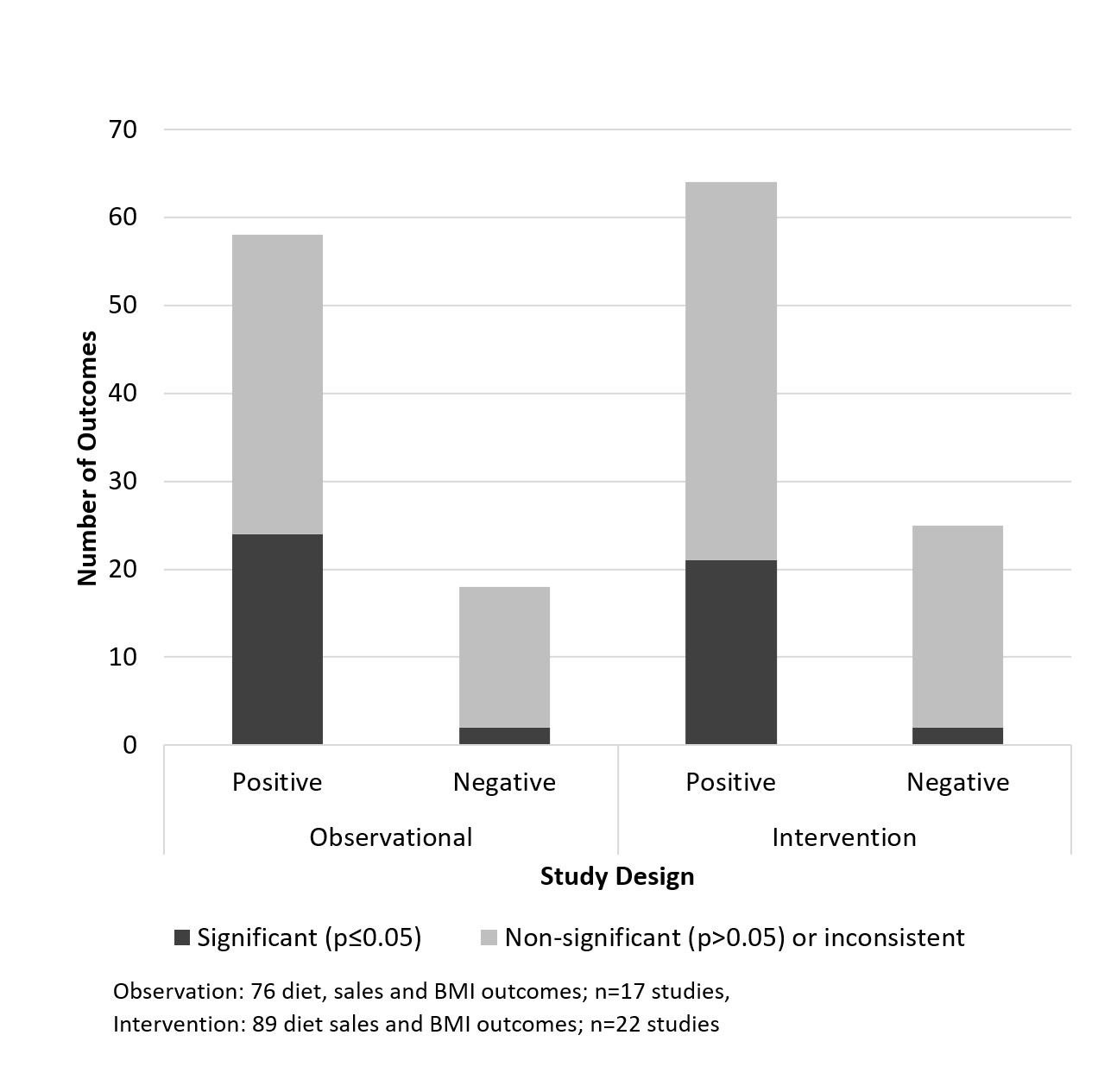
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**Figure 1 PRISMA Diagram**



**Figure 2 Summary of placement strategy vote counting results from observational and intervention studies in relation to the review hypothesis**



**Table 1: PICOS criteria for inclusion and exclusion of studies**

|  |  |  |
| --- | --- | --- |
|  | Inclusion Criteria | Exclusion Criteria |
| General | * Published in English * Published between 2005 and February 2019 |  |
| Study Design | * Intervention Studies * Observation Studies | * Ecological Studies |
| Population | * Studies with individuals aged 18 + years as primary population * High income countries | * Low income countries |
| Exposure/ Intervention | * Positioning of food/ beverage items of foods which have clear association with health * Availability of food/ beverage items | * Studies that focus solely on price, food labelling and portion size * Inadequate description of in-store placement measures |
| Setting | * Supermarkets * Convenience Stores | * Non- permanent location (Outdoor/ Farmers Markets, Pop up Stalls) * Cafeterias * Speciality food stores e.g. greengrocers, butchers |
| Outcomes | * Dietary Intake * Food Sales Data * Body Composition | * Food/ beverage outcome (intake/ sales) that do not have a clear alignment with healthy eating guidelines |

**Table 2: Effect Direction Plot of Observational Studies**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author, year | Study design | Socio-Economic Status | Sample Size | Placement of healthy foods | Placement of unhealthy foods | Placement of healthy and unhealthy foods | Outcome type+ | Result direction and significance | Risk of Bias |
| Bodor et al.  (2008)59 | CS | Low | 102 | A |  |  | Diet | 6 | Low |
| Caldwell et al.  (2009)50 | LT | Not provided | 130 | A |  |  | Diet | 6 | High |
| Caspi et al.  (2017)60 | CS | Not provided | 594 | A  P |  | A | Sales  Sales  Sales | 7  2  2 | Low |
| Cohen et al.  (2015)51 | CS | Low | 980 | P | P |  | BMI  BMI | **2** | Moderate |
| Franco et al.  (2009)65 | CS | Varied | 759 | A |  |  | Diet | 6 | Low |
| Gustafson et al. (2011)53 | CS | Not provided | 186 | A  A |  |  | BMI  Diet |  | Low |
| Gustafson et al. (2013)52 | CS | Low | 121 | A |  |  | Diet | 4 | Low |
| Jani et al.  (2018)54 | CS | Not provided | 3817 | A |  |  | BMI | 2 | High |
| Jilcott Pitts et al. (2017)61 | CS | Not provided | 479 | A |  |  | Diet | 4 | Low |
| Kerr et al.  (2012)55 | CS | Varied | 637 |  | P |  | Sales | 2 | Moderate |
| Martin et al.  (2012)62 | CS | Low | 372 | A |  |  | Sales | 2 | Low |
| Nakamura et al.  (2014)56 | CS | Not provided | 1\* | P | P |  | Sales  Sales | 2 | Moderate |
| Rose et al.  (2009)66 | CS | Not provided | 1243 | A | A |  | BMI  BMI | 3  3 | Low |
| Ruff et al.  (2016)63 | CS | Varied | 1904 | P  A |  |  | Sales  Sales | 4  5 | Low |
| Sanchez-Flack et al. (2017)64 | CS | Low | 369 | A |  |  | Sales | 4 | Moderate |
| Thornton et al.  (2010)58 | CS | Varied | 1082 | A |  |  | Diet | 4 | Moderate |
| Thornton et al.  (2011)57 | CS | Varied | 1007 |  | A |  | Diet | 2 | Moderate |

**Study Design:** CS= Cross-sectional, LT= Longitudinal **; Sample Size: \*** for sample size indicates number of stores rather than number of participants. **Placement Type:** A= Availability; P= Positioning; **Outcome Type**: +sales represents sales/purchasing  
**Effect Direction and Significance: ** Positive result p<0.05; **** Positive result p>0.05;**** Negative result p<0.05**;** Negative result p>0.05;  
 Inconsistent results.  
Number of outcomes within each category is 1 unless indicated in subscript beside effect direction.Reported effect direction and significance for multiple outcomes:   
 - All outcomes report effect in same direction and with same level of statistical significance **OR** - Where direction of effect varies across multiple outcomes:  
 ≥70% of outcomes report similar direction and similar statistical significance.   
 Inconsistent findings= If <70% of outcomes report consistent direction of effect ( )

**Table 3: Effect Direction Plot of Intervention Studies**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author, year | Study design | SES status | Sample Size | Placement of healthy foods | Placement of unhealthy foods | Placement of healthy and unhealthy foods | Outcome type+ | Effect direction and significance | Risk of Bias |
| Adam et al.  (2017)35 | QE | Not provided | 10\* | P | P |  | Sales  Sales |  | High |
| Adjoian et al.  (2017)39 | RCS | Low | 3\* | P |  |  | Sales | 2 | High |
| Albert et al.  (2017)40 | RCS | Low | 550 |  |  | PM | Sales  Diet | 3 | High |
| Ayala et al. (2013)31 | RCT | Low | 119 | APM |  |  | Diet | 3 | High |
| Dannefer et al.  (2012)41 | RCS | Low | 294 | APM |  |  | Sales | 2 | High |
| De Wijk et al.  (2016)46 | AT | Not provided | 2\* |  |  | P | Sales |  | High |
| Ejlerskov et al. (2018a1)30 | TS | Varied | 30,000# |  |  | P | Sales | 2 | High |
| Ejlerskov et al. (2018a2)30 | NE | Varied | 30,000# |  |  | P | Sales |  | High |
| Ejlerskov et al. (2018b)42 | RCS | Varied | 30,000# |  |  | P | Sales |  | High |
| Foster et al.  (2014)32 | RCT | Low | 8\* |  | APM |  | Sales | 13 | Moderate |
| Gittelsohn et al.  (2010)36 | QE | Low | 83 | AM |  |  | Diet |  | High |
| Holmes et al.  (2012)27 | TS | Not provided | 1\* | APM |  |  | Sales | 16 | High |
| Jilcott Pitts et al. (2018)43 | RCS | Low | 223 | AM  AM  AM |  |  | Sales  Diet  BMI | 3 | High |
| Lawman et al.  (2015)44 | RCS | Low | 8671 | AM |  |  | Sales | 3 | High |
| Sigurdsson et al. (2009)49 | AT | Not provided | 2\* |  | AP |  | Sales | 2 | High |
| Sigurdsson et al. (2011)47 | AT | Not provided | 2\* | P |  | P  PM | Sales  Sales  Sales |  | High |
| Sigurdsson et al. (2014)48 | AT | Not provided | 2\* | P |  | PM | Sales  Sales |  | High |
| Song et al.  (2009)37 | QE | Low | 13\* | AM |  |  | Sales | 10 | High |
| Thorndike et al. (2017)33 | RCT | Low | 575 |  |  | PM | Sales | 2 | Moderate |
| Toft et al.  (2017)38 | QE | Not provided | 3\* |  |  | APM | Sales | 6 | High |
| Wensel et al.  (2019)34 | RCT | Low | 10\* | P |  |  | Sales | 2 | High |
| Winkler et al.  (2016)45 | RCS | Low | 4\* |  |  | P | Sales | 5 | High |

**Study Design:** QE: Quasi-experimental; RCS: Repeated cross-sectional; AT: Alternating treatment; TS: Time series; RCT: Randomised controlled trial; NE: Natural experiment; **Sample Size**: \* related to number of store, #estimated sample size**;   
Placement Type:** A= Availability; P= Positioning**;** M= Multicomponent Study; **Outcome Type**: +sales represents sales/purchasing **Effect Direction: ** Positive result p<0.05; **** Positive result p>0.05;**** Negative result p<0.05**;** Negative result p>0.05; Inconsistent resultsNumber of outcomes within each category is 1 unless indicated in subscript beside effect direction.Reported effect direction and significance for multiple outcomes:   
 - All outcomes report effect in same direction and with same level of statistical significance **OR**  
 - Where direction of effect varies across multiple outcomes:  
 - ≥70% of outcomes report similar direction and similar statistical significance.   
 - Inconsistent findings= If <70% of outcomes report consistent direction of effect (  )

**Table S1: PRISMA Checklist**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Section/topic** | | **#** | | **Checklist item** | **Reported on page #** | |
| **TITLE** | | | | |  | |
| Title | | 1 | | Identify the report as a systematic review, meta-analysis, or both. | 1 | |
| **ABSTRACT** | | | | |  | |
| Structured summary | | 2 | | Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. | 2 | |
| **INTRODUCTION** | | | | |  | |
| Rationale | | 3 | | Describe the rationale for the review in the context of what is already known. | 4-5 | |
| Objectives | | 4 | | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). | 6 | |
| **METHODS** | | | | |  | |
| Protocol and registration | | 5 | | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. | 6 | |
| Eligibility criteria | | 6 | | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. | Table 1 | |
| Information sources | | 7 | | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched. | 6 | |
| Search | | 8 | | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated. | Supp. Table 2 | |
| Study selection | | 9 | | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis). | 6-7 | |
| Data collection process | | 10 | | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators. | 7 | |
| Data items | | 11 | | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made. | 7 | |
| Risk of bias in individual studies | | 12 | | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. | 7-8 | |
| Summary measures | | 13 | | State the principal summary measures (e.g., risk ratio, difference in means). | 8-9 | |
| Synthesis of results | | 14 | | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis. | 8-9 | |
| **Section/topic** | **#** | | **Checklist item** | | | **Reported on page #** | |
| Risk of bias across studies | 15 | | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies). | | | 7-8 | |
| Additional analyses | 16 | | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified. | | | N/A | |
| **RESULTS** | | | | | |  | |
| Study selection | 17 | | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. | | | Figure 1 | |
| Study characteristics | 18 | | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. | | | Supp. Tables 5&6 | |
| Risk of bias within studies | 19 | | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). | | | Sup. Tables 3&4 | |
| Results of individual studies | 20 | | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. | | | 17-21 | |
| Synthesis of results | 21 | | Present results of each meta-analysis done, including confidence intervals and measures of consistency. | | | 17-23 | |
| Risk of bias across studies | 22 | | Present results of any assessment of risk of bias across studies (see Item 15). | | | 23 | |
| Additional analysis | 23 | | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). | | | N/A | |
| **DISCUSSION** | | | | | |  | |
| Summary of evidence | 24 | | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). | | | 23-29 | |
| Limitations | 25 | | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). | | | 29-30 | |
| Conclusions | 26 | | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | | | 31 | |
| **FUNDING** | | | | | |  | |
| Funding | 27 | | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. | | | 32 | |

**Table S2: Search Strategy**

|  |  |
| --- | --- |
| **Database** | **Search Term** |
| Ovid MEDLINE(R) without Revisions | 1 fruit/ or nuts/ or seeds/  2 Vegetables/  3 (low adj fat).ti,ab.  4 (reduced adj fat).ti,ab.  5 (healthy or healthful).ti,ab.  6 (fresh adj produce).ti,ab.  7 (fresh adj food).ti,ab.  8 fruit.ti,ab.  9 vegetable\*.ti,ab.  10 ((healthy or healthful) adj2 (diet\* or food)).ti,ab.  11 nutritious.ti,ab.  12 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11  13 exp Diet/  14 Feeding Behavior/  15 food preferences/  16 food habits/  17 13 or 14 or 15 or 16  18 12 or 17  19 (habit\* or choice\* or prefer\*).ti,ab.  20 food.ti,ab,hw.  21 19 and 20  22 18 or 21  23 Food Supply/  24 Food Industry/  25 supermarket\*.ti,ab.  26 (grocery adj1 store\*).ti,ab.  27 (food adj1 store\*).ti,ab.  28 (food adj1 retail\*).ti,ab.  29 (retail adj1 store\*).ti,ab.  30 food.ti,ab,hw.  31 29 and 30  32 outlet.ti,ab.  33 30 and 32  34 23 or 24 or 25 or 26 or 27 or 28 or 31 or 33  35 22 and 34  36 limit 35 to english language  **37 limit 36 to yr="2005 -Current"** |
| Scopus  Limits:  Health Sciences or Social Sciences and Humanities | ( ( ( ( TITLE ( ( ( healthy OR healthful ) W/2 ( diet\* OR food\* ) ) ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( ( ( healthy OR healthful ) W/2 ( diet\* OR food\* ) ) ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( nutritious ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( nutritious ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ( TITLE ( fruit OR nuts OR seeds ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( fruit OR nuts OR seeds ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( vegetables ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( vegetables ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( low W/2 fat ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( low W/2 fat ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( reduced W/2 fat ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( reduced W/2 fat ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) ) OR ( ( ABS ( healthy OR healthful ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( "fresh produce" ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( "fresh produce" ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( "fresh food" ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( "fresh food" ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( fruit OR vegetable\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( fruit OR vegetable\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) ) ) OR ( ( KEY ( diet ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( KEY ( feeding behavior ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( KEY ( food preferences ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( KEY ( food habits ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) ) ) OR ( ( TITLE-ABS-KEY ( food ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) AND ( ( TITLE ( ( habit\* OR choice\* OR prefer\* ) ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( ( habit\* OR choice\* OR prefer\* ) ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) ) ) ) AND ( ( ABS ( food W/2 store\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ( KEY ( food supply ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( KEY ( food industry ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( supermarket ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( supermarket ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( grocer\* W/2 store\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( ABS ( grocer\* W/2 store\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) OR ( TITLE ( food W/2 store\* ) AND SUBJAREA ( mult OR medi OR nurs OR vete OR dent OR heal OR mult OR arts OR busi OR deci OR econ OR psyc OR soci ) AND PUBYEAR > 2004 ) ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) |
| PsycINFO | TI low N2 fat or AB low N2 fat  2 TI reduced N2 fat or AB reduced N2 fat  3 TI healthy or healthful or AB healthy or healthful  4 TI fresh N2 produce or AB fresh N2 produce  5 TI fresh N2 food or AB fresh N2 food  6 TI fruit or AB fruit  7 TI vegetable\* or AB vegetable\*  8 TI nutritious or AB nutritious  9 TI seeds or AB seeds  10 TI nuts or AB nuts  11 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10  12 DE "Eating Behavior"  13 (DE "Eating Attitudes") OR (DE "Food Preferences")  14 DE "Diets"  15 S12 OR S13 OR S14  16 S11 OR S15  17 TI habit\* or choice\* or prefer\* or AB habit\* or choice\* or prefer\*  18 DE "Food" or TI food or AB food  19 S17 AND S18  20 S16 OR S19  21 TI supermarket\* or AB supermarket\*  22 TI grocer\* or AB grocer\*  23 TI greengrocer\* or AB greengrocer\*  24 TI hypermarket\* or AB hypermarket\*  25 TI food N1 store\* or AB food N1 store\*  26 TI retail\* or AB retail\*  27 TI food or AB food  28 S26 AND S27  29 TI food N1 outlet\* or AB food N1 outlet\*  30 S21 OR S22 OR S23 OR S24 OR S25 OR S28 OR S29  31 S20 AND S30  32 Limit to English |
| ScienceDirect | TITLE-ABSTR-KEY(fruit or nut or seed or vegetable or healthy or healthful or nutritious or fresh or diet or choice or choose or select or buy or purchase or prefer or habit) AND TITLE-ABSTR-KEY(point of purchase or checkout or tills or multi-buy or bundle or kiosk or layout or mix 'n' match or meal deal or shelf or aisle or bogof or get one free or display)  TITLE-ABSTR-KEY (Point of purchase or placement or tills or checkout or cashier or aisle or shelf or shelves or close or proximity or position or display or layout or presentation or marketing or strategy or impulse or promotion or promote or environment) AND TITLE-ABSTR-KEY (supermarket or food store or grocery store) |
| Cochrane Central Register of Controlled Trials | Supermarket  “Grocery store”  Food AND store  Food AND retail  Food AND outlet  food AND industry  (fruit\* or nut\* or seed\* or vegetable\* or healthy or healthful or nutritious or choice\* or choos\* or select\* or buy or purchase\* or fresh or prefer\* or habit\* or food or diet\*) AND (supermarket or shop or outlet or retail or grocery or store) AND (placement or till or cashier or aisle or shelf or shelves or close or proximity or position or display or layout or presentation or marketing or strateg\* or impulse or promotion or promote or environment) |
| Econlit (American Economic Association's electronic database) | (fruit\* or nut\* or seed\* or vegetable\* or healthy or healthful or nutritious or choice\* or choos\* or select\* or buy or purchase\* or fresh or prefer\* or habit\* or food or diet\*) AND (supermarket or shop or outlet or retail or grocery or store) AND (placement or tills or cashier or aisle or shelf or shelves or close or proximity or position or display or layout or presentation or marketing or strateg\* or impulse or promotion or promote or environment)  (behavior\* or behaviour\* or choice\* or choos\* or select\* or buy or purchas\* or habit\* or prefer\*) AND (placement or till or cashier or aisle or shelf or shelves or close or proximity or position or display or layout or presentation or marketing or strateg\* or impulse or promotion or promote or environment) AND (supermarket or shop or outlet or retail or grocery or store) AND (fruit\* or nut\* or seed\* or vegetable\* or healthy or healthful or nutritious or fresh or food or diet\*)  (supermarket or grocery or store) AND (fruit\* or nut\* or seed\* or vegetable\* or healthy or healthful or nutritious or fresh or food or diet\*) AND (placement or till or aisle\* or shelf\* or shelv\* or position or display or layout or presentation or marketing or strateg\*) AND (behavior\* or behaviour\* or choice\* or choos\* or select\* or buy or purchas\* or habit\* or prefer\*)  (point of purchase or checkout\* or tills or multi-buy\* or bundle\* or kiosk\* or layout or mix 'n' match or meal deal\* or shelf or aisle or bogof or get one free or display) AND (supermarket or food store or grocery store) |
| Cochrane Issue (Protocols for systematic reviews) | (food or diet\*) AND (healthy or healthful or nutritious or fresh or fruit\* or vegetable\* or mediterranean)  Supermarket  Food AND store  Food AND retail  Food AND outlet  Food AND industry  food AND (choice\* or habit\* or prefer\*) |
| Cochrane | Supermarket  “Grocery store”  Food AND store  Food AND retail  food AND outlet  food AND industry  food AND (choice\* or habit\* or prefer\*)  (food or diet\*) AND (healthy or healthful or nutritious or fresh or fruit\* or vegetable\* or mediterranean) |
| DARE | (fruit\* or nut\* or seed\* or vegetable\* or healthy or healthful or nutritious or choice\* or choos\* or select\* or buy or purchase\* or fresh or prefer\* or habit\* or food or diet\*) AND (supermarket or shop or outlet or retail or grocery or store) AND (placement or till or cashier or aisle or shelf or shelves or close or proximity or position or display or layout or presentation or marketing or strateg\* or impulse or promotion or promote or environment) |
| NIHR journals library | Supermarket or supermarkets  Grocery  Food  Shop or shops  Retail  outlet |

**Table S3: Quality Assessment Grading for Observational Studies**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Quality Assessment Criteria** | | | | | | | | | | | | | | | |
| **Observational Study** |  | **Study Design** | **Sample Description** | **Store Description** | **Exposure Measurement** | **Outcome** | **Blinding** | **Follow- up** | **Non- Participants** | **Variability** | **Analytical Methods** | **Confounding** | **Sample Size** | **Funding and Conflicts** | **Overall Risk of Bias\*** |
| Bodor et al. (2008) S1 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | **Low** |
| Caldwell et al. (2009) S2 | -1 | -1 | -1 | 0 | 0 | 0 | -1 | -1 | 1 | 1 | 0 | -1 | 1 | **High** |
| Caspi et al. (2017) S3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | **Low** |
| Cohen et al. (2015) S4 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | -1 | -1 | 0 | 0 | **Moderate** |
| Franco et al. (2009) S5 | 0 | 1 | -1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | **Low** |
| Gustafson et al. (2011) S6 | 1 | 1 | -1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | **Low** |
| Gustafson et al. (2013) S7 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | **Low** |
| Jani et al. (2018) S8 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | -1 | -1 | -1 | 0 | -1 | 1 | **High** |
| Jilcott Pitts et al. (2017) S9 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | -1 | 1 | 1 | 1 | 0 | 1 | **Low** |
| Kerr et al. (2012) S10 | 0 | -1 | 0 | 0 | 1 | -1 | 0 | 0 | 0 | 1 | -1 | 0 | -1 | **Moderate** |
| Martin et al. (2012) S11 | 0 | 1 | 1 | 1 | -1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | **Low** |
| Nakamura et al. (2014)  S12 | 0 | -1 | 0 | 0 | 1 | 0 | 0 | -1 | 1 | 1 | 1 | -1 | 0 | **Moderate** |
| Rose et al. (2009)  S13 | -1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | **Low** |
| Ruff et al. (2016)  S14 | 1 | 1 | 0 | -1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | **Low** |
| Sanchez-Flack et al. (2017)  S15 | 1 | 1 | 1 | 1 | -1 | 0 | 0 | -1 | 1 | 1 | 1 | 0 | 1 | **Moderate** |
| Thornton et al. (2010)  S16 | 0 | 1 | -1 | 0 | 0 | 0 | 0 | -1 | 1 | 0 | -1 | 1 | 1 | **Moderate** |
| Thornton et al. (2011)  S17 | 0 | -1 | -1 | 0 | -1 | 0 | 0 | -1 | 1 | 1 | 1 | 1 | 0 | **Moderate** |
| *-1= Poor Quality; 0=Medium Quality; 1= High Quality*  ***\*Overall Risk of Bias: Observational Studies***- ≥5 Poor=High risk of bias, 2-4 Poor= Moderate risk of bias, ≤1 Poor= Low risk of bias | | | | | | | | | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Quality Assessment Criteria** | | | | | | | | | | | | | | | | | | | |
| **Intervention Studies** |  | **Study Design** | **Randomisation** | **Assessor Blinding** | **Participant Blinding** | **Baseline Similarity** | **Selection Criteria** | **Participant Recruitment** | **Follow- up** | **Completers vs non completers** | **Drop out reasons** | **Outcome measurement** | **Intervention Integrity** | **Variability of Measures** | **Analytical Methods** | **Confounding** | **Sample Size** | **Funding and Conflicts** | **Overall Risk of Bias\*** |
| Adam et al. (2017) S18 | 0 | -1 | 0 | 0 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | -1 | -1 | **High** |
| Adjoian et al. (2017)  S19 | -1 | -1 | -1 | -1 | -1 | 0 | -1 | 0 | 0 | 1 | 0 | -1 | -1 | 0 | -1 | -1 | 0 | **High** |
| Albert et al. (2017)  S20 | 0 | -1 | -1 | 0 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | 0 | -1 | -1 | 1 | **High** |
| Ayala et al. (2013)  S21 | 1 | -1 | -1 | 0 | -1 | 1 | 1 | -1 | 0 | 1 | 0 | 0 | 1 | -1 | -1 | -1 | 0 | **High** |
| Dannefer et al.  (2012)  S22 | -1 | -1 | -1 | -1 | -1 | 0 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | **High** |
| De Wijk et al.  (2016)  S23 | -1 | -1 | -1 | 0 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 1 | -1 | 0 | -1 | -1 | 0 | **High** |
| Ejlerskov et al. (2018a1)  S24 | 0 | -1 | -1 | 0 | -1 | -1 | 0 | -1 | 0 | -1 | 0 | -1 | 1 | 1 | 0 | 0 | 1 | **High** |
| Ejlerskov et al. (2018a2)  S24 | 0 | -1 | -1 | 0 | -1 | -1 | -1 | -1 | -1 | -1 | 0 | -1 | 1 | 1 | 0 | 0 | 1 | **High** |
| Ejlerskov et al. (2018b)  S25 | 0 | -1 | -1 | 0 | -1 | -1 | 0 | -1 | 0 | -1 | 0 | -1 | 1 | 1 | 1 | 0 | 1 | **High** |
| Foster et al.  (2014)  S26 | 1 | 1 | -1 | 0 | -1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | -1 | 0 | **Moderate** |
| Gittelsohn et al.  (2010)  S27 | 0 | -1 | -1 | 0 | -1 | 0 | -1 | -1 | 1 | 0 | -1 | 0 | 0 | 1 | 0 | 0 | 0 | **High** |
| Holmes et al.  (2012)  S28 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 0 | -1 | 0 | -1 | -1 | 0 | **High** |
| Jilcott Pitts et al. (2018)  S29 | 0 | -1 | -1 | 0 | -1 | -1 | -1 | -1 | -1 | 0 | 1 | -1 | 0 | 1 | 0 | -1 | 1 | **High** |
| Lawman et al.  (2015)  S30 | -1 | -1 | -1 | -1 | -1 | 0 | 1 | -1 | -1 | -1 | 0 | -1 | 0 | 1 | -1 | 0 | 0 | **High** |
| Sigurdsson et al. (2009)  S31 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 0 | 0 | -1 | -1 | -1 | -1 | **High** |
| Sigurdsson et al. (2011)  S32 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 0 | 0 | -1 | -1 | -1 | 0 | **High** |
| Sigurdsson et al. (2014)  S33 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | -1 | -1 | -1 | -1 | -1 | 0 | **High** |
| Song et al. (2009)  S34 | 0 | -1 | -1 | 0 | 0 | -1 | -1 | 1 | 0 | 1 | -1 | -1 | 1 | 0 | -1 | -1 | 1 | **High** |
| Thorndike et al.  (2017)  S35 | 1 | -1 | -1 | 0 | -1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | -1 | 1 | **Moderate** |
| Toft et al. (2017)  S36 | 0 | -1 | -1 | 0 | -1 | -1 | -1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | -1 | 1 | **High** |
| Wensel et al. (2019)  S37 | 1 | -1 | -1 | 0 | -1 | 1 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | -1 | -1 | 1 | **High** |
| Winkler et al.  (2016)  S38 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 | 1 | -1 | -1 | 1 | 1 | 0 | -1 | 1 | **High** |
| *-1= Poor Quality; 0=Medium Quality; 1= High Quality*  ***\*Overall Risk of Bias: Intervention studies***: ≥6 Poor= High risk of bias, 3-5 Poor= Moderate risk of bias, ≤2 Poor= Low risk of bias | | | | | | | | | | | | | | | | | | | |

**Table S4: Quality Assessment Grading for Intervention Studies**

**Table S5: Summary Table of Observational Studies**

| **Author, Year, Country** | **Study Design** | **Setting** | **Participant**  **Sample** | **Placement Strategy** | **Exposure**  **Variable** | **Outcome** | **Key Findings** | **Result Summary \*** | **Risk of Bias** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bodor et al. (2008) S1  USA | Cross-sectional | 15 convenience stores within 100m distance of participants’ homes in 4 contiguous census tracts  Deprived neighbourhoods in central New Orleans | n=102  Recruitment: Participants from random sample of households  Age: 82% aged 32+ years  Sex: 73% Female  Ethnicity: 37% White  53% Black  9% Other  Income: 31% below poverty threshold | Availability | **A:** Linear shelf space (m) of:   1. Fresh F 2. Total F (fresh, canned, frozen) 3. Fresh V 4. Total V (fresh, canned and frozen)   **AV:** Total number of F&V varieties  No details provided about when in-store audits were conducted | Total daily serves of F  Total daily serves of V  24-hour telephone administered recall using list of commonly consumed F&V, collected in 2001 | An increase in fresh F shelf space (m) within 100m of home, was associated (non-significant) with F intake (β 0.09; SE 0.11; p=0.43)  An increase in total F shelf space (m) within 100m of home, was associated (non-significant) with F intake (β 0.09; SE 0.07; p=0.23)  An increase in fresh F varieties within 100m of home, was associated (non-significant) with F intake (β 0.07; SE 0.09; p=0.41)  An increase in fresh V shelf space (m) within 100m of home, was associated (significant) with V intake (β 0.35; SE 0.16; p=0.03)  An increase in total V shelf space (m) within 100m of home, was associated (non-significant) with V intake (β 0.09; SE 0.05; p=0.07)  An increase in fresh V varieties within 100m of home, was associated (non-significant) with V intake (β 0.23; SE 0.12; p=0.06) |  | Low |
| Caldwell et al.  (2009) S2  USA | Longitudinal Survey  (Post hoc analysis as part of existing study)  BL  FU1: 4-16 weeks  FU2: 12 months | 9 Colorado communities with one+ supermarkets  No neighbourhood SES details | n= 130  Recruitment: Participants of Colorado Healthy People 2010 Initiative living in 1 of the 9 assessed communities  No demographics for post-hoc analysis | Availability | **A:** Total metres2 of fresh F&V shelf space  **A:** Total linear metres of frozen, canned and juiced F&V shelf space.  **AV:** Total number of varieties of fresh F&V available in store e.g. 5 different types of apple – each counted as different variety.  No details provided about when in-store audits were conducted | Self-reported F&V consumption in past 7 days (portions).  6 questions about F&V and F juice taken from the Youth Risk Behaviour Survey | Greater availability (m2) of fresh F&V was associated with increased F&V consumption from BL to FU1 (β 0.02; CI95% 0.00, 0.04; p=0.01) and BL to FU2 (β 0.01; CI95% 0.00, 0.03; p=0.16)  Increased availability (m) of frozen, canned and juiced F&V was associated with increased F&V consumption from BL to FU1 (β 0. 46; CI95% 0.12, 0.80; p=0.01) and BL to FU2 (β 0. 12; CI95% -0.22, 0.46; p=0.47)  Increased number of varieties of fresh F&V was associated with increased F&V consumption from BL to FU1 (β 0.04; CI95% 0.01, 0.07; p=0.01) and BL to FU2 (β 0.02; CI95% -0.01, 0.05; p=0.15) |  | High |
| Caspi et al.  (2017) S3  USA | Cross-sectional | 99 convenience stores  Minnesota  No neighbourhood SES details reported | n=594  Recruitment: Convenience sample of shoppers exiting stores and participated in interview  Age (mean): 40 years  Sex: 58% male  Ethnicity: 3% Hispanic  48% White  36% Black  Employed: 64% | Availability  Position | **A:** Availability (Healthy Food Supply Score (HFS) using Yale Rudd Centre Tool) for 69 foods.  [HFS score (possible range 0-31) summarises availability, quality, variety and price of food in store. Higher scores represent healthier stores.]  **A:** Weight (lb) of F&V and wholegrain products for which standard items weights multiplied by counts of items  **A:** Linear shelf space (ft) for:   1. F&V 2. SSBs 3. Salty snacks   **A:** Shelf space Ratio F&V: SSBs and salty snacks  **Av:** Number of varieties of fresh, frozen and canned F&V and wholegrain products  **P:** Healthy food items found at checkout (Yes/ No)  **P:** F&V seen from front of the store (Yes/ No)  In-store audits conducted between Jul-Nov 2014 | Healthy Eating Index-2010 Score (0-100) for customer purchases. Higher scores indicate greater compliance with healthy eating guidelines.  Proportion of customers purchasing at least 1 F&V portion  Proportion of customers purchasing at least 1 wholegrain item.  Customer purchase assessment conducted when exiting the store. | Higher store HFS scores were associated with higher customer HEI-2010 (β 0.2; SE 0.2; p=0.2)  Customers of stores with high shelf space of F&V had higher mean customer HEI-2010 scores when compared to store with no and low F&V shelf space (Mean HEI score: High 35.2; Low 30.8, None 28.8; p for trend<0.01)  Customers of stores with a higher shelf space ratio of F&V: unhealthy beverages and snacks had higher mean customer HEI-2010 scores when compared to store with low ratios (Mean HEI score: High 35.9; Low 30.2, None 28.8; p for trend<0.01)  Customers had greater odds (non-significant) of purchasing at least 1 portion of F&V if stores stocked ≥90 lbs of fresh and frozen F&V compared to those selling 1-29 lbs (OR 3.0; CI95% 0.9, 9.9; p>0.05)  Customers had greater odds (non-significant) of purchasing at least 1 wholegrain item if stores stocked ≥30 lbs of wholegrains compared to those selling 0.4 lbs (OR 1.9; CI95% 0.5, 6.0; p>0.05)  Customers had greater odds (non-significant) of purchasing at least 1 portion of F&V if stores had higher shelf space of fresh F&V (OR 2.1; CI95% 0.7, 5.8; p>0.05)  Customers had greater odds (non-significant) of purchasing at least 1 portion of F&V if stores had a higher shelf space ratio of F&V: Unhealthy drinks and salty snacks (OR 2.7; CI95% 0.9, 7.9; p>0.05)  Customers had greater odds (significant) of purchasing at least 1 portion of F&V if stores stocked ≥14 varieties of F&V compared to those selling <7 varieties (OR 3.9; CI95% 1.2, 12.3; p<0.05)  Customers had greater odds (non-significant) of purchasing at least 1 wholegrain item if stores stocked ≥4 varieties of wholegrains compared to those selling 0-1 varieties (OR 1.1; CI95% 0.3, 3.8; p<0.05)  Customers had greater odds (non-significant) of purchasing at least 1 portion of F&V if stores had healthy food items at the checkout (OR 1.3; CI95% 0.6, 2.9; p<0.05)  Customers had greater odds (significant) of purchasing at least 1 portion of F&V if stores had fresh F&V visible from the entrance (OR 2.3; CI95% 1.0, 5.8; p<0.05) |  | Low |
| Cohen et al.  (2015) S4  USA | Cross-sectional | 13 supermarkets  where participants reported shopping  2 low-income, majority African American neighbourhoods, Pittsburgh | n=980  Recruitment: Main food shopper in houses from stratified random sample of 2900 residential addresses from the study neighbourhoods  Age: >75% 40+ years  Sex: 73% Female  Ethnicity: 94% African American  Government benefits (SNAP): 50% | Position | **P:** Number of prominent store position displays (end-of-aisle, special floor and checkout) for:   1. SSBs 2. Unhealthy snack foods (confectionery, biscuits, cakes and salty snacks) 3. F&V and products with >50% whole grains   Final exposure variable= number of prominent position displays multiplied by frequency of visits to store, summed for all stores visited  In-store audits conducted May – Dec 2011 | BMI (kg/m2) - 84% objectively measured by research staff, others were self-reported.  2 interview administers 24-hour diet recalls completed and used to derive:   1. Healthy Eating Index score 2. Daily F&V portions 3. Daily sugar sweetened beverage intake (oz) | Greater exposure to sugar-sweetened beverage displays in prominent positions was associated with higher BMI (β 0.01/display, p=0.05)  Greater exposure to unhealthy snack foods in prominent positions was associated (non-significant) with higher BMI (β 0.000/display, p>0.05)  Greater exposure to F&V and wholegrain products in prominent positions was associated (non-significant) with higher BMI (β 0.00/display, p>0.05)  No CI95% reported |  | Mod |
| Franco et al.  (2009) S5  USA | Cross-sectional | n=226 supermarkets and convenience stores located in 159 contiguous census tracts located 1 mile from participants’ homes  Varying levels of neighbourhood deprivation, Baltimore City and Baltimore County | n=759  Recruitment: Participants in Baltimore arm of Multi-Ethnic Study of Atherosclerosis  Age (mean): 63 years  Sex: 52% Female  Ethnicity: 50% Black  50% White  Income: 18% Low | Availability | **A:** Continuous availability score (Standard deviation (SD)) (availability sub-component adapted NEMS-S) of healthier food items across 8 food categories for:   1. All stores in census tract 2. All stores in 1-mile radius 3. Closest store to home residence.   In-store audits conducted in 2006 | 2 dietary patterns:   1. Fat and processed meat pattern (poor quality) 2. Whole grains and F pattern (better quality)   Identified using principal component analysis on self-reported dietary data collected via 120-item FFQ for foods eaten in previous year collected between 2000-2002. | For each SD increase in healthy food availability in census tract, the poor quality dietary pattern score decreased (β -0.02; SE 0.04; p>0.05)  For each SD increase in healthy food availability in closest food store, the poor quality dietary pattern score decreased (β -0.05; SE 0.04; p>0.05)  For each SD increase in healthy food availability in all stores within 1 mile, the poor quality dietary pattern score decreased (β -0.01; SE 0.04; p>0.05)  For each SD increase in healthy food availability in census tract, the better quality dietary pattern score increased (β 0.03; SE 0.04; p>0.05)  For each SD increase in healthy food availability in closest food store, the better quality dietary pattern score decreased (β -0.00; SE 0.04; p>0.05)  For each SD increase in healthy food availability in all stores within 1 mile, the better quality dietary pattern score decreased (β -0.09; SE 0.04; p>0.05) |  | Low |
| Gustafson et al. (2011) S6  USA | Cross-sectional | 22 supermarkets identified by participants as being used for primary food shop  Small urban city, with majority white population, Lexington, Kentucky  No neighbourhood SES details reported. | n=121  Recruitment: Participants (n=1400) of a previous state-wide survey on cancer control and prevention sent a postal invitation    Age (mean): 42 years  Sex: 58% Females  Ethnicity: 94% White  2% African American  Income: 60% High (>= $50,000) | Availability | **A:** Availability score (adapted NEMS-S) for 55 healthier food items across 15 food categories  Data collected NEMS-S to derive a composite score incorporating availability, price and quality.  No details provided about when in-store audits were conducted | Binary variables for 4 food groups based on self-reported consumption:   1. F&V (<2 or ≥ 2 times per day) 2. High fibre cereals (<1 or ≥1 per day) 3. Sweetened beverages (never or ≥ 1 per week) 4. Biscuits and cakes (<5 or ≥5 per week)   26 items NHANES 2009-2010 dietary screener administered via telephone | Greater healthier food availability was associated with lower odds (non-significant) of consuming F&V (OR: 0.95; CI95% 0.83, 1.08; p>0.05)  Greater healthier food availability was associated with significantly lower odds of consuming sugar sweetened beverages (OR: 0.65; CI95% 0.14, 0.83; p≤0.05)  Greater healthier food availability was associated with lower odds (non-significant) of consuming biscuits and cakes (OR: 0.94; CI95% 0.38, 2.39; p>0.05)  Greater healthier food availability was associated with greater odds (non-significant) of consuming high-fibre cereal (OR: 1.05; CI95% 0.93, 1.20; p>0.05) |  | Low |
| Gustafson et al. (2013) S7  USA | Cross-sectional | 80 supermarkets identified by participants as being used for primary food shop  Primarily low-income and minority communities from urban and non-urban districts in North Carolina | n=186  Recruitment: Low-income women enrolled in weight loss intervention study  Age (mean): 51 years  Income: 69% low (<= $29,000) | Availability | **A:**  Availability score (adapted NEMS-S) ranging from 0-37 for 37 food items from 9 healthy food groups:   1. Non-fat/ low fat milk 2. F 3. V 4. Low-fat meats 5. Frozen F 6. Frozen V 7. Canned V 8. 100% whole wheat bread 9. Non-sugar sweetened cereal   Final score for each store categorised by tertiles into low, medium, high. Analyses compared high with low availability.  In-store audits conducted in spring and summer 2009 using availability subcomponent of NEMS-S | BMI (kg/m2 )- Objectively measured height and weight  Self-reported consumption F&V (portions per day)  Consumption data collected using the validated rapid food survey | High availability of healthy food, when compared with low availability, was associated (non-significant) with greater BMI (OR 1.13; CI95% -2.34, 4.47; p>0.05)  High availability of healthy food, when compared with low availability, was associated (non-significant) with lower consumption of F&V (OR 0.73; CI95% -0.77, 2.23; p>0.05) |  | Low |
| Jani et al.  (2018) S8  New Zealand | Cross-sectional | 392 supermarkets  2 urban and 96 rural resident defined neighbourhood in Waikato/ Lake Districts.  No neighbourhood SES details reported. | n= 98 geographical neighbourhood boundaries for which obesity prevalence was calculated  Recruitment: Retrospective data from n= 3817 participants of the Te Wai o Rona: Diabetes prevention strategy study.  Ethnicity: 100% Polynesian (Māori) | Availability | **A:** The number of supermarkets within each neighbourhood where the healthier items was available as well as or instead of the regular item for all of the following items:   1. White vs wholemeal bread 2. Skin vs lean chicken 3. Regular vs trim meat 4. Whole milk vs skimmed milk 5. SSB vs water   **A:** Availability (adapted NEMS-S) of all 5 healthier alternative items listed above (Availability score ranging from 0-10)  In-store audits conducted in 2005 | Median obesity prevalence for neighbourhood defined as BMI ≥30kg/m2  BMI(kg/m2) - Objectively measured height and weight  Analyses adjusted for:   1. location (rural/urban) 2. median neighbourhood income | Greater number of supermarkets containing the healthy options available for all items was correlated with a non-significant decrease in BMI prevalence (r= -0.01, p= 0.99)  Higher healthy food availability score for all items was correlated with a non-significant increase in BMI prevalence (r= 0.01, p= 0.96) |  | High |
| Jilcott Pitts et al. (2017)S9  USA | Cross-sectional  Part of North Carolina Healthy Food Small Retailer Program | 16 convenience stores  North Carolina  No neighbourhood SES details reported. | n=479  Recruitment: Convenience samples of shoppers exiting store  Age (mean): 43 years  Sex: 41% Female  Ethnicity: 65% African American | Availability | **A**: Availability (Healthy Food Supply Score (HFS)) for 18 foods using adapted NEMS-S  [HFS score (possible range 0-31) summarises availability, quality, variety and price of food in store. Higher scores represent healthier stores]  No details provided about when in-store audits were conducted | Objective, non-invasive reflection spectroscopy (RS) to measure skin carotenoids, biomarker of F&V intake. Readings range from 0-800, with higher score indicating higher skin carotenoids and greater consumption of F&V  Self-report consumption of:   1. F&V portions / day 2. Soft drink/ day 3. Sweetened F drink/ day   Data collected using the National Cancer Institute F&V Screener | A positive association (non-significant) was observed between store level HFS score and skin carotenoids measured by RS device (β 2.21; CI95% -2.80, 7.21, p=0.38)  A negative (non-significant) association was observed between store HFS score and self-reported daily F&V consumption (β -0.01; CI95% -0.16, 0.13; p=0.86)  A negative (non-significant) association was observed for store HFS score and daily soft drink consumption (β -0.01; CI95% -0.08, 0.06; p=0.81)  A negative (non-significant) association was observed for store HFS score and daily sweetened F drink consumption (β -0.04; CI95% -0.09, 0.01; p=0.16) |  | Low |
| Kerr et al.  (2012)S10  USA | Cross-sectional | 37 supermarkets in 3 neighbourhoods  Varying levels of neighbourhood deprivation, San Diego | n= 637  Recruitment: Convenience sample of adult shoppers exiting study stores  No demographic characteristics provided | Position | **P:** Presence of food items from 7 food groups (crisps, confectionary, soft drinks, biscuits, F drinks and F&V)in store positions of high prominence:   1. Aisle ends near checkouts 2. Checkouts sides 3. Checkout ends   In-store audits conducted in 2007 using the GroPromo tool | % food dollars spent on:   1. Unhealthy Items (crisps, confectionary, soft drinks, biscuits and F drinks) 2. F&V   Data collected from customer receipts straight after in-store audits were conducted | Greater numbers of unhealthy items in high prominence areas was significantly associated with lower % of food dollars spent on F&V (β -0.7; p<0.01)  Greater numbers of unhealthy items in high prominence locations was significantly associated with higher % of food dollars spent on unhealthy products (β 0.41; p=0.04) |  | Mod |
| Martin et al.  (2012)S11  USA | Cross-sectional | 19 convenience stores  Deprived areas with predominantly Hispanic and African American communities in Connecticut | n=372  Recruitment: Convenience sample of store customers approached before entering store  Age (mean): 38 years  Sex: 84% female  Ethnicity: 54% African American  40% Hispanic  6% Other  Government benefits (SNAP): 70% | Availability | **AV:** Number of varieties of:   1. Fresh F 2. Fresh V   In-store audits conducted in Jan-Feb 2009 using adapted NEMS-S | Probability of purchasing:   1. Fresh F 2. Fresh V   Self-reported purchasing data for the previous 3 months, collected by interviews in March-May 2009 | Increased in-store F variety was associated (significantly) with increased odds of customers purchasing F at the store (OR 1.12; CI95% 1.01, 1.25; p=0.03)  Increased in-store V availability was associated (significantly) with increased odds of customers purchasing F at the store (OR 1.15; CI95% 1.07, 1.23; p=0.01) |  | Low |
| Nakamura et al.  (2014)S12  UK | Cross-sectional | One supermarket located in England  No neighbourhood SES details | N/A | Position | **P:** Dichotomise variable (present/ not present) for end of aisle displays of 3 drink products:   1. Carbonated Beverages 2. Tea 3. Coffee   In-store audit conducted for 13 weeks over a 1-year period from 2010-2011 by TNS PathTracker researchers | Mean weekly sales for 3 drink products  Objective store-level sales data collected by TNS PathTracker for same 13 weeks over a 1-year period from 2010-2011 | Carbonated beverages significantly greater in sales volume when placed at the end of aisle (β 0.42 CI95% 0.23, 0.61; p<0.01). Estimated increase (log transformed coefficient) = 51.7%  Coffee significantly greater in sales volume when placed at the end of aisle (β 0.55; CI95% 0.29, 0.82; p<0.01). Estimated increase (log transformed coefficient) = 73.5%  Tea significantly greater in sales volume when placed at the end of aisle (β 0.76; CI95% 0.22, 1.30; p<0.001). Estimated increase (log transformed coefficient) = 113.8% |  | Mod |
| Rose et al.  (2009) S13  USA | Cross-sectional | 38 supermarkets,  119 convenience/ petrol stores, general merchandise and liquor stores in 103 census tracts  Urban areas, South-Eastern Louisiana.  No neighbourhood SES details | n=1243  Recruitment: Random sample of households contacted via telephone  Age: 63% aged <50 years  Sex: 66% Female  Ethnicity: 50% White  42% African American  5% Latino  3% Other | Availability | **A:** Total shelf space (m) in all food stores within 1km distance from participants’ homes for:   1. Total F&V 2. Total energy dense snack foods (confectionery, biscuits, salty snacks soft drink)   In-store audits conducted in 2004-2005 | BMI (kg/m2) - Self-reported weight and height  Data collected in 2004-2005 through telephone interview | Neighbourhood (within 500m of home) availability of F&V was not significantly associated with BMI (β 0.00; SE 0.00; p>0.05)  Neighbourhood (within 500m of home) availability of energy dense snack was significantly associated with BMI (β 0.00; SE 0.00; p>0.05)  Neighbourhood (within 1km of home) availability of F&V was not significantly associated with BMI (β 0.00; SE 0.00; p>0.05)  Neighbourhood (within 1km of home) availability of energy dense snack was significantly associated with BMI (β 0.00; SE 0.00; p<0.05)  Neighbourhood (within 2km of home) availability of F&V was not significantly associated with BMI (β -0.00; SE 0.00; p>0.05)  Neighbourhood (within 2km of home) availability of energy dense snack was significantly associated with BMI (β 0.00; SE 0.00; p>0.05) |  | Low |
| Ruff et al.  (2016) S14  USA | Cross-sectional | 171 convenience stores (Bodegas)  Varying levels of neighbourhood deprivation, New York City | n= 1904  Recruitment: Convenience sample of shoppers exiting stores  Age: 61% 18-44 years  39% 45+ years  Sex: 45% Female  Ethnicity: 35% Black  29% Hispanic  18% White | Availability  Position | **Av:** Total number of individual types of fresh F&V available  **P:** Water placed at eye level (Yes/ No)  **P:** Fresh F&V displayed at front of store (Yes/ No)  No details provided about when in-store audits were conducted | Purchases of fresh F&V  Purchases of SSBs  Data recorded from bag checks when customers were exiting store | When compared to stores with high varieties of fresh F&V (11+ varieties), customers had decreased odds (significant) of purchasing fresh F&V if stores stocked fewer varieties of fresh F&V:   * 1 -5 types (OR 0.11; CI95% 0.04, 0.31; p<0.05) * 6 -10 types (OR 0.16; CI95% 0.06, 0.42; <0.05)   Customers had decreased odds (non-significant) of purchasing fresh F&V if the store did not have fresh F&V displayed at the front of the store (OR 0.827; CI95% 0.309, 2.214; p>0.05)  Customers had decreased odds (non-significant) of purchasing SSBs if the store did not have fresh F&V displayed at the front of the store (OR 0.745; CI95% 0.504, 1.102; p>0.05)  Customers had decreased odds (non-significant) of purchasing SSBs if the store did not have water displayed at eye level (OR 0.945; CI95% 0.72, 1.242; p>0.05)  Customers had decreased odds (non-significant) of purchasing fresh F&V if the store did not have water displayed at eye level (OR 0.784; CI95% 0.36, 1.73; p>0.05)  When compared to stores with 11+ varieties of fresh F&V, customers had greater odds of purchasing SSBs if stores stocked fewer varieties of fresh F&V:   * No varieties (OR 2.271; CI95% 1.274, 4.049; P<0.05) * 1-5 varieties (OR 1.788; CI95% 1.079, 2.963; P<0.05) * 6-10 varieties (OR 1.33; CI95% 0.777, 2.277; p>0.05) |  | Low |
| Sanchez-Flack et al. (2017)S15  USA | Cross-sectional | 16 convenience stores (Tiendas)  Located in areas with >20% Hispanic residents in San Diego County | n=356  Recruitment: Convenience sample of customers exiting stores  Age (mean): 42 years  Sex: 70% female  Ethnicity: 100% Hispanic  Employed: 60%  Government benefits (SNAP/ WIC): 48% | Availability | **A:** Total availability of 73 fresh, 28 canned and 16 frozen F&V, plus any others available. Scores summed to produce a continuous fresh F&V availability score and a continuous canned and frozen F&V availability score for each store  **A:** Total number of fresh F&V displays  **A:** Total shelf-space (feet2) dedicated to fresh F&V  In-store audits conducted between November 2013 and October 2013 | Self-reported dollars spent on F&V per week at study store.  Data collected through store exit interviews with participants. | A positive association (significant) between the number of fresh F&V available and dollars spent on F&V per week in store (β 0.36; CI95% 0.09, 0.63; p=0.01)  A positive association (non-significant) between the number of canned and frozen F&V available and dollars spent on F&V per week in store (β 0.07; CI95% -0.14, 0.28; p=0.48)  When F&V shelf-space and number of F&V displays were considered in the same model, a positive association (significant) was observed between the number of F&V displays and dollars spent on F&V per week in store (β 0.02; CI95% 0.01, 0.04; p=0.01)  When F&V shelf-space and number of F&V displays were considered in the same model, a negative association (significant) was observed between F&V shelf-space (ft2) and dollars spent of F&V per week in store (β -0.29; CI95% -0.52, -0.06; p=0.02) |  | Low |
| Thornton et al.  (2010) S16  Australia | Cross-sectional | 143 supermarkets in 37 neighbourhoods  Random sample of neighbourhoods with varying levels of deprivation, Melbourne | n= 1082  Recruitment: Participants in the Social Status and Activity in Women study, living in a study neighbourhood which contained a supermarket within 3km of their home  Demographics of wider study (n=1399)  Age (mean): 41 years  Sex: 100% female  Neighbourhood SES: Low 33.2%  Mid 38.5%  High 28.3% | Availability | **A:** Availability of 15 commonly consumed F; summed to produce total F availability for each store  **A:** Availability of 23 commonly consumed V; summed to produce total V availability for each store  In-store audits conducted in 2006 using a structured checklist | Self-reported daily consumption of F&V portions; dichotomous outcome created for F&V separately:   1. High intakes= ≥2 portions of F/V daily 2. Low intakes= <2 portions of F/V daily   Data collected in 2004 via postal questionnaire adapted from the Australian National Nutrition Survey | A lower (non-significant) mean F availability was observed for customers who consumed ≥2 portions of F daily (10.5 (SD 2.2)) when compared to those who consumed <2 portions of F daily (10.6 (SD 2.1) (p=0.35)  A lower (non-significant) mean F availability was observed for customers who consumed ≥2 portions of V daily (10.5 (SD 2.2)) when compared to those who consumed <2 portions of V daily (10.7 (SD 2.1)) (p=0.190  A lower (non-significant) mean V availability was observed for customers who consumed ≥2 portions of F daily (20.3 (SD 4.0)) when compared to those who consumed <2 portions of F daily (20.5 (SD 3.8) (p=0.52)  A lower (significant) mean V availability was observed for customers who consumed ≥2 portions of V daily (20.2 (SD 4.1) when compared to those who consumed <2 portions of V daily (20.8 (SD 3.6)) (p=0.03) |  | Mod |
| Thornton et al.  (2011) S17  Australia | Cross-sectional | 71 supermarkets in 35 neighbourhoods  Random sample of neighbourhoods with varying levels of deprivation, Melbourne | n=1007  Recruitment: Participants in the Social Status and Activity in Women study, living in one of the assessed neighbourhoods which contained a supermarket within 3km of their home  Demographics of wider study (n=1399)  Age (mean): 41 years  Sex: 100% female  Neighbourhood SES: Low 33.2%  Mid 38.5%  High 28.3% | Availability | **AV:** Mean number of varieties of chocolates for all supermarkets within 3km from home; categorical variable developed:  <40 items,  40-49 varieties,  ≥50 varieties    **Av:** Mean number of varieties of confectionery for all supermarkets within 3km from home; categorical variable developed:  <40 items,  40-49 varieties,  ≥50 varieties  In-store audits conducted in 2006 using a structured checklist | Self-reported consumption for previous month (1-3/ month, 1/ week, 2-6/ week, 1+/day)  of:   1. Chocolate 2. Confectionery   Data collected in 2004 via postal questionnaire adapted from the Australian National Nutrition Survey | For chocolate, greater variety was non-significantly associated with frequency of consumption of chocolate with OR’s very close to 1. Effect estimates were higher for daily consumption (ORs>1.4, p>0.3). However, ≥50 varieties were associated with lower odds of consumption 2-6 times per week (OR (95% CI): 0.71 (0.39-1.29), p=0.26).  For confectionary, greater variety was non-significantly associated with frequency of consumption with ORs very close to 1. Larger positive effect estimates were found for the association between variety and consumption 2-6 times per week (ORs>1.27, p>0.40). A variety of 40-49 was associated with higher monthly consumption (OR=1.31, p=0.35) and ≥50 varieties was associated with higher daily consumption (OR=1.46, p=0.48). |  | Mod |

**Result summary:** Direction of result, significance level (**** Positive result p<0.05; **** Positive result p>0.05; **** Negative result p<0.05**;** Negative result p>0.05; Direction inconsistent) & health rating of exposure; **SES:** Socio-economic Status**; F:** Fruit**; V:** Vegetables**; F&V:** Fruit and vegetables; **WIC**: Women, Infants, Children; **SNAP**: Supplemental Nutrition Assistance Program; **SSBs:** Sugar Sweetened Beverages; **A:** Availability; **Av:** Variety as part of availability; **P:** Positioning; **OR:** Odds Ratio

**Table S6: Summary Table of Intervention Studies**

| **Author, Year, Country** | **Study Design** | **Setting** | **Participant Sample** | **Placement Strategy** | **Intervention Description** | **Outcome Measure** | **Key Findings** | **Effect  Summary\*** | **Risk of Bias** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Adam et al.  (2017) S18  Denmark | Quasi-experimental design  Matched control  BL: 5 weeks  Intervention period: 5 weeks | 10 supermarkets;  5 intervention  5 control  Stores matched on geographical location  No neighbourhood SES details | N/A | Position | **P:** Dairy items coded in relation to energy density (Red: high energy, Yellow: medium energy, Green: low density)  Dairy products then placed in differing shelf positions according to their energy code:  Green: favourable (middle and eye- level) position,  Yellow: Intermediate position,  Red: less favourable position  **Control:** Usual shelf allocation | Weekly sales of 80 dairy items coded as green, yellow or red according to energy density  Objective store sales data  [Results only present for combined green and red categories] | A significant effect of the shelf positioning intervention on calories sales of green dairy products was observed (β=0.09, SE=0.03, p<0.001)  No significant effect of the shelf positioning intervention on calories sales of red dairy products was observed (β=-0.04, SE=0.05, p>0.1) |  | High |
| Adjoian et al.  (2017) S19  USA | Repeated cross-sectional measures  One control checkout per store  Measures recorded on 6 occasions over a 1-week period | 3 supermarkets  Deprived neighbourhood, New York | N/A | Position | **P:** Introduction of a healthy checkout containing products that met nutritional criteria (for kcal, fat, sat fat, trans fat, sodium, sugar, fibre):   * Nuts, seeds, dried F and/or trail mix * Granola bars * Fresh F/packaged F (apple sauce) * Bottled water or carbonated water * Chewing gum   Not all products on the checkout met the nutrition criteria  **Control:** 1 checkout in each store took part in the study but received no changes | % of customers, observed by researcher, purchasing healthy, unhealthy or neutral items from checkout area | More customers purchased healthy products when using the healthy checkout compared with those using the standard checkout (56.5% v 20.5%, p<=0.001)  Fewer customers using the healthy checkout purchased an unhealthy product compared with those using the standard checkout (45.7% v 74.4%, p=0.007) |  | High |
| Albert et al. (2017) S20  USA | Repeated cross-sectional measures  Matched control  BL  FU: length of intervention period unclear, ranging from 1-2 years | 8 convenience stores;  3 intervention  5 control  (1 intervention store withdrew and became a control store  Stores matched on store characteristics (not described)  Majority Latino community, California | Intervention BL: n=264  Intervention FU: n=208  Control BL: n=286  Control FU: n= 199  Recruitment: In-store  Majority of respondents at both time points were:   * Female * Aged >43 years * Married or living with partner * Foreign born * Mexican heritage * High school education or lower | Position | **P:** F&V positioned at front of store and crisps/soft drink move to back of store  **Multi-component:** Store refurbishment, social marketing campaign  **Control:** No in-store intervention and no community work in surrounding neighbourhood. | Self-reported % of food dollars spent on F&V each week.  Self-report variety of F&V purchased during visit to store  Self-report total serving of F&V consumed per day. | No significant difference in % of food dollars spent on F&V was observed between the intervention and control groups for the study period (Intervention mean difference 1.7; Control mean difference 1.5, p>0.01)  A significant increase in mean number of F&V varieties purchased between BL and FU for intervention participants was observed (BL: 0.2 (SD 0.6), FU:0.5 (SD 1.1) p<0.001)  A significant difference in mean number of F&V varieties purchased was observed between the intervention and control group for the study period (Intervention mean difference 0.3; Control mean difference 0.0, p<0.001)  No significant difference in F&V intake/day was observed between intervention and control groups for the study period (Intervention mean difference 0.1; Control mean difference -0.3, p>0.01) |  | High |
| Ayala et al. (2013) S21  USA | Clustered randomised control trial  Delayed treatment control  BL  4 month FU | 4 convenience stores (Tiendas),  2 intervention  2 control  Majority Latino community, North Carolina | n=119  Recruitment: In-store (convenience sample)  BL: In-store  FU: Telephone  Age (mean): 32 years  Sex: 66% Female  Ethnicity: 85% Mexican  SES: Mean monthly income $US 1,500 | Availability  Position | **A&P**: New ready-to-eat F&V display at principal cash register  2-month duration  **Multi- component:** Staff training, food demonstrations, social marketing campaign  **Control:** Delayed treatment control | Self-report F&V consumption (portions/day)  Self- reported variety of F&V consumed  (Validated National Cancer Institute F&V All- Day Screener) | Increase in F&V consumption from 2.04 (1.19) to 2.88 (2.01) in the intervention group compared to 2.61 (1.53) to 2.84 (2.35) in the control group (p=0.06)  Variety of F consumed in the past month (out of 32) changed from 20.5 (5.75) to 20.93 (5.74) in the intervention group and 20.12 (5.49) to 19.13 (6.16) in the control (p>0.1)  Variety of V consumed in the past month (out of 43) changed from 25.93 (5.90) to 26.86 (7.77) in the intervention group and 26.42 (6.24) to 25.53 (7.54) in the control (p>0.1) |  | High |
| Dannefer et al. (2012) S22  USA | Repeated cross-sectional measures  No control group  BL  6-7 month FU | 8 convenience stores (Bodegas)  Deprived neighbourhoods, New York | BL: n= 294  FU: n=323  Recruitment: In-store (convenience sample)  BL: Exit interviews  FU: Exit Interviews  No demographic characteristics provided | Availability  Position | **A:** Increased variety of fresh F&V.  Increased availability of low salt canned V, canned F in F juice, whole-grain bread and 1% milk  **P:** Water displayed at eye-level  **Multi-component:**  Staff training, social marketing campaign | Self-report food and beverage purchases on store visit | Among 124 people at BL and 153 at FU who purchased a beverage, the percentage purchasing at least one bottle of water increased from 6% (n=8) to 12% (n=18)  Among the 111 customers at baseline and post intervention who purchased promoted healthier options, the percentage purchasing healthier options increased from 5% (n=6) before the intervention to 16% (n=18) after the intervention |  | High |
| De Wijk et al.  (2016) S23  Netherlands | Alternating treatment time series  No control group  Intervention period: 12 weeks of 2 alternating treatments | 2 supermarkets in Veenendaal  No neighbourhood SES details | N/A | Position | 2 alternating treatments for the positioning of 5 types of bread (whole grain, dark wheat, wheat, light wheat, white) conducted in 2 periods  **P1:** Healthy bread first.  7- week period  Whole grain bread placed at entrance to aisle followed by dark wheat, wheat, light wheat and white)    **P2:** Healthy bread last.  5-week period  White bread placed at entrance to aisle followed by light wheat, wheat, dark wheat and whole grain) | Ratio:  Mean bread sales per week, for each bread type, for supermarket A: mean bread sales per week, for each bread type, for supermarket B  Objective store sales data | No significant effect of the manipulation on sales of the different bread types (F=1.90, p=0.174 for time period and F=1.95, p=0.115 for the interaction between type of bread and time period) |  | High |
| Ejlerskov et al. (2018a1)S24  UK | Time series using repeated cross-sectional data  Matched control  Natural experiment evaluating supermarket chain-led checkout food policies  BL: 13 4-week periods  FU: 13 4-week periods | 9 UK supermarket chains;  6 intervention  3 control  Purchasing data representative of UK grocery market sales | n≈30,000 households  Purchasing of take-home food weighted and uplifted to represent n=27,385,050 households, aggregated into 4-weekly periods, to provide supermarket chain level data | Position | **P:** Voluntary supermarket chain-led checkout food policy limiting the positioning of unhealthy food items at checkouts  Policy presence identified through supermarket annual reports, webpages and press releases- intervention chains included those with i) clear and consistent (n=3) and ii) vague and inconsistent (n=3) policies  **Control:** Supermarket chains with no checkout food policy | Supermarket chain purchases per 4-week block of single-serve checkout foods (confectionery, chocolate and crisps collated)  Data from Kantar Wordpanel ‘take-home’ dataset | Compared to the counterfactual, implementation of supermarket chain-led checkout food policies was associated with statistically significant decreases in the purchasing of common checkout foods at:   * 4 weeks following the policy implementation (-157.7; CI95% -242.8, -72.7) * 12 months following the policy implementation (-185.1; CI95% -248.5, -121.7) |  | High |
| Ejlerskov et al. (2018a2)S24  UK | Natural experiment evaluating supermarket chain-led checkout food policies  Matched control  Data collected annually from 2016-2017 | UK supermarket chains;  3 intervention  3 control | n≈7,500  Data weighted and uplifted to represent UK population n= 50, 398,000 individuals aged 13-79 years | Position | **P:** Voluntary supermarket chain-led checkout food policy limiting the positioning of unhealthy food items at checkouts  Policy types classified through supermarket annual reports, webpages and press releases- these analyses include i) clear and consistent (n=3) and ii) no checkout policy (n=3) | Annual household purchases of single-serve checkout foods (confectionery, chocolate and crisps collated) per market share  Data from Kantar Worldpanel ‘out-of-home’ dataset | When compared to supermarket chains with no checkout food policy, those with clear and consistent policies had significantly fewer annual unit purchases of common checkout foods per market share (β -25000; CI95% -37100, -12900) |  |  |
| Ejlerskov et al. (2018b) S25  UK | Repeated cross-sectional data analysis  Natural experiment evaluating supermarket chain-led checkout food policies  Matched control  Data collected annually from 2013-2017 | UK supermarket chains;  6 intervention  4 control | n≈30,000 households  Data weighted and uplifted to represent all UK households n=27,385,050 households  Range of demographics across all supermarket chains:  Age (mean): 49.7- 58.6 years  Social class (means): 3.25-3.98 [5= most affluent] | Position | **P:** Voluntary supermarket chain-led checkout food policy limiting the positioning of unhealthy food items at checkouts  Policy types classified through supermarket annual reports, webpages and press releases- these analyses include i) clear and consistent (n=3) and ii) no checkout policy (n=4) | Annual household purchases of single-serve checkout foods (confectionery, chocolate and crisps collated) per market share  Annual purchases grouped according to social class (occupation of main household shopper)  Data from Kantar Worldpanel ‘take-home’ dataset | Significantly fewer purchases of common checkout foods per household per market share were made from supermarket chains with clear and consistent checkout food policies, when compared to purchases from supermarket chains with no checkout food policy (ratio 0.86; CI95% 0.78, 0.96)  A significant interaction between social class and checkout food policy was observed (p=0.02). When compared to all households, households in the two most affluent and the least affluent social class made fewer purchases of common checkout foods from supermarkets with a clear and consistent policy   * AB (lowest): (RGM+ 0.79, CI95% 0.65, 0.96) * C1: (RGM 0.74, CI95% 0.61, 0.91) * C2: (RGM 1.05, CI95% 0.86, 1.29) * D: (RGM 0.96, CI95% 0.79, 1.18) * E (Highest): (RGM 0.79, CI95% 0.65, 0.97) |  | High |
| Foster et al.  (2014) S26  USA | Cluster randomised control trial  Matched control  BL: 3 month  FU: 6 month | 8 supermarkets from two large chains;  4 intervention  4 control  Stores matched on:   * Supermarket chain * Store size * Subsidised sales   Deprived neighbourhoods, Philadelphia and Wilmington | N/A | Availability  Position | **A:** Reduced shelf space of whole milk and full calorie soft drinks by 30%  **A:** Increased shelf space of reduced fat milk (2%, 1%, skim), lower calorie frozen meals, diet soft drinks and water  **P:** Reduced fat milk, low calorie frozen meals, diet soft drinks and water placed in more prominent shelf position  **Multi-component:** Signage, food demonstrations  **Control:** No intervention received | Difference between intervention and control stores in mean change of weekly sales from BL to FU for targeted products  Objective store sales data | Compared to control stores, intervention stores showed significantly greater mean change in sales of:  Skim milk (oz) (Mean change 1509.1 (SE 1079.9), p<0.01)  1% milk (oz) (Mean change 3383.2 (SE 1403.8), p<0.01)  Lower calorie frozen chicken nuggets (units) (Mean change 20.5 (SE 10.4), p<0.01)  Lower calorie frozen turkey dinner (units)  (Mean change 10.8 (SE 6.2), p<0.05)  Water in-aisle (oz) (Mean change 1690 (SE 6649.8), p<0.05)  Water checkout (units) (Mean change 18.5 (SE 6.0), p<0.01)  No significant differences in mean change of sales between intervention and control stores for other items:  Whole milk (oz) (Mean change -3910.6 (SE 4942.7), p=0.67)  2% milk (oz) (Mean change -2417.9 (SE 3410.9), p=0.55)  Lower calorie frozen steak meal (units) (Mean change 10.5 (SE 12.1), p=0.65)  Pepsi in-aisle (oz) (Mean change -2706.5 (SE 6250.6), p=0.88)  Diet Pepsi in-aisle (oz) (Mean change -507 (SE 970.5), p=0.29)  Regular checkout beverages (units) (Mean change -13.5 (SE 9.3), p=0.62)  Low Calorie checkout beverages (units) (Mean change 1.5 (SE 4.4), p=0.22) |  | Mod |
| Gittelsohn et al.  (2010) S27  USA | Quasi-experimental design    Unmatched control  BL  FU: 19 months | 13 convenience stores and 3 supermarkets;  Intervention: 7 convenience stores (Korean) and 2 supermarkets in East Baltimore  Control: 6 convenience stores (Korean) and 1 supermarket in West Baltimore  Deprived neighbourhoods with majority African American community, Baltimore | n= 83  Recruitment: In-store and community action centres (convenience sample)  FU: In person interview  No demographic characteristics provided | Availability | Intervention was delivered in 5 phases, each lasting 2 months:  **A:** Increased availability of:   1. Low sugar cereal, high-fibre cereals and low-fat milk 2. Cooking oil spray 3. Fresh F and low fat snacks 4. Wholegrain bread and low fat mayonnaise 5. Water and diet carbonated drinks   **Multi-component:** Signage, food demonstrations, staff training, financial incentives for store owners  **Control:** No intervention received | Self-reported ‘healthy food getting’ assessing consumption of 26-foods in previous 30-days from all food sources including shops, church, food stamps, friends and family. | ‘Healthy food getting’ scores (consumption), from BL to FU, showed a non-significant reduction in the intervention group compared to the control group (β= -0.09, p=0.4) |  | High |
| Holmes et al.  (2012) S28  USA | Time series  No control group  BL: 5 weeks  FU:12 weeks | 1 supermarket  Majority white neighbourhood, Roanoke | N/A | Availability  Position | **A&P:** New child targeted display in a prominent location promoting 32 food items including F&V and healthier child friendly diary, meat and cereal products  **Multi-component**: Food demonstrations | Change in mean weekly sales of targeted items as proportion of total sales  Objective store sales data  (We only present results for F&V, whole-grain products and sunflower seeds total n=15) | 4 items showed significant increases in sales during the intervention period (p<0.05) (whole wheat bagels, sunflower seeds, bananas and radishes)  6 other items showed an increase in sales but were not statistically significant (yellow peppers, carrots, lemon, apple, kiwi, non-fat milk)  2 items showed significant decreases in sales during the intervention period (p<0.05) (broccoli and tomatoes)  4 items showed decreased sale but were not statistically significant (pineapple, mango, orange, whole-wheat pita)  Add detail about effect sizes/ change in proportion  (Due to the difficulty in classifying some food items as healthy/ unhealthy without nutritional information, in some cases we only report the foods that can be easily classified in accordance to the dietary guidelines e.g. F&V) |  | High |
| Jilcott Pitts et al. (2018) S29  USA | Repeated cross-sectional study  Matched controls    Natural experiment evaluating North Carolina Healthy Food Small Retailer Program  BL  FU: 6 months | 8 convenience stores; 4 intervention,  4 control  Stores matched on:   * Store type * Store size * Food desert type * % SNAP * % African American   8 census tract areas   * 15-53% SNAP * 23-88% African American | BL: n= 279  FU: n= 223  Recruitment: In-store (convenience sample)  Demographics across data collection points:  Age (mean): 42.5 - 44.9 years  Sex: 30.3-44.2% Female  Ethnicity: 39.5-87.2% Black | Availability | Intervention included a $25,000 grant to increase the availability of healthy foods (F&V, low-fat milk, whole grain products) in stores  Intervention was unique to each store  **A:** Assessed by Healthy Food Supply (HFS) score. On average, intervention stores increased by 3.13 points and control stores decreased by -0.44 points from pre study to FU.  [HFS score (possible range 0-31) summarises availability, quality, variety and price of food in store. Higher scores represent healthier stores.]  **Multi-component:** Promotional events, purchasing of display equipment  **Control:** Did not receive $25,000 grant to make adaptations to store | Store-level healthfulness of sales from bag check data using HEI-2010  Participant self-reported consumption of:   1. F&V 2. SSBs   Participant skin carotenoid status measured by pressure mediated reflection spectroscopy  Participant BMI (km/m2) using self-reported height and weight | A non-significant difference between groups in mean change of store-level HEI scores was observed, with scores decreasing in both intervention and control groups (Intervention store mean difference = -1.19; control stores mean difference = -0.08; p= 0.83)  A non-significant difference between intervention and control groups in mean daily F&V intake was observed with consumption increasing among intervention participants (β= 0.68, SE=0.64; p=0.29)  A non-significant difference between intervention and control groups in mean SSB intake was observed with consumption decreasing among intervention participants (β= -0.25, SE=0.37; p=0.50)  A non-significant difference between intervention and control groups in mean skin carotenoids was observed, indicating consumption decreased among intervention participants  (β= -7.92, SE=14.77; p=0.59)  A non-significant difference between intervention and control groups in mean BMI was observed, indicating an increased BMI among intervention participants (β= 0.67, SE=1.27; p=0.60) |  | High |
| Lawman et al.  (2015) S30  USA | Repeated cross-sectional measures  No control group  BL  FU: 12 months | BL: n= 173  FU: n= 113  Convenience stores  Deprived neighbourhoods, Philadelphia | BL: n= 8671  FU: n= 5949  Recruitment: In-store (convenience sample)  Sex: 41% Female (BL & FU) | Availability | **A:** Introduction of 4 new healthy foods (2 new products from 2 different groups: fresh F&V, canned / dried F&V, low fat diary, lean meats, whole grains)  **Multi-component:** social marketing campaign, staff training | Change in energy (kcal), fat (g), protein (g), carbohydrates (g), sugar (g), fibre (g) and sodium (mg) in foods purchased at BL and FU  Researcher conducted CPA when exiting store  [Results only present for fibre, sugar and sodium due to clear relationship with health] | A non- significant reduction in sugars (g) was observed between intervention BL and FU: (Change -0.37; SE 2.77; p=0.85)  A non-significant increase in dietary fibre (g) was observed between intervention BL and FU: (Change 0.08; SE 0.14; p=0.56)  A non-significant increase in sodium (mg) was observed between intervention BL and FU: (Change 31.49; SE 89.55; p= 0.72) |  | High |
| Sigurdsson et al. (2009) S31  Iceland | Alternating treatment time series  No control group  BL: 44-52 days  Intervention period: 72 days of 4 interventions | 2 discount supermarkets in Reykjavik  No neighbourhood SES details | N/A | Availability  Position | **A&P:** Introduction of a large display at the front of the store with 112 facings of the target potato crisp brand  **P:** Alternating placement of target brand of potato crisps between low (24cm), middle (123cm) and high shelves (173cm) | Sales of target potato chip brand as a percentage of total potato chip sales (24 brands including target brand)  Objective store sales data | Mean relative sales of the target brand were highest when positioned on the middle shelf compared to positioning on low and high shelf in both stores (Store A: middle 7.5%, range 6.6%-8.6%; low 4%, range 2.9%- 5.8%; high 3.3%, range 2.7%-3.6%. Store B: middle 5.7%, range 5%-6.2%; low 4.4%, range 4.1%- 5%; high 4.4%, range 4.1%-4.7%.)  Mean relative sales of target crisp brand during presence of extra display at the front of store, appeared to be higher than BL in both stores (store A:12.6%, range 8.3%-15.7%; store B: 9%, range 3% -12.3%) |  | High |
| Sigurdsson et al. (2011) S32  Norway | Alternating treatment time series  No control group  Intervention period: 56 days of 3 interventions and baseline | 1 small supermarket  1 discount supermarket  No neighbourhood SES details | N/A | Position | 3 interventions alternating with baseline condition for periods of 4 days  **P1:** Bananas in aisle and at checkout (alongside confectionery)  **P2:** Bananas in aisle and on confectionery shelf  **P3:** Bananas in aisle, at checkout and on confectionery shelf (and shelf prompts)  **Multi-component:** Signage | Mean proportion of banana sales compared to total F sales (including bananas) for each condition of the study  Objective store sales data | Mean sales of bananas increased from BL (small: 26.38%, range: 22.35- 30.23%; discount: 16.94%, range: 15.56- 17.79%) for the checkout position (small: 27.58%, range 27.17-28.08%; discount: 18.24%, range15.96-20.54%)  Mean sales of bananas for the confectionery shelf condition were inconsistent  Mean sales of bananas increased from BL for checkout, confectionery shelf and shelf prompt condition (small: 28.46%, range 25.34-31.57%; discount: 21.45%, range 20.26-22.64%) |  | High |
| Sigurdsson et al. (2014) S33  Norway | Alternating treatment time series  No control group  BL:12-16 days  Intervention period: 12-40 days alternating 2 interventions and baseline.  FU:12 days | 1 small supermarket  1 discount supermarket  No neighbourhood SES details | N/A | Position | 2 interventions alternating with baseline condition for periods of 4 days  **P1:** Dried fish and dried F & nut mix located at checkouts with confectionary and chewing gum next to checkout  **P2 (Multi-component):** P1 plus signage  BL: Confectionary and chewing gum positioned at checkout. Dried fish and dried F & nut mix positioned in standard location | Total unit of sales of targeted products in 4-day period  Objective store sales data | Sales of dried fish and dried F & nut mix increased relative to BL for both the store position only and the store position + shelf prompt condition for both products (~15-200% no specific details given)  Sales of confectionary and chewing gum reduced slightly in one store during the intervention phase and remained lower than BL in the FU period |  | High |
| Song et al.  (2009) S34  USA | Quasi-experimental design (feasibility study)  Unmatched control  BL  FU: 10 months | 13 convenience stores (Korean)  Intervention: 7 convenience stores in East Baltimore  6 control in West Baltimore  Deprived neighbourhoods with majority African American community, Baltimore | N/A | Availability | Intervention was delivered in 5 phases, each lasting 2 months:  **A:** Increase availability of:   1. Low sugar cereal, high-fibre cereals and low-fat milk 2. Cooking oil spray 3. Fresh F and low fat snacks 4. Wholegrain bread and low fat mayonnaise 5. Water and diet carbonated drinks   **Multi-component:** Signage, food demonstrations, staff training, financial incentives for store owners  **Control:** No intervention received  [Intervention details taken from Gittelsohn et al, 2010 due to lack of detail in manuscript] | Sales of 10 promoted healthy foods reported for the previous 7 days  Binary measures (0= no units sold/ week, 1= 1 or more units sold/ week) for each product self-reported by store managers | Compared to control stores, a positive intervention association was observed for:  Cooking spray (Intervention mean 0.3(SD 0.5); Control mean -0.5 (SD 0.6); p=0.05)    Low sugar cereal (Intervention mean 3.9 (SD8.8; Control mean -1.9 (SD1.4); p=0.13)  Baked/low-fat crisps (Intervention mean 1.1 (SD 2.0); Control mean 0 (SD 0); p=0.13)  Low-salt crackers (Intervention mean 0.3(SD 0.8); Control mean -0.4 (SD 0.7); p=0.13)  Whole wheat bread (Intervention mean 0.4 (SD 6.2); Control mean -1.9 (SD 8.3); p=0.71)  100% F juice (Intervention mean 4.9 (SD 39.4); Control mean -10.6 (SD 59.8); P=0.63)  Compared to control stores, a positive intervention association was observed for:  High fibre cereal (Intervention mean -0.8 (SD 2.1); Control mean -2.8 (SD 2.6); p=0.20)  Low fat milk (Intervention mean -0.4 (SD 1.3); Control mean -1.9 (SD2.7); p=0.23)  Diet beverages (Intervention mean -10.0 (SD 39.2); Control mean 10.5 (SD 29.5); p=0.58)  Water (Intervention mean -15.8(SD 91.9); Control mean -2.2 (SD 56.5); P=0.83) |  | High |
| Thorndike et al. (2017) S35  USA | Randomised control trial (pilot study)  Matched controls  BL: 11 months  Intervention period: 5 months | 6 convenience stores accepting both WIC and SNAP vouchers;  3 intervention  3 control  Stores matched on monthly WIC sales  Deprived neighbourhoods with majority Hispanic community, Chelsea, Massachusetts | n=575 over 2 cross-sectional survey  Recruitment: In-store  n=295 intervention  Sex: 53% Female  Age: 55% 18-39years  37% 40-59 years  8% >=60years  Ethnicity: 82% Hispanic/ Latino  n=280 control  Sex: 57% Female  Age: 56% 18-39years  38% 40-59 years  6% >=60years  Ethnicity: 92% Latino/ Hispanic | Position | **P:** Positioning fresh F&V at the front of the store (replacing baked goods in one store and crisp display in another)  **Multi-component:** Staff-training, store refurbishment | WIC F&V voucher sales ($US) per store per month. Data received from WIC state office  Self-reported purchases of F&V by customers exiting the store | During the intervention period, F&V WIC voucher sales increased in intervention stores by $40/month and decreased in control stores by $23/month. (Difference in trend: $63/month (CI $4-121), p=0.036)  No significant difference in % of customers purchasing fresh F&V for intervention and control store customers between BL and intervention periods (Difference: intervention 1; control -4%, p=0.29) |  | Mod |
| Toft et al.  (2017) S36  Denmark | Quasi- experimental design  Unmatched control  BL: 1 month  Intervention period: 3 months  Post intervention: 1 month | 3 supermarkets;  1 intervention  2 control  No neighbourhood SES details | N/A | Availability  Position | **A:** Increased stocking of F&V (mainly fresh)  **P:** F&V placed in produce bins in high traffic areas such as at the entrance, end –caps and near the checkout. F&V replaced non-food items snacks and confectionary in these areas  **Control:** No clear description | Weekly store sales data for all F&V, confectionery, sugary beverages, cakes, fish and wholegrain products.  Index created for each store [number sold products in intervention year/ number products sold in previous year) x 100]  Objective store sales data. | A non-significant increase in total F&V sales was observed for the intervention (estimate 0.02 (SD 0.06), p=0.72)  A non-significant increase in fresh V sales was observed for the intervention (estimate 0.04 (SD 0.06) p=0.496)  A non-significant decrease in fresh F sales was observed for the intervention (estimate -0.0016 (SD 0.09) p=0.100)  A non-significant increase in organic fresh F&V sales was observed for the intervention (estimate 0.0231 (SD 0.06) p=0.680)  A significant decrease of 14.3% in cake sales was observed for the intervention (estimate -0.14, p=0.046)  A non-significant decrease of 0.07% in confectionery sales was observed for the intervention (estimate -0.07, p=0.09) |  | High |
| Wensel et al.  (2019) S37  USA | Randomised controlled pilot trial  Unmatched control  BL: 2 months  Post intervention FU: 1 month | 4 convenience stores;  2 intervention (position only)  2 control  Deprived neighbourhoods with majority African American community, Baltimore | N/A | Position | **P:** WIC eligible food products moved to the front of the store and/or to eye level.  Intervention was implemented for 1 month  **Control:** No treatment | Change from BL to FU in total sales of WIC eligible food products at store level in past 7 days  Change from BL to FU in total sales of WIC eligible food products to WIC consumers in past 30 days  Sales data reported by the store owner | Product positioning only strategies showed a non-significant difference between intervention and control groups (p>0.05), with sales decreasing among intervention stores for:   * Total store sales β -35.5 (SE 54.1) * Total sales to WIC customers β -76.5 (SE 39.7) |  | High |
| Winkler et al.  (2016) S38  Denmark | Repeated cross-sectional measures  No control stores  BL: 4 weeks  Intervention period: 4 weeks  Post intervention:7 weeks1 | 4 supermarkets  in Bornholm  No neighbourhood SES details | N/A | Position | **P:** Healthy snack products displayed at one checkout above the conveyor belt in each store, replacing sugar confectionery. Most commonly healthy snack products included:   1. Fresh F 2. Dried F 3. Dried F bars 4. Carrot snack packs | Weekly store sales data for all sugar confectionary and most common intervention items (fresh F, dried F, dried F bars, carrot snack packs)  Objective store sales data | A non- significant reduction in sugar confectionary sales was observed for the intervention period when compared to the pre and post intervention periods (Pre: 0.93 (CI 0.80-1.06); Post: 0.96 (0.84-1.11)  A non- significant reduction in fresh F sales was observed for the intervention period when compared to the pre and post intervention periods (Pre: 0.94 (CI 0.80-1.11); Post: 0.92 (0.78-1.09)  A non- significant reduction in dried F sales was observed for the intervention period when compared to the pre and post intervention periods (Pre: 0.80 (CI 0.58-1.11); Post: 0.86 (0.62-1.19)  A non- significant increase in F bar sales was observed for the intervention period when compared to the pre and post intervention periods (Pre: 1.31 (CI 0.78-2.20); Post: 1.37 (0.82-2.30)  A non- significant increase in carrot snack pack sales was observed for the intervention period when compared to the pre and post intervention periods (Pre: 1.01 (CI 0.73-1.39); Post: 1.13 (0.82-1.56) |  | High |

**Effect summary:** Direction of result and significance level **( ** Positive result p<0.05; **** Positive result p>0.05; **** Negative result p<0.05**;** Negative result p>0.05),and health rating of intervention (H: Healthy; UH: Unhealthy; H&UH: Healthy and Unhealthy items were considered as the intervention);   
**BL:** Baseline**; FU:** Follow- Up**; SES:** Socio- Economic Status**; F&V:** Fruit and vegetables**; F:** Fruit; **V:** Vegetables; **CPA:** Customer Purchase Assessment; **WIC**: Women, Infants, Children; **SNAP**: Supplemental Nutrition Assistance Program; **RGM:** Ratio of Geometric Mean

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