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Rapid Review: Nutrition and cancer prevention and effective policies to increase healthy eating

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Executive Summary

Background

As the leading cause of death in Canada, cancer has a significant impact on the social, financial and psychosocial quality of life of cancer patients and their loved ones. Cancer is also a significant economic and public health concern at the health system level. Increasing cancer incidence will continue to burden the Canadian health system, underscoring the need for sustained and effective initiatives. While our understanding of the relationship between diet and cancer continues to evolve, it is clear that the relationship exists such that some foods and diets reduce one's risk for cancer while others increase it. Policy interventions targeted at the population level, which have been shown to be more effective than policies targeting individual behaviours (Temple, 2020), should be implemented to achieve population level goals related to cancer reduction.

This rapid review includes evidence available up to May 31, 2022, to answer the question: **What are effective policy and program initiatives to increase healthy eating and/or decrease unhealthy eating for cancer prevention?**

Key Points

Increasing healthy eating

Interventions with evidence of effect:

- This review found evidence that some policy interventions help people increase healthy eating; the certainty of evidence is low as the evidence is provided to a large extent by observational studies, and the effect is either small or imprecise (GRADE). However, the strength and direction of effect are not likely to change as new evidence emerges, due to the challenges inherent in evaluating the effects of policy interventions at the population level.

- Based on the best available evidence, the following interventions have the strongest evidence to increase healthy eating:
    - Front-of-package food labelling
    - Direct food provision of fruits and vegetables in schools and workplaces
    - Improved school meal standards including improved access to drinking water
    - Universal school meals
    - Food pricing via subsidy
    - Presence of farmers' markets
    - In-store choice architecture
    - Local government incentives
    - Multicomponent interventions in workplaces

Interventions with evidence that they may be effective:

- The review identified other measures that may help people increase healthy eating; the certainty of the evidence is very-low (GRADE). These results may change as new evidence emerges. Interventions include:
    - Mass media campaigns

Interventions with no evidence of effect:

- The review also identified other measures that do not help people increase healthy eating; the certainty of the evidence is low (GRADE). These results are unlikely to change as new evidence emerges. Interventions include:
    - Farmers' markets in low-income communities

Decreasing unhealthy eating

Interventions with evidence of effect:

- This review found evidence that some policy interventions help people decrease unhealthy eating; the certainty of the evidence is low as the evidence is provided by observational studies and the effect is either small or imprecise (GRADE). However, the strength and direction of effect are not likely to change as new evidence emerges, due to the challenges inherent in evaluating the effects of policy interventions at the population level.

- Based on the best available evidence, the following interventions have the strongest evidence to decrease unhealthy eating:
    - Front-of-package labelling
    - Nutrition labels on menus
    - Sugar Sweetened Beverages (SSB) labels (e.g., warning labels)
    - Direct food provision of fruits and vegetables in schools
    - Limiting food competition items (i.e., unhealthy foods)
    - Improving school meal standards
    - Food taxes on unhealthy foods
    - Creating a healthy food service environment (e.g., in-store choice architecture)
    - Healthier default food retail menu items for children
    - Voluntary reformulation
    - Federal government incentives
    - Multi-component interventions to reduce salt and SSB intake

Interventions with evidence that they may be effective:

- The review identified other measures that may help people decrease unhealthy eating; the certainty of the evidence is very-low (GRADE). These results may change as new evidence emerges. Interventions include:
    - Mass media campaigns

Interventions with no evidence of effect:

- The review also identified other measures that do not help people decrease unhealthy eating; the certainty of the evidence is low (GRADE). These results are unlikely to change as new evidence emerges. Interventions include:
    - Labelling vending machine items
    - Planning restrictions to limit sales of unhealthy foods (i.e., SSBs) in urban and remote communities

Overview of Evidence and Knowledge gaps

- Many of the syntheses in this review are based on naturalistic observational or non-randomized studies. Given the inherent nature of the interventions and population data collection methods, more rigorous research designs are not feasible, practical, affordable or even ethical.
- This review did not find any syntheses that included information on the cost-effectiveness of interventions, although a few authors commented on the financial feasibility of the interventions. It is important that rigorous cost-effectiveness or cost-benefit analysis studies be conducted in this field and subsequently synthesized.
- Very few syntheses reported on the differential impacts for diverse populations. Some syntheses included information on the differences between gender, however the data was limited and offered no comparator to contextualize results. Further research is urgently needed to understand if and how policy interventions address the needs of priority populations and ensure that appropriate population-level interventions are considered with a health equity lens to promote optimal health outcomes for all.

Background

Cancer is the leading cause of death in high income countries globally, having surpassed heart disease in 2016 (Dagenais et al., 2020). It is estimated that approximately 2 in 5 Canadians will develop cancer in their lifetime, with 1 in 4 total deaths attributed to cancer. Single year cancer incident estimates have steadily increased from 225,800 in 2019 (Brenner et al., 2020) to 233,900 in 2022 (Brenner et al., 2022).

There have been improvements to cancer treatments and survival rates. Notably, five-year net survival rates have increased from 55% in the 1990s to 64% in 2021 (Canadian Cancer Statistics, 2022), while death rates due to colorectal cancer, for example, have decreased. Despite these declines, overall increased incidence and prevalence of cancer have a significant effect on the quality of life of cancer patients and their loved ones. A recent study of cancer patients found that a cancer diagnosis is perceived as something that encompasses their social, financial, psychosocial, dietary and physical activities, resulting in a perceived lower quality of life (Alam et al., 2020). These effects are not limited to the individual; cancer is also an economic and public health concern creating a strain on the healthcare system. This underscores the importance of prevention for quality of life of Canadians and the sustainability of the healthcare system.

Modifiable risk factors are those behaviours and exposures that can lower or raise a person's risk of cancer (e.g., tobacco use, alcohol consumption, physical activity and diet) (Cancer Systems Quality Index – Ontario Health, 2019). They are thought to be responsible for upwards of 30% of all new cancer diagnoses (ComPARe, 2019). Diet is particularly important, given that a healthy diet consisting of adequate fruit and vegetable consumption is associated with a reduced risk of developing several cancers, such as esophageal, stomach, lung, pancreatic and prostate cancer. Alternatively, an unhealthy diet high in sugars, saturated and trans-fats, low fibre foods and high sugar drinks has been shown to be associated with increased risk for endometrial, breast and colorectal cancers (Cancer.Net, 2019).

The most recent report from the World Cancer Research Fund International found strong evidence that consumption of a healthy diet decreases the risk of colorectal and prostate cancer. Equally strong evidence was found for limits on the consumption of other foods linked to certain diet-related cancers (WCRF, 2018). Echoing the findings of the World Cancer Research Fund, the International Agency for Research on Cancer 2020 Report highlights the need to avoid sugar-sweetened beverages (SSB) and advocates for generous intake of fruits, vegetables, and whole grains to reduce cancer risk. The report concludes that an overall healthy diet pattern should emphasize high intake of fruits and vegetables and whole grains rather than refined grains (IARC, 2020). Taking their conclusions one step further, the report highlights that plant sources of protein and fat further reduces the risk of cancer. Notably, the report distinguishes between cancer cases and deaths attributable to diet from those attributable to obesity as recent evidence suggests that obesity is a complex illness caused by a number of different factors, modifiable and unmodifiable (Obesity Canada, 2021). Citing obesity as an indirect effect of diet, diet as a risk factor independent of obesity was estimated to account for 5-10% of the population attributable risk for cancer.

In line with the International Agency for Research on Cancer report, Canada's food guide recommends a diet that consists mainly of plant foods (e.g., fruits, vegetables, whole grains, nuts, seeds, beans, lentils, and soy) and to choose whole foods (e.g., lean meat, fish, and eggs) and limit highly processed foods (e.g., sugar-sweetened beverages) (Health Canada, 2015). However, despite the established link between diet and cancer, it is estimated that 6 out of 10 Canadian adults do not consume a healthy diet (ComPARe, 2019), with specific indicators (e.g., fruit and vegetable intake) trending downward (Statistics Canada, 2015). Although there were no differences for adult sugar intake between 2004 and 2015, trends in unhealthy eating (e.g., intake of SSBs) among Canadian children trended upwards with an increase in intake from 23.7% in 2004 to 25.9% in 2015. These data suggest population level policies are urgently needed, especially for children, recognizing the latency period between diet and occurrence of cancer.

To our knowledge, there is limited population-level data on the likelihood of meeting diet guidelines according to populations identified using the PROGRESS-Plus framework (place of residence, race/ethnicity/culture/language, occupation, gender/sex, religion, education, socioeconomic status, social capital) (Cochrane Methods Equity, 2021). Surveillance data from the 2015 Canadian Community Health Survey indicates that women, aged 31–50 and 51–70, who were in the top three income domiciles and living with someone in the household with higher education, were associated with higher quality diets (Hosseini et al., 2022). These findings are in line with previous findings that education and income significantly explain the differences in diet quality of adults and children (Olstad et al., 2021). The body of research on the relationship between diet quality and food security continues to evolve in support of the association between household food insecurity and subsequent ill-health. Understanding this relationship will be imperative to prevent subsequent diet-related ill-health outcomes, including cancer.

Estimates suggest that adherence to healthy eating food guidelines could result in a reduction in the risk of cancer. A recent study based on population-level data from the Netherlands (n=120,852) with a 20-year follow-up period found that highest adherence to the World Cancer Research Fund diet recommendations appeared to be associated with a significant decrease in cancer of unknown primary risk compared to the lowest adherence, after adjusting for age (HR: 0.76 (95% CI = 0.62, 0.92)). Data from the Canadian ComPARe study suggests that an increase of 1 serving of fruit/day across the Canadian population is estimated to prevent 85,181 cumulative cases of colorectal, lung, breast, bladder, pancreas, and esophageal cancer by 2024. If the servings were increased by 2 servings/day, the increase in cumulative cancer is estimated to be 150,244 (ComPARe, 2019).

As the body of evidence that exists on the benefits and risks associated with diet continues to evolve, there is a need to better understand which types of interventions are most effective, particularly for those at greater social disadvantage, at all levels of policy. In an effort to reduce premature death from non-communicable disease, including cancer, the World Cancer Research Fund International created the NOURISHING framework, a policy framework that recognizes policy action in three domains: food environment, food system and behaviour change communication. This review focuses on policy solutions in the food environment, specifically food labelling, food provision, food pricing and government incentives, food

promotion, food composition, food retail and multi-component interventions which include at least two domains implemented congruently. Using this framework, we present the most highly synthesized and quality appraised available evidence in each of these policy domains to help inform decision and policy makers on the most effective strategies to improve diet among Canadians, and thus prevent cancers.

Methods

Research Question

What are effective policy and program initiatives to increase healthy eating and/or reduce unhealthy eating for cancer prevention?

Search

The Health Evidence™ database was searched for evidence pertaining to the effectiveness of interventions aiming to increase healthy eating and/or reduce unhealthy eating. Searches were limited to English-language records published after January 1st, 2012, until May 31, 2022, with a high-methodological quality rating.

A copy of the full search strategy is available in Appendix 1.

Search results were uploaded into Endnote and duplicates were removed. Titles and abstracts were screened in duplicate using DistillerSR software with the DistillerSR Artificial Intelligence System (DAISY).

Full texts of potentially relevant records were screened by a single reviewer, and double checked by a second during data extraction.

Study Selection Criteria

English-language guidelines, umbrella reviews and/or systematic reviews with or without meta-analyses that reported on the effectiveness or cost-effectiveness of interventions that fall within the seven food environment policy areas as per the World Cancer Research Fund International NOURISHING policy framework were eligible for inclusion. Given the nature of the interventions not being amenable to experimental research designs, reviews could also include observational studies.

Syntheses that focused on disease or condition-specific populations were excluded, as were syntheses that focused exclusively on studies conducted in low to middle income countries. All included syntheses must have reported effectiveness in terms of increase in healthy eating (consumption or sales of fruits and vegetables) or decrease in unhealthy eating (consumption or sales of SSB, trans-fat, salt or other foods described as "unhealthy").

A summary of eligibility criteria is presented in Table 1.

Table 1: Eligibility Criteria

	Include	Exclude
Population	General population School-aged children to end-of-life	Disease-specific populations (obesity, diabetes, etc.) Children, aged infants to pre-schoolers
Intervention/Exposure	Policies regarding healthy eating and nutrition, including: • Food labelling (e.g., food packaging, menu boards, menu labelling) • Nutrition policies (e.g., school-based policies) • Food prices (e.g., taxation, subsidies) • Incentives from government programs to support healthy eating (e.g., school menus, government-based incentives and food stamps) • Food promotion (e.g., broadcast media, social media, children's settings, and in-store advertisements) • Food composition • Food retail (e.g., in-store advertisements, restaurants, food retail locations)	Interventions containing an education component Programs regarding healthy eating and nutrition, including: - Food banks - Direct-to-consumer price discounts - Fruit & vegetable stamps Alcoholic beverages
Comparator	N/A	N/A
Outcome	Changes in healthy and/or unhealthy eating	Knowledge, attitudes, beliefs
Setting	Community (incl. restaurants, schools, workplaces)	Home-based interventions LMIC Hospital- and LTC-based policies and programs
Study design	Reviews Reviews of reviews	Modelling studies and/or data
Timeframe	2012-present	-

Data Extraction and Synthesis

Data were extracted by two independent reviewers and disagreements were resolved through discussion. Data were extracted related to review methodology (primary objective, search date, and inclusion and exclusion criteria), and details of included studies (number of studies and study designs, number of included participants, populations included according to the PROGRESS-Plus tool, quality of included studies where reported). Results from narrative syntheses and meta-analyses were extracted related to nutrition.

Given the rapid nature of this review, complete data extraction and synthesis was prioritized for the NOURISHING policy food environment domains that were most amenable to action at a regional or national policy level, namely food labelling, nutritional food standards in school and workplace settings, food pricing, government incentives, food promotion, food composition and food retail. Where scientific statements and/or umbrella reviews were identified that reported on multiple domains, outcomes for any combination of the previously identified domains were extracted and synthesized. A full list of identified reviews that met inclusion criteria but were not critically appraised or extracted can be requested from the authors.

Appraisal of Evidence Quality

We evaluated the quality of included evidence using the Health Evidence Quality Assessment Tool – Review Articles (Health Evidence™, 2005). Quality assessment was completed by one reviewer and verified by a second reviewer. Conflicts were resolved through discussion. Completed quality assessments for each included study are available on request.

A modified version of the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach was used to assess the certainty of the evidence based on eight key domains. In the GRADE approach to quality of evidence, **observational studies,** provide **low certainty** evidence, while randomized controlled trials provide **high certainty** evidence. This assessment can be further reduced based on other domains:

- High risk of bias
- Inconsistency in effects
- Indirectness of interventions/outcomes
- Imprecision in effect estimate
- Publication bias

and can be upgraded based on:

- Large effect
- Dose-response relationship
- Accounting for confounding.

The overall certainty of the evidence for each outcome was determined taking in to account the characteristics of the available evidence, and a judgement of overall certainty is provided. For the purposes of this review, the categories of the certainty of the evidence have been broadly defined as (Shünemann et al., 2013):

High certainty: there is evidence that the policies implemented result in increases in healthy eating or decreases in unhealthy eating; the true effect lies close to the estimate of effect. It is unlikely that the findings will change as new studies emerge.

Moderate certainty: there is evidence that the policies implemented result in increases in healthy eating or decreases in unhealthy eating; the true effect is likely to be close to the estimate of effect, but it is possible that it is substantially different. Further research will be important to gauge the confidence in the estimate of effect which may change the estimate.

Low certainty: there is evidence that the policies implemented result in increases in healthy eating or decreases in unhealthy eating; in this field it is not likely that the findings will change as new studies emerge given more rigorous research designs such as randomized controlled trials (RCTs) are neither feasible nor practical. While it is possible low certainty evidence may not accurately represent the true effect of an intervention, a higher level of certainty is likely not achievable for these types of interventions, and therefore represents the strongest and best available evidence, that is not likely to change over time

Very-low certainty: there is evidence that policies implemented may result in little to no effect on healthy eating and/or unhealthy eating; it is possible that the findings may change as new studies emerge. This may be as a result of greater consistency of effects across studies, increased precision, and/or reduced indirectness of interventions/outcome.

Implications for public health practice:

The expected harms of not acting, (e.g., not implementing interventions to either increase healthy eating or decrease unhealthy eating) related to morbidity and mortality from cancer is high and will exacerbate health inequities.

Methodological Limitations

While we followed a rigorous process as outlined in our published rapid review methodology, there are limitations in the rapid review process as compared to systematic review methodology (Neil-Sztramko et al., 2021). For example, the evidence included in this review is limited to English language papers. The exclusion of non-English papers may bias the results in favour of demonstrating intervention effectiveness, as non-English speaking authors are thought to be more likely to publish research demonstrating statistically significant positive effects in International, English-language journals whereas negative findings or no effect are more likely to be published in local journals (Boutron et al., 2022). Furthermore, the review is limited to syntheses given the large number of reviews available related to the research question. It is possible that primary (single) studies published very recently that are not included in any of the reviews could change our findings; however, given the body of evidence included in our review represents hundreds of primary studies, the results of a few single studies are not likely to dramatically change the key messages reported in our review. For inclusion in this review, syntheses had to be relevant to the Canadian context which resulted in some reviews which included only studies conducted in low- and middle-income countries being excluded. This may reduce the generalizability of the results to certain populations and contexts in Canada and may exclude interventions shown to be effective in other contexts.

HealthEvidence.org was the key source used for identifying syntheses evaluating intervention effectiveness. This could have resulted in some syntheses not being captured in our search. Given the rapid nature of this review, screening of search results was conducted by one screener, as opposed to two independent raters as suggested by Cochrane.org (Cochrane Training, 2021). It is not possible to quantify the impact of these limitations on the findings of this review, although it is possible that we have overestimated intervention effectiveness.

Findings

The findings of this review focus on seven of the NOURISHING framework food environment domains that were most amenable to action at a regional or national policy.

Summary of the Certainty of Evidence

A PRISMA diagram outlining the flow of studies through screening is available in Figure 1. Overall, 30 syntheses were included. A breakdown of number of syntheses by intervention domain is listed in Table 2.

Table 2: Intervention domains and definitions

Intervention type	NOURISHING-Framework definition	Reviews of reviews (Date most recently published)	Systematic reviews/Meta-analyses (Date most recently published)
Food labelling: regulatory system implemented by the government for consumer-oriented labelling on food packaging and menu boards in restaurants to enable consumers to easily make informed food choices and prevent misleading claims. • Menu labelling	Nutrition label standards and regulations on the use of the claims and implied claims on food.	1 (2022)	9/3 (2021)
Food provision: government ensures that there are healthy food service policies implemented in government-funded settings to ensure healthy food choices are available, and the government actively encourages and supports private companies to implement similar policies. • School nutrition policies • Public/private sector nutrition policies	Offer healthy food and set standards in public institutions and other specific settings.	3 (2022)	8/1 (2021)
Food prices: targeted changes on the price of healthy foods or unhealthy foods to encourage healthier food choices. • Food-related income supports	Use economic tools to address food affordability and purchase incentives.	1 (2022)	6/1 (2021)
Government incentives/dis-incentives: infusion of funds or resources for schools, workplaces, etc. • Minimize taxes on healthy goods • Increase taxes on unhealthy food • Subsidies on healthy food	Use economic tools to address food affordability and purchase incentives.	-	2/None (2022)
Food promotion: comprehensive government policy to reduce the impact across all media, particularly children (<16 years). • Promotion to children via broadcast media • Promotion to children in children's settings	Restrict food advertising and other forms of commercial promotion.	1 (2021)	1/None (2017)

Food composition: government systems implemented that ensure processed foods and out of home meals minimize density and nutrients of concern (sodium, saturated fats, trans fats, added sugar). • Pre-packaged children's meals • Mandatory sodium restrictions • Trans fat ban	Improve nutritional quality of the whole food supply.	-	2/None (2019)
Food retail: government has the power to implement policies and programs to support the availability of healthy foods and limit the availability of unhealthy foods in communities (outlet density and locations) and instore (product placement). • Food-service outlets • Agricultural subsidies • Farmers markets with government vouchers	Set incentives and rules to create a healthy retail and food service environment	2 (2022)	1/None (2019)
Multi-component: any combination of the aforementioned domains, so long as they do not involve an educational component.	-	1 (2020)	5/None (2021)

Food Labelling

Key Findings

- There is evidence that front-of-package labelling results in a large increase in healthy eating (low certainty; GRADE).
- There is evidence that front-of-package labelling results in decreases in calories, fat and TFA consumption (low certainty; GRADE).
- There is evidence that nutrition labels in restaurant and food service settings results in a moderate to large decrease in energy intake. The evidence also suggests that the addition of contextual information to labelling further increases the effect (low certainty; GRADE). The evidence on the effectiveness of nutrition labels in restaurants and food service settings on SSB consumption was mixed.
- There is evidence that warning labels on SSBs results in a moderate to large reduction in SSB sales (low certainty; GRADE).
- There is evidence that nutrition labelling of vending machine items results in no effect on food purchases (low certainty; GRADE).
- Syntheses evaluating the cost-effectiveness of food labelling interventions for both healthy eating and unhealthy eating are needed.
- Across syntheses, very few studies reported on the differential effects among diverse populations, such that no definitive conclusions can be made. There is an urgent need for primary studies to collect and report data on intervention effects separately for diverse populations.

Ten syntheses reported on the effectiveness of food labelling interventions to increase healthy eating and/or reduce unhealthy eating in the general population. Food labelling interventions were categorized broadly according to the WHO NOURISHING framework. Within this framework, food labelling interventions fall under nutrition label standards and regulations and are categorized under sub-policy areas: clearly visible interpretative labels and menu labelling. Outcomes are generally reported as reductions in kcal sold or consumed.

Table 3: GRADE Summary of Findings for Food Labelling interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of randomized and/or non-randomized studies	3	⊕⊕◯◯ Low[1]	• **Front-of-package labelling** (e.g., traffic light, nutrient warning, symbol coding) results in increases in healthy eating by a large amount.
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	8	⊕⊕◯◯ Low[1]	• **Front-of -package labelling** (e.g., traffic light, nutrient warning, symbol coding) results in decreases in unhealthy eating. • **Nutrition labels on menus** results in decreases in unhealthy eating (e.g., calories purchased and consumed) by a moderate to large amount. The impact is

				greater when additional contextual or interpretive information is added. • **SSB labelling** results in decreases in unhealthy eating (e.g., SSB sales) by a moderate to large amount. • **Labelling in vending machines** results in little to no difference in SSB sales or energy consumed.
[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence. No additional up or downgrades were made.				

Three reviews reported on the effectiveness of food labelling interventions to increase healthy food consumption. Results were not consistent across reviews. Two reviews, including a meta-analysis (Shangguan et al., 2015) and a network analysis (Song et al., 2021) reported food labelling resulted in statistically significant increases in healthy eating. A third review, a literature review (Grech et al., 2015), found inconsistent results across studies; concluding there was an unclear effect.

Front-of-package nutrition labels were found to be effective in helping consumers select a healthier food option. Results from a network analysis (Song et al., 2021) reported statistically significant positive effects for the use of front-of-package nutrition labels. The analysis found evidence for all labelling types in comparison to the control, however use of front-of-package nutrient warning labels (OR: 3.61 (95% CI = 2.82, 4.63) resulted in twofold higher odds of selecting a healthier food option than traffic light labelling (e.g., a colour coded quick reference label to communicate the nutritional quality of the food) (OR: 1.50 (95% CI = 1.20, 1.87)) or health warnings labels (OR: 1.65 (95% CI= 1.32 to 2.06)). Results from a second large systematic review (>two million participants) (Shangguan et al., 2015) reported positive effects for the use of food and beverage labelling (e.g., food package labelling, menu labelling or other point-of-purchase labelling) for some outcomes. Specifically, food labelling interventions resulted in a statistically significant increase in the consumption of vegetables 13.5% (95% CI = 2.4, 24.6)), but not other foods (i.e., fruit and a combination of fruit and vegetables). A notable concern of these findings is the high variation in results across studies (I^2>91.9%). Further sub-group analysis suggests that the source of the heterogeneity is intervention duration; meaning length of the intervention explained differences in effects, with longer interventions having larger observed effects on consumer intake of total fat, compared to those of shorter duration (p<0.01).

Eight reviews reported on the effectiveness of food labelling to decrease unhealthy eating. Findings across reviews were generally consistent, finding food labels were effective in reducing selection and/or consumption of unhealthy foods.

Front-of-package food labelling was described in four systematic reviews with meta-analyses (Sinclair & Cooper, 2014, Crockett et al. 2017, Shangguan et al., 2015, An et al., 2020). Reviews consistently reported positive findings for various food labelling interventions. For example, front of package labelling resulted in statistically significant reductions in consumption (measured as % change) of energy (-6.6% (95% CI = -8.8, -4.4)), total fat (-10.6% (95% CI = -17.7, -3.5)), artificial trans-fat (-64.3% (95% CI = -91.1, -37.5)), and other unhealthy dietary options (e.g., SSBs, French fries, white bread) (-13.0% (95% CI = -2.4, -24.6) (Shannaguan et al., 2015).

Despite high heterogeneity identified (I^2 range: 91.5%, 97.9%), sub-group analysis suggests that the source of the heterogeneity is a result of the intervention duration; interventions that were longer have large observed effects of labelling on consumer intake of total fat (p<0.01).

The use of nutrition labels on menus in restaurants or foodservice settings was explored in two systematic reviews (Crockett et al., 2018, Sinclair & Cooper, 2014). Both reviews reported positive findings for the use of labels. For instance, restaurants with nutrition labels on menus as a standalone intervention reported a statistically significant reduction in energy purchased (Mean Difference (MD): -46.72 kcal (95% CI = -78.35, -15.01)) (Crockett et al., 2018). Furthermore, when additional contextual or interpretive information was included, an even larger effect occurred with consumers reducing their selection (MD: -81 kcal (95% CI = -138.99, -22.36); p=0.007)) and consumption of calories (MD: -67 kcal (95% CI = -116.99, -17.79; p=0.008)) of calories (Sinclair & Cooper, 2014). The findings were supported by a recently conducted umbrella review (Hansen et al. 2021) reporting a pooled statistically significant reduction in energy purchased in restaurants due to labelling (MD: -196.74 (95% CI = -326.5, -62.8)).

Labelling was also found to result in statistically significant reductions in sales and consumption of SSBs. A 2019 Cochrane review (von Philipson et al., 2019) reported that rating score labelling was associated with decreased SSB sales (values NR), traffic light labelling with decreased purchases of SSBs with declining sales ranging from -25% (p<0.001) to -56% (95% CI = -67,-45) and emoticon labelling decreasing consumption by -16 percentage points (-16% (95% CI = -27, -4)). A recent systematic review (An et al., 2019) found that, in comparison to control, the use of SSB warning labels was associated with a statistically significant reduction in the odds of choosing SSBs (OR: 0.49 (95% CI = 0.41, 0.56)). Sub-group analysis noted that labels using symbols to represent the health effect was associated with further reduced odds of choosing SSBs (OR: 0.67 (95% CI = 0.39, 0.95)). The evidence for the effectiveness of menu-board calorie labelling on SSB consumption was mixed.

One systematic literature review (Grech et al., 2015) described various types of labelling of SSBs and unhealthy snacks in vending machines. The overall conclusion was that labelling in vending machines had no effect, however the authors note that it was not possible to draw conclusions on the overall efficacy of the strategy.

Differential impacts due to gender were reported in two reviews (Nikolaou et al., 2015, Sinclair & Cooper, 2014). Results suggest that gender influenced the effect of menu labelling on selection and consumption of calories, with women using the information to select and consume fewer calories (p<0.001). The intervention had no effect on men (Sinclair & Cooper, 2014). However, without any contextualization or further analysis, it is unclear as to why these differences exist. No reviews reported on differential impacts among diverse populations other than gender.

None of the included reviews presented data on the cost-effectiveness of food labelling interventions. Comments by the various authors as to the cost-effectiveness of the interventions were mixed. One study author (Sinclair et al., 2014) described food labelling as low cost, while another study author (Grech et al., 2015) identified cost as a barrier to

implementation of food labelling interventions. A final review author (Hysensi et al., 2017) suggested that other interventions were more cost-effective than labelling.

Table 4: Food Labelling

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food labelling (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Quality of included studies
Nikolaou, C.K., Hankey, C.R. & Lean, M.E.J. (2015). Calorie-labelling: does it impact on calorie purchase in catering outlets and the views of young adults? *International Journal of Obesity, 39*(3), 542-545.	To determine the effects of calorie labelling on calories purchased.	2014 (2009-2013)	Population: Young adults (mean age = 20.3 years; SD: 2.9) Intervention: Calorie labelling as a result of legislation.	6 studies meta-analyzed: • 4 cross-sectional • 1 natural experiment • 2 quasi-experimental Total sample size NR	Gender (n=4 studies) Reduction of 99 kcal for women; p<0.0001 vs. 94.6 kcal for men; p=0.003	Mandated calorie labelling in restaurants led to a reduction in energy consumption although the finding was not statistically significant: • -5.8 kcal (95% CI = -19.4, 7.8); 10 studies, I^2 = NR For those consumers who noticed the labelling, the effect size was greater and statistically significant: • -124.5 kcal (95% CI = -150.7, -113.8); 10 studies, I^2 = NR Results of a survey conducted among 1440 young adults (mean age = 20.3; SD: 2.9) revealed that 46% of respondents indicated they would welcome calorie information in catering settings. Females who opposed labelling were heavier than those who did not (p=0.02).	-	Only moderate to high quality studies were included.

Sinclair, S.E., Cooper, M. & Mansfield, E.D. (2014). The influence of menu labeling on calories selected or consumed: a systematic review and meta-analysis. *Journal of the Academy of Nutrition & Dietetics, 114*(9), 1375-1388.e15.	To evaluate whether the provision of menu-based nutrition information affects the selection and consumption of calories in restaurants and other food service establishments.	March 2013 (1996-2013)	Population: Adults and adolescents Intervention: Nutrition information in a restaurant or other food service settings on calories selected or consumed.	17 studies: • 10 experimental • 7 quasi-experimental Total sample size >4,000	Gender (n=NR) Gender influenced the effect of menu labelling on selection and consumption of calories, with women using the information to select and consume fewer calories.	Menu labelling with calories alone reduced calories selected (-30.84 kcal (95% CI = -95.85, 34.18); p=0.35) and consumed (-13 kcal (95% CI = -62.29, 36.82); p=0.61) but the findings were not statistically significant. The addition of contextual or interpretive information on menus resulted in a statistically significant reduction in both the selection (MD: -81kcal (95% CI = -138.99, -22.36; p=0.007)); and consumption (MD: -67 (95% CI = -116.99, -17.79; p=0.008)) of calories	See PROGRESS -Plus results.	6/17 (35%) studies were assessed as higher quality. 11/17 (65%) studies were assessed as lower quality.
Grech, A. & Allman-Farinelli, M. (2015). A systematic literature review of nutrition interventions in vending machines that encourage consumers to make healthier choices. *Obesity Reviews, 16*(12), 1030-41.	To determine the efficacy of nutrition interventions in vending machines in prompting dietary behaviour change to improve diet quality or weight status of the consumers of vended snacks compared with consumers of vending machines where there is no change to the products typically sold.	2014 (1981-2014)	Population: General population Intervention: Strategies to improve the nutritive content of snacks and beverages purchased.	8 studies: • 3 RCTs • 3 c-RCTs • 2 non-randomized crossover trials Total sample size NR	NR	While some studies found small statistically significant effects, overall, the review found colour coded, traffic labelling in vending machines did not increase the purchase of healthier products. Labels using health claims (e.g., "better choice", "low-fat", or "low calorie") did not provide a clear result (data NR). Adding energy labels to vended snacks with nutritional information bar graphs produced a statistically significant increase in the purchase of healthier options (data NR), however the authors state that it was not possible to draw conclusions on the overall efficacy of this strategy.	-	5/8 (63%) studies were assessed as having low risk of bias. 7/8 (88%) studies were assessed as having a moderate risk of bias.

Hyseni, L., Elliot-Green, A., Lloyd-Williams, F., Kypridemos, C., O'Flaherty, M., McGill, R., . . . & Capewell, S. (2017). Systematic review of dietary salt reduction policies: Evidence for an effectiveness hierarchy? *PLOS ONE, 12*(5), e0177535.	To explore the effectiveness of salt reduction interventions.	October 2015 (1997-2015)	Populations: General population (excluding pregnant women). Intervention: Nutritional labelling on salt intake.	2 studies: • 1 crossover RCT • 1 cross sectional Total sample size >55,000	NR	Results on the effectiveness of labelling to reduce salt intake were mixed: • one study reported that there was no difference in salt intake for those who reported frequent use of labels compared to those who did not report frequent use of the labels. • Participants exposed to a traffic light system had a statistically significant reduction in salt consumption compared to those exposed to monochrome labels; 0.4 grams/day, p<0.001.	-	Low quality
Crockett, R.A., King, S.E., Marteau, T.M., Prevost, A.T., Bignardi, G., Roberts, N.W., . . . & Jebb, S.A. (2018). Nutritional labelling for healthier food or non-alcoholic drink purchasing and consumption. *Cochrane Database of Systematic Reviews, 2*(2), Cd009315.	To evaluate the impact of nutritional labelling for food and non-alcoholic drinks on purchasing and consumption of healthier items.	April 2017 (1984-2016)	Populations: General population Intervention: Nutrition labelling	11 studies: • 3 RCTs • 1 c-RCT • 1 q-RCT • 6 interrupted time series Total sample size >4500	NR	Results from a meta-analysis assessing the effectiveness of labelling interventions found: • Labelling menus in restaurants, cafeteria or coffee shops resulted in a statistically significant reduction in calories purchased; MD: -46.72 kcal (95% CI = -78.35, -15.01); 3 trials, I^2 = NR • Labeling menus in a lab setting found a non-statistically significant reduction in calories selected MD: -50.27 kcal (95% CI = -104.41, 3.88); 8 studies, I^2 = 46%	-	Low quality

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., . . . & Mozaffarian, D. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine, 56*(2), 300-314.	To examine the influence of food and beverage labelling on consumer behaviours and health outcomes.	May 2015 (1990-2015)	Population: General population Intervention: Food labelling, menu labelling or other point-of-purchase labelling.	60 studies: • 16 RCTs • 44 non-randomized Total sample size >2,000,000 observations	NR	Results from a meta-analysis found that food labelling led to a statistically significant increase in consumption of vegetables but not other foods (% change): • Vegetables : 13.5% (95% CI = 2.4, 24.6) ; 5 trials, I^2 = 91.9%* • Fruits : 10.9% (95% CI = -16.0, 37.7) ; 3 studies, I^2 = 82.2%* • Whole grains: 4.4% (95% CI = -11.8, 40.6); 5 studies; I^2 = 86.9%* • Protein : 0.6% (95% CI = -2.8, 4.0) ; 5 studies, I^2 = 36.6% Food labelling led to statistically significant reductions in consumption of energy, total fat, artificial trans-fat, and other unhealthy dietary options, but not saturated fat and sodium: • Energy: -6.6% (95% CI = -8.8, -4.4); 31 trials; I^2 = 91.5%* • Total fat: -10.6% (95% CI = -17.7, -3.5); 13 trials, I^2 = 97.9%* • Saturated fat: -8.4% (95% CI = -23.7, 6.8); 5 trials, I^2 = 94.8%* • Sodium: -15.3% (95% CI = -31.3, 0.7); 7 trials, I^2 = 97.8%* • Artificial trans-fat: -64.3% (95% CI = -91.1, -37.5); 13 trials, I^2 = 97.9%* • Other healthy options: -0.3 (95% CI = -16.4, 15.7); 3 trials, I^2 = 82.4%* • Other unhealthy dietary options: -13.0% (95% CI = -25.7, -0.2); 16 trials, I^2 = 92.4%* **Results should be interpreted with caution given high heterogeneity within studies.	Authors conclude that high heterogeneity was a result of the intervention duration, with longer durations having a greater effect on total fat intake (p<0.01).	36/60 (60%) studies were assessed as high quality. 11/60 (18%) studies were assessed as medium quality. 13/60 (22%) studies were assessed as low quality.

von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2006-2017)	Population: General population (hospitals excluded). Interventions: Any intervention implemented at an environmental level, reporting effects on direct or indirect measures of SSB intake or health outcome (nutritional standards in public institutions).	8 studies: • 1 controlled study • 2 controlled before and after study • 5 interrupted time series Total sample size NR	NR	The effectiveness of labelling strategies on the consumption of SSBs was mixed: • traffic-light labelling is associated with a statistically significant decrease in sales of SSBs ranging from --56% (95% CI = -67, -45) to -25%; p<0.001 (additional statistical measures NR). • Rating score labelling (e.g., using a star rating to identify the level of healthfulness) was associated with decreasing sales of SSBs; results range from -274% (statistical measures NR) to -0.026, p<0.001. • menu-board calorie labelling effects are mixed. Results vary ranging from -0.3% calories/transaction, (p<0.01) to +1.7 kcal/transaction (95% CI = -1.5, 4.9). The findings for emoticon labelling for children showed a statistically significant reduction in choosing SSB by -16 percentage points (95% CI = -27, -4).	-	2/8 (25%) studies were assessed as moderate quality. 3/8 (37.5%) studies were assessed as low quality. 3/8 (37.5%) studies were assessed as very low quality.
An, R., Liu, J., Liu, R., Barker, A.R., Figueroa, R.B. & McBride, T.D. (2021). Impact of Sugar-Sweetened Beverage Warning Labels on Consumer Behaviors: A Systematic Review and Meta-Analysis. *American Journal of Preventive Medicine, 60*(1), 115-126.	To synthesize the evidence regarding the impact of SSB warning labels on consumer behaviours.	December 2019 (2006-2019)	Population: Adults or children. Intervention: SSB warning labels.	23 studies: • 13 RCTs (6 included in the meta-analysis) • 9 non-RCTs Total sample size >35,000	NR	In comparison to the control, the use of SSB warning labels was associated with statistically significant reductions in the odds of choosing SSBs: • Odds Ratio (OR): 0.49 (95% CI = 0.41, 0.56);6 trials, I^2= 0% Sub-group analysis of label type indicates that labels using symbols for health effect (vs no label) had a larger and statistically significant effect on reducing the odds of choosing SSBs: • OR: 0.67 (0.39, 0.95); 2 trials, I^2= 0%	Label type	Moderate quality

Hansen, K.L., Golubovic, S., Eriksen, C.U., Jørgensen, T. & Toft, U. (2022). Effectiveness of food environment policies in improving population diets: a review of systematic reviews. *European Journal of Clinical Nutrition, 76*(5), 637-646.	To assess the effectiveness of different food environment policies in improving population diets.	September 2021 (2010-2020)	Population: General population of any age; children: 0-17 years, adults: >18 years; gender and ethnicity. Intervention: Direct provision of health goods (fruits and vegetables), competition and standards for school meals.	2 systematic reviews including meta-analysis: • 19 RCTs • 16 non-RCTs Total sample size NR	NR	The effectiveness of nutritional labels on food purchases was tested in real-world settings and in laboratory settings. Results from the meta-analysis indicate a small, but statistically significant reduction in energy purchased in restaurants due to labelling: • Mean Difference (MD): -196.74 (95% CI = -326.5, -62.8); 3 trials The authors note that this represents an average 7.8% reduction in calories purchased. Results from the narrative synthesis were mixed with 2/7 studies reporting statistically significant reductions in energy purchased, while 5/7 studies did not (data NR).	-	1/2 (50%) studies were assessed as being high quality. 1/2 (50%) studies were assessed as being moderate quality.

Song, J., Brown, M.K., Tan, M., MacGregor, G.A., Webster, J., Campbell, N.R.C., . . . & He, F.J. (2021). Impact of color-coded and warning nutrition labelling schemes: A systematic review and network meta-analysis. *PLOS Medicine, 18*(10), e1003765.	To assess the impact of colour - coded interpretive labels and warning labels on changing consumers' behaviour.	May 2021 (1998-2001)	Population: General population. Intervention: Traffic light labelling systems, nutrient warning, health warning and nutrient score.	156 studies* represented in 138 articles: • 101 RCTs • 55 non-RCTs Total sample size NR *148/156 (95%) were conducted in laboratory settings.	NR	In comparison to the control, the use of labels was associated with a statistically significant increase in the odds of choosing more healthful products: • nutrients warning label OR: 3.61 (95% CI = 2.82, 4.63) • health warning OR: 1.65 (95% CI = 1.32, 2.06) • traffic light labelling OR: 1.50(95% CI = 1.20, 1.87))	-	14/156 (8.9%) studies were assessed as having low risk of bias 32/156 (22.4%) studies were assessed as having a moderate risk of bias. 107/156 (68.59%) studies were assessed as having a high risk of bias.
Abbreviations: CI: Confidence Interval c-RCT: Cluster Randomized Control Trial MD: Mean Difference NR: Not Reported OR: Odds Ratio RCT: Randomized Control Trial SD: Standard Deviation SSB: sugar-sweetened beverage								

Food Provision

Key Findings

School-based

- There is evidence that fruit and vegetable provision in schools results in an increase in consumption of fruits and vegetables (low certainty, GRADE).
- There is evidence that improving school meal standards in schools results in a large increase in consumption of fruits and vegetables (low certainty, GRADE).
- There is evidence that food provision interventions result in small to moderate decreases in consumption of unhealthy snacks and sugar-sweetened beverages (SSBs)(low certainty, GRADE).
- There is evidence that limiting food competition within schools results in decreases in consumption of unhealthy snacks and SSBs (low certainty, GRADE).
- There is evidence that improving school meal standards results in decreases in intake of fats, saturated fats and SSBs (low certainty, GRADE).
- There is evidence that provision of universal free meals in schools results in a large increase in food security (low certainty, GRADE).

Workplace-based

- There is evidence that food provision interventions within the workplace result in a small increase in consumption of fruits and vegetables (low certainty, GRADE).
- There is limited evidence that stand-alone workplace-based food provision interventions result in a small increase in healthy eating (low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of food provision interventions in school and workplace-based settings for both healthy and unhealthy eating are needed.
- Across reviews, very few studies reported on differential effects among diverse populations highlighting the urgent need for primary studies to collect and report data for diverse populations in differing contexts.

Eleven syntheses reported on the effectiveness of food provision interventions to increase healthy eating and/or reduce unhealthy eating in schools and workplaces. Nine syntheses reported on school-based policies and two reported on workplace-based policies. Food provision interventions were categorized broadly according to the WHO NOURISHING framework and by setting. Within this framework, food provision interventions fall under healthy food and set standards in public institutions and are categorized under sub-policy areas: direct food provision (e.g., fruit and vegetable initiatives), limits on food competition (e.g., mandatory standards limiting specific food and beverages available in schools), improved school standards (e.g., voluntary guidelines for food available in schools) and standards in social support programmes (e.g., universal school meals). Workplace-based interventions were categorized by direct food provision.

Table 5: GRADE Summary of Findings for Food Provision interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
School-based				
Healthy eating	Syntheses of randomized and/or non-randomized studies	8	⊕⊕◯◯ Low[1]	• **Direct food provision interventions** (e.g., fruit and vegetable initiatives) in schools results in increases in healthy eating. • **Improving school meal standards** results in increases in healthy eating (e.g., fruit and vegetables and water) by a large amount. • **Universal school meals** results in increases in food security by a large amount.
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	4	⊕⊕◯◯ Low[1]	• **Direct food provision interventions** (e.g., fruit and vegetable initiatives) in schools results in decreases in unhealthy eating (e.g., SSB intake) by a small to moderate amount. • **Limiting food competition items** results in decreases in unhealthy eating (e.g., unhealthy snacks and SSBs). • **Improving school meal standards** results in decreases in unhealthy eating (e.g., energy from fats, saturated fats and SSBs) by a small amount.
Workplace-based				
Healthy eating	Syntheses of randomized and/or non-randomized studies	2	⊕⊕◯◯ Low[1]	• **Direct food provision interventions** (e.g., fruit and vegetable initiatives) in workplaces results in increased healthy eating by a small amount. • **Standalone provision interventions** alone in workplaces results in increases in healthy eating.

[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence. No additional up or downgrades were made.

School-based reviews

Eight reviews reported on the effectiveness of school-based interventions on measures of healthy eating. Five reviews reported on fruit and vegetable initiatives (Hansen et al., 2021, O'Brien et al., 2021, Cohen et al., 2021a, Micha et al., 2018, Flodgren et al., 2020) and three on nutritional standards for food available in schools (von Phillsborn et al., 2019, Wolfenden et al., 2017, Micha et al., 2018).

Fruit and vegetable initiatives in schools were widely reported, with mixed and limited findings as an intervention to increase healthy eating among children and adolescents. Evidence from three umbrella reviews suggested the intervention had a small effect (Hansen et al., 2021, O'Brien et al., 2021, Flodgren et al., 2020). For example, one review (O'Brien et al., 2021) found that school-based food provision policies resulted in small, statistically significant increases in

fruit and vegetable consumption (Mean Difference (MD) = 0.2 (95% CI = 0.14, 0.26)), but had no effect on vegetable consumption alone. Remaining reviews reported no statistically significant change over time; no increase in consumption after 2 months (Hansen et al., 2021), or 12-month follow-up (Flodgren et al., 2020).

Similar results were reported by two additional systematic reviews (Micha et al., 2018, Wolfenden et al., 2017) including one review with a meta-analysis of 70 studies (Micha et al., 2018), to determine the effect of fruit and vegetable provision on habitual consumption (e.g., within and outside school) of healthy foods. Results show small increases in consumption for fruit (0.27 servings/day (95% CI = 0.17, 0.36), fruits and vegetables (0.04 servings/day (95% CI = 0.00, 0.08) and vegetables (0.28 servings/day (95% CI =0.17, 0.40). However, these results should be interpreted with caution as substantial heterogeneity was observed across study results.

School based nutrition standards were effective in increasing healthy eating through healthier meals and increased water consumption. All four reviews which reported on school nutrition policies reported positive findings in favour of increased standards (Micha et al., 2018, Wolfenden et al., 2018, von Phillipsborn et al., 2019, Cohen et al., 2021a). Results indicate that improved nutrition standards for lunch content resulted in statistically significant increases in consumption of fruit (0.76 servings/day (95 CI% = 0.67, 1.16)) (Micha et al., 2018). Policy initiatives to increase availability of water in schools (e.g., installation of more water fountains and bottle refill stations) were also effective as reported in a recent Cochrane review. Two studies included in the review reported statistically significant increases in water consumption; 22 events/100 students, $p<0.01$ and 220 mL/day (95% CI = 140, 280), respectively (von Phillipsborn et al., 2019). Results from narrative reviews (Wolfenden et al., 2017, Cohen et al., 2021a) generally support these findings.

Four reviews reported on the effectiveness of school-based interventions to reduce unhealthy eating. One review (von Phillipsborn et al., 2019) reported on direct provision of fruits and vegetables, and two reviews reported on school-based nutrition policies (von Phillipsborn et al., 2019, Micha et al., 2018). All included reviews included limits on food competition (von Phillipsborn et al., 2019, Micha et al., 2018, Driessen et al., 2013, Flodgren et al., 2020).
The impact of direct provision of fruits as an intervention was limited to SSB consumption. (von Phillipsborn et al., 2018). Results indicate that direct provision had a statistically significant reduction on SSB intake ($p=0.003$). Students who received fruit for free showed a greater reduction of SSB (-1.4 units), compared to those who received fruit as part of a paid subscription program (-1.1 units), or those who did not participate in the program (-0.7 units), $p=0.002$.

Limits on competitive food and beverage standards (i.e., interventions to limit availability of foods sold separately from school approved menus) to reduce unhealthy eating were broadly inclusive to limiting SSBs and unhealthy snacks in school vending machines, cafeterias, and canteens. Evidence from four reviews agreed that food competition standards were an effective mechanism to decrease unhealthy eating in schools.

Two reviews reported on the effectiveness of competitive standards to lower unhealthy snack consumption. Results from a meta-analysis (Micha et al., 2018) found that introducing limits on competitive food items decreased consumption of unhealthy snacks slightly (-0.17 servings/day (95% CI = -0.22, -0.13)). A second review reported that limits in school snack bars, canteens and vending machines had a positive effect (e.g., decreasing unhealthy snack purchases) on food purchasing in 15/16 (94%) studies included (data NR).

Competitive standards to lower SSB consumption in schools reported positive results to decrease unhealthy eating with mixed effect sizes. One review of 240 schools (von Phillipsborn et al., 2019) reported SSB reductions as high as -99 mL/day (95% CI =-173, -26)). The share of students consuming SSBs decreased by as much as 10% (95% CI = 3, 17). A second review reported similar results, reporting a mean difference (MD) = -66mL/day (95% CI = -130, -2) (Flodgren et al., 2020). A third review, including a meta-analysis (Micha et al., 2018) reported smaller reductions on SSB consumption (-0.18 servings/day (95% CI = -0.31, -0.05)).

Three systematic reviews reported on the effectiveness of school-based nutrition meal standard policies to decrease unhealthy eating (Micha et al., 2021, von Phillipsborn et al., 2019, Dreissen et al., 2014). Findings were consistent that school-based nutrition meal standards did not reduce unhealthy eating, however the impact across reviews was mixed. For example, one meta-analysis (Micha et al., 2021) found statistically significant reductions in energy (% change) from intake of fats (-1.49% (95 CI = -2.42, -0.57)) and saturated fats (-0.93% (95% CI = -1.15, -0.7)). These results should be interpreted with caution however as high heterogeneity was observed (I^2>90%) across study results.

A second review (von Phillipsborn et al., 2019) reported on the effectiveness of meal standards to reduce SSB consumption in schools. Results were inconsistent, with reductions ranging from -190 mL/day (95% CI = -280, -180) to 0.7 mL/day/student (statistical measures NR). Increased access to water appeared effective at reducing sugar-sweetened milk consumption, but by a very small amount (-3 mL/day (95 CI = -5, -1)).

Federal and local provision polices for school meal consumption and food security were reported in two syntheses (Cohen et al., 2021a,b). Findings were consistent between reviews that social support standards were effective in increasing school meal consumption and overall diet. One review (Cohen et al., 2021a) found that the expansion of food provision policies to include all students (as opposed to only those meeting economic eligibility status), increased school meal consumption. The review also reported that when students had limited access to unhealthy foods, consumption of school provided foods increased (data NR). A second review (Cohen et al., 2021b) explored food provision (e.g., universal free school meals) on diet quality and food security. Results from the USA indicate a low number of positive associations between universal free school meals and diet quality (2/7; 29%) and food security (2/7; 29%). Results from the same study concluded that students who attended schools with universal free meals were far more likely to be food secure than those children who did not attend schools with universal free meals (OR: 2.85 (95% CI = 1.67, 4.88)). Results from OECD countries other than the USA reported higher positive associations between universal school meals and diet quality (13/16; 68%) and food security (2/3; 67%).

Workplace-based reviews

Two systematic reviews (Wolfenden et al., 2018, Geaney et al., 2013) reported on the effectiveness of workplace-based interventions to increase healthy eating. In both reviews, provision of healthier food items (e.g., fruits and vegetables and healthier catering items) resulted in small increases in consumption of healthier food. One review concluded that there is limited evidence to suggest that workplace-based dietary modification interventions alone can increase healthy eating.

Few reviews reported on differential effects among diverse populations. One study (von Phillipsborn et al., 2019) reported results of sub-group analysis on SSB consumption amongst participants with foreign-born parents or grandparents. Results suggest that consumption of SSBs was lower for those with foreign born parents or grandparents than those without, however results were not statistically significant. However, without any contextualization or further analysis, it is unclear as to why these differences exist. No other reviews reported on differential impacts among diverse populations.

None of the included reviews reported on cost or cost-effectiveness of food provision policies, although one review (Cohen et al., 2021a) commented that school-wide participation in universal school meal provision could be implemented with minimal costs or additional labour. The same review posited that providing universal school meals could reduce food insecurity experienced by families who can then save funds otherwise allocated for school meals to increase their purchasing power for other foods.

There is limited evidence of the effectiveness of school and workplace-based policies on food consumption in the long-term. Few studies within the reviews reported follow-up times greater than 12 months, and one review (O'Brien et al., 2021) noted that the positive effects of school policies immediately declined at the conclusion of the intervention.

Table 6: Food Provision

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food provision (total, by design) and sample size	PROGRESS-Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Quality of included studies
Schools (n=9)								
Hansen, K.L., Golubovic, S., Eriksen, C.U., Jørgensen, T. & Toft, U. (2022). Effectiveness of food environment policies in improving population diets: a review of systematic reviews. *European Journal of Clinical Nutrition, 76*(5), 637-646.	To assess the effectiveness of different food environment policies in improving population diets.	September 2021 (2010-2020)	Population: General population of any age; children: 0-17 years, adults: >18 years; gender and ethnicity. Intervention: Direct provision of health goods (fruits and vegetables).	1 systematic review including meta-analysis: • 19 RCTs • 1 clinical control trial Total sample size = 1,536	NR	Direct provision of fruit and vegetables increased fruit and vegetable intake, however the finding was not statistically significant: • Standardized Mean Difference (SMD): 0.02 (95% CI = -0.08, 0.12); 2 studies, I^2 = 0%. Results from an included clinical trial report that provision of 1 piece of fruit and vegetables increases daily intake by 0.2 servings after 2 months (statistical measures NR).	-	Moderate quality

O'Brien, K.M., Barnes, C., Yoong, S., Campbell, E., Wyse, R., Delaney, T., . . . & Hodder, R.K. (2021). School-Based Nutrition Interventions in Children Aged 6 to 18 Years: An Umbrella Review of Systematic Reviews. *Nutrients, 13*(11), 4113.	To evaluate evidence of school-based nutrition interventions designed to improve dietary outcomes in children and adolescents.	June 2021 (2011–2021)	Population: children aged 6-18 years. Intervention: school-based interventions aimed to improve children's healthy food intake.	3 systematic reviews including: • 2 meta-analyses; 191 studies: 15 RCTs, 13 C-RCTs, 163 quasi-experimental • 1 narrative review; 10 studies: 2 RCTs, 8 quasi-experimental • Total sample size <10,000	NR	Direct provision of fruits and vegetables showed statically significant increases in consumption of fruits with no effect on vegetables or total calories (values NR): • fruit mean difference (MD): 0.2 (95% CI = 0.14, 0.26); 10 trials, I^2 = 67% • vegetables (MD): 0.00 (95% CI = -0.01, 0.01); 7 trials, I^2 = 69% Results from a narrative review report no effect for improving diet in general (data NR).	-	2/3 (66%) studies were assessed as being critically low quality. 1/3 (33%) studies were assessed as being low quality.

Cohen, J.F.W., Hecht, A.A., Hager, E.R., Turner, L., Burkholder, K. & Schwartz, M.B. (2021a). Strategies to Improve School Meal Consumption: A Systematic Review. *Nutrients, 13*(10), 3520.	To evaluate studies examining policies to increase school meal consumption.	May 2021 (2000-2019)	Population: elementary/ middle and/or high schools. Intervention: Community eligibility status (based on community SES), competitive food policies, state/federal policies, district wellness policies.	19 studies: • Health Hunger Free Kids Act (n=6; 5 pre-post, 1 cross-sectional) • Local and state policies: access to competitive foods (foods and beverages sold separately from meal programs) (n=6; 3 pre-post, 3 cross-sectional) • Other local policies (n=7; pre-post-test, 1 cross-sectional) Total sample size >81,000	NR	Results measuring the effectiveness of a federal food provision act (*Health Hunger Free Kids Act)* reported mixed results; 4 studies reported a positive effect with increased consumption of school meals, and 2 studies reported a negative effect on consumption (values NR). Of the 3 high quality studies included in the review, 2 found a positive association between the policy and school meal consumption. Five of 6 studies measuring the effectiveness of local and state food competition policies reported that consumption of school meals was inversely associated with access to competitive foods; i.e., schools with limited access to food and beverages outside the school meal plan had greater consumption of school provided meals. Only one study included was of high quality; the results of this study were comparable with the majority of study results, finding that students consumed more of the healthier school meals when access to competitive foods was limited. Other results from local policies included: • limiting unhealthy foods (i.e., flavoured milk); results were mixed, but milk consumption was adversely impacted by offering juice on the lunch menu. • offering fruits and vegetables; results showed an increase in consumption (results NR). • requiring food providers to increase fresh and less-processed ingredients with restrictions on the availability of deep-fried foods; results were mixed with only 1 of 3 schools reporting lower consumption of school provided meals.	-	7/19 (37%) studies were assessed as having a low risk of bias. 11/19 (58%) studies were assessed as having high risk of bias. 1/19 (5%) studies were assessed as having a very high risk of bias.

Cohen, J.F.W., Hecht, A.A., McLoughlin, G.M., Turner, L. & Schwartz, M.B. (2021). Universal School Meals and Associations with Student Participation, Attendance, Academic Performance, Diet Quality, Food Security, and Body Mass Index: A Systematic Review. *Nutrients, 13*(3), 911.	To evaluate the association between universal free school meals diet quality and food security.	December 2020 (1990-2020)	Population: primary (i.e., elementary) and secondary (i.e., middle and/or high-school) aged-children. Intervention: Universal free meals during the academic year.	46 studies: • 8 c-RCTs • 19 quasi-experimental (pre-post, control) • 11 quasi-experimental (pre-post, no control) • 8 cross-sectional Total sample size >700,000	SES; ≥40% of students in a district or school must be from low-SES household, determined using existing administrative data (e.g., participation in Supplemental Nutrition Assistance Program).	The effect of universal school meals on the diet quality and food insecurity of students were broken down by location (values and statistical measures are reported where available). In the United States: • 2/7 (29%) studies found a positive association between universal free school meals and diet quality (statistical measures NR). • 2/7 (29%) studies found a positive association with food security as a result of food provision policies: ○ Of these 7 studies, 1 study with a high risk of bias reported a statistically significant positive effect after implementing universal school meals; children who attended schools with universal meals (based on socioeconomic eligibility) were more likely to be food secure than children who attended schools that did not provide meals; OR: 2.85 (95% CI = 1.67, 4.88) • 3/7 (43%) studies examined only the effect of provision of a universal free breakfast and found mixed results with 1 study reporting that universal breakfast was associated with increased nutrient consumption (values NR); 1 study reporting on likelihood of eating breakfast, reported universal free breakfast programs resulted in a statistically significant increased likelihood of eating breakfast 5 days/week compared to those not receiving the program ($p<0.01$). In OECD countries: • 13/19 (68%) studies found improvements in student's dietary outcomes, 3 found no improvement. ○ Of these studies, 2 studies with low risk of bias reported that free school lunches resulted in a statistically significant increase of 16% in vegetable intake, and 48% in fish intake, and 30% reduced intake of saturated fats; $p<0.0001$	-	25/46 (54%) studies were assessed as having a low risk of bias. 13/46 (28%) studies were assessed as having high risk of bias. 8/49 (18%) studies were assessed as having a very high risk of bias.

						• 3 studies examined food security with mixed results, 2 studies found improvements in food security and 1 found no association between provision of school meals and food security. 14/15 (93%) studies found a positive association between universal school meal provision and participation. Increases were largest among students who previously did not qualify for free or reduced-price meals.		
Flodgren, G.M., Helleve, A., Lobstein, T., Rutter, H. & Klepp, K.-I. (2020). Primary prevention of overweight and obesity in adolescents: An overview of systematic reviews. *Obesity Reviews, 21*(11), e13102.	To summarize recent evidence on the effects of interventions aimed at preventing overweight and obesity in adolescents.	November 2019 (2008-2019)	Population: adolescents aged 10-19. Interventions: structural and environmental interventions.	3 reviews: • 19 RCT • 12 non-RCT Total sample size = 4,697	NR	Free delivery of fruits and vegetables to adolescents in school settings had little to no effect on consumption at 21 weeks and 12 months follow-up (values NR). One review reported that policies reducing sugar-sweetened beverages (SSBs) in schools resulted in a small statistically significant reduction in SSB consumption; MD: -66 mL/day (95% CI = -130, -2); 5 studies, I^2 = 62.8%, p=0.04.	-	Moderate to low quality

von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2006-2017)	Population: general population (hospitals excluded). Interventions: Implemented at an environmental level, reporting effects on direct or indirect measures of SSB intake or health outcome (nutritional standards in public institutions).	16 studies; • 1 RCT • 2 c-RCT • 4 quasi-experimental • 7 pre-post with control • 2 interrupted time series Total sample size >1,500,000	Participants with foreign-born parents or grandparents.	A broad range of school-based interventions were evaluated on their effectiveness to lower SSB consumption. School-based fruit provision policies on the intake of SSB: • Statistically significant reduction in SSB intake, p=0.003 (data NR) • Statistically significant reduction in SSB intake measured as unhealthy snack frequency scores; results range from -1.4 in the free-fruit intervention group to -1.1 in the fruit subscription group and -0.7 in the control group, p=0.002. Policies aimed at improved access to drinking water in schools on SSB intake showed mixed results: • Total SSB intake ranged from a statistically significant reduction; -190 mL/day (95% CI = -280, -100) to +0.7 mL/day/student (no statistical analysis reported). • Sugar sweetened milk consumption decreased by -3 mL/day (95% CI = -5, -1). • Juice consumption decreased -20 mL/day (95% CI = -40,20) Water intake saw a statistically significant increase: • 22 events/100 students, p<0.01 • 220 mL/day (95% CI – 140, 280) Policies aimed at reducing availability of SSBs in schools on SSB intake had mixed effects: • Total SSB intake reductions ranged from -99mL /day (95% CI = -173, -26) to -14 mL/day (-69, 41). • Share of students consuming SSB ranged from -4% (95% CI = -10,2) to -10% (95% CI = -17, -3).	Those with foreign-born parents or grandparents reported a decrease of -20 mL/day (95% CI = (-60, 20), compared to those without foreign born parents or grandparents ±0 mL/day (95% CI = -60, 60).	Certainty of evidence is very low

Micha, R., Karageorgou, D., Bakogianni, I., Trichia, E., Whitsel, L.P., Story, M., . . . & Mozaffarian, D. (2018). Effectiveness of school food environment policies on children's dietary behaviors: A systematic review and meta-analysis. *PLOS ONE, 13*(3), e0194555.	To quantify the impact of school food environment policies on dietary habits in children and adolescents.	December 2017 (1991-2016)	Population: individuals in primary or secondary schools, aged 6-18. Intervention: School food environmental policies.	91 studies; 21 narrative, 70 meta-analyzed • 39 RCTs • 26 quasi experimental with control • 26 quasi-experimental without control Total sample size NR	NR	School food environment policies with direct provision of fruits and vegetables showed statically significant increases in habitual consumption of fruits, and vegetables. • Fruit: 0.27 servings/day (95% CI = 0.17, 0.36); 10 trials, I^2 = 78.3%* • Fruits and vegetable: 0.04 servings/day (95% CI = 0.00, 0.08); 7 trials, I^2 = 23.4% • Vegetables: 0.28 servings/day (95% CI = 0.17, 0.40); 10 studies, I^2 = 90.2%* Introduction of competitive food and beverage standards (e.g., limits on unhealthy food items sold outside of the school nutritional standards) in schools resulted in statistically significant reductions in habitual intake of: • SSB: -0.18 servings/day (95% CI = -0.31, -0.05); 3 studies, I^2 = 73.7%. • unhealthy snacks -0.17 servings/day (95% CI = -0.22, -0.13); 9 studies, I^2 = 59.6% School-meal standards increased fruit intake: • fruit: 0.76 servings/day (95% CI = 0.67, 1.16); 2 studies, I^2 = NR • vegetable: 0.30 servings/day (-0.0001, 0.59); 2 studies, I^2 = NR • fruits and vegetables: 0.12 (95% CI = -0.06, 0.51); 5 studies, I^2 = NR • Water: 0.33 glasses/day (95% CI = -0.27, 0.93); 3 studies, I^2 = NR Results of in-school competitive food standards were also statistically significant: • SSB: -0.02 servings/day (95% CI = -0.04, -0.01); 5 studies, I^2 = 59.6% • unhealthy snacks -0.05 servings/day (95% CI = -0.08, -0.02); 9 studies, I^2 = 49.2% School meal standards produced statistically significant reductions in habitual consumption of total fats, saturated fats and sodium: • total fat: -1.49% energy (95% CI = -2.42, -0.57); 6 studies, I^2 = 90.9%*		43/91 (47%) studies were assessed as being high quality 48/91 (53%) studies were assessed as being low quality

						• saturated fat: -0.93% energy (95% CI = -1.15, -0.7); 4 studies I^2 = 0%. • Sodium: -170 mg/day (95% CI = -242, -98); 4 studies, I^2 = 54.3% School food environment policies targeting habitual water intake showed no effect on consumption of water (glasses/day). *Results should be interpreted with caution given high heterogeneity (>75%) across studies.		
Wolfenden, L., Nathan, N.K., Sutherland, R., Yoong, S.L., Hodder, R.K., Wyse, R.J., . . . & Williams, C.M. (2017). Strategies for enhancing the implementation of school-based policies or practices targeting risk factors for chronic disease. *Cochrane Database of Systematic Reviews, 11*(11), Cd011677.	To examine the effectiveness of implementation strategies on student health behaviour (e.g., dietary intake).	July 2017 (1998-2017)	Population: schools aged children (5-< 18 years). Intervention: healthy eating policies implemented in publicly funded schools.	3 non-randomized trials Total sample size >20,000	SES	Diet related policies or practices within schools were evaluated with the following results: • 9/12 (75%) studies report improvements in at least one measure of dietary intake (i.e., fruit and vegetable consumption, total energy intake, total saturated fat intake) due to a dietary related policy or practice (statistical measures NR). Students attending schools where state-wide nutrition policies were implemented had better quality diets as measured by an unhealthy eating food index, in comparison to students at schools not implementing these policies (data NR).	-	Very low
Driessen, C.E., Cameron, A.J., Thornton, L.E., Lai, S.K. & Barnett, L.M. (2014). Effect of changes to the school food environment on eating behaviours and/or body weight in children: a systematic review. *Obesity Reviews, 15*(12), 968-82.	To examine the effect of isolated food environment interventions on eating behaviours (e.g., food purchasing).	November 2013 (2001-2013)	Population: school-aged children from elementary to high school. Intervention: school policies in which a material change was made to the school environment.	7 studies; all non-randomized trials. Total sample size NR	NR	School-based interventions to change the availability of food in school canteens or snack bars and vending machines were evaluated for effectiveness on food purchasing. 15/16 (94%) of the studies reported a statistically significant positive effect on food purchasing (data NR).	-	Weak

Workplaces (n=2)								
Wolfenden, L., Goldman, S., Stacey, F.G., Grady, A., Kingsland, M., Williams, C.M., . . . & Yoong, S.L. (2018). Strategies to improve the implementation of workplace-based policies or practices targeting tobacco, alcohol, diet, physical activity and obesity. *Cochrane Database of Systematic Reviews, 11*(11), Cd012439.	To assess the effects of strategies for improving workplace-based policies on employee health behaviour (e.g., dietary intake).	August 2017 (1990-2013)	Population: anyone in any type of workplace-based setting in location. Intervention: healthy eating policies implemented in the workplace.	2 RCTs Total sample size = 19,419	NR	Workplace interventions to improve nutrition were evaluated with mixed results: 1 RCT reported on the effectiveness of greater fruit and vegetable availability in workplace cafeterias: • at 6-month follow-up there was a small but statistically significant increase in the grams of fruit and vegetables consumed compared to the control; 11.75 grams/day (95% CI = 2.73, 20.77). A second RCT studied the effectiveness of healthier workplace-based catering policies: • at 2-year follow up there was a statistically significant increase among employees on daily servings of fruits and vegetables consumed compared to the control; 5.60%; Standard Error (SE): 1.30, p<0.001 • There were no other statistically significant differences between the groups with the exception of dietary fibre consumed with those exposed to the intervention consuming more; 1.70%; SE: 0.87, p>0.05	-	Very low
Geaney, F., Kelly, C., Greiner, B.A., Harrington, J.M., Perry, I.J. & Beirne, P. (2013). The effectiveness of workplace dietary modification interventions: a systematic review. *Preventive Medicine, 57*(5), 438-47.	To evaluate the effectiveness of workplace dietary modification interventions on employees' dietary behaviour.	November 2011 (1999-2011)	Population: participants >18 years old working or volunteering in public or private organizations. Intervention: workplace dietary modification interventions including provision of fruits and vegetables in healthier menu options.	12 articles representing 6 studies: • 3 RCTs • 3 quasi-experimental Total sample size = 8,334	NR	Workplaces implemented a broad range of nutrition standards to improve the diet of employees: • 4/6 (67%) studies reported small increases in fruit and vegetable consumption (≤half serving/day; statistical measures NR). There is limited evidence to suggest that workplace dietary modification interventions alone can increase healthy eating.	-	NR due to incomplete reporting

Abbreviations:
CI: Confidence Interval
c-RCT: Cluster Randomized Control Trial
ES: Effect Size
FE: Food environment
MD: Mean Difference
NR: Not Reported
RCT: Randomized Control Trial
SE: Standard Error
SMD: Standardize Mean Difference
SSB: Sugar-Sweetened Beverage

Food Prices

Key Findings

- There is evidence that food price discounts via subsidy result in increases in consumption of fruits, vegetables, and other healthy foods (low certainty, GRADE).
- There is evidence that food price increases via tax result in decreases in consumption of unhealthy foods and beverages (low certainty, GRADE).
- There is evidence that price increases on sugar-sweetened beverages (SSBs) result in reduced consumption for both adults and children. There is limited evidence however, that reductions in SSBs results in increased consumption of healthier beverage choices (e.g., water) versus reduced overall beverage consumption (low evidence, GRADE).
- The findings illustrate minimum price increases or decreases are needed to achieve behaviour modification.
- Syntheses evaluating the cost-effectiveness of food pricing interventions for both healthy and unhealthy eating are needed.
- Across reviews, only one reported on differential effects among diverse populations highlighting the urgent need for primary studies to collect and report data for diverse populations in differing contexts.

Seven syntheses reported on the effectiveness of food pricing interventions to increase healthy eating and/or decrease unhealthy eating in the general population. Food pricing interventions were categorized using the WHO NOURISHING framework. Within this framework, food pricing interventions fall under food environment policies, and are categorized as economic tools, further categorized under the sub-policy area of health-related food tax (e.g., price increases on unhealthy foods). The effect of pricing was mainly concentrated on consumption of sugar-sweetened beverages, fruit and vegetables and sales of these items.

Table 7: GRADE Summary of Findings for Food Pricing Interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of randomized and/or non-randomized studies	5	⊕⊕◯◯ Low[1]	• **Food pricing interventions via subsidy** result in increases in healthy eating (e.g., fruits, vegetables, healthy snacks, and beverages).
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	4	⊕⊕◯◯ Low[1]	• **Food pricing interventions via tax** result in decreases in unhealthy eating (e.g., SSB and sugar-added foods).
the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence. No additional up or downgrades were made.				

All five reviews reporting on the effectiveness of price reduction interventions (e.g., subsidies) to increase healthy food consumption reported positive findings. Of those, one review with an included meta-analysis (Afshin et al., 2017) reported a statistically significant increase in

healthy food consumption. Specifically, they found that for every 10% decrease in the price of healthy foods via subsidy, consumption of those foods increased by 12% (95% CI = 10,15). Subgroup analysis on type of healthy food (e.g., fruits, vegetables, healthy beverages and other health foods (not defined)), reported similar responses to the 10% reduction; fruits and vegetable consumption increased by 14% (95% CI = 11,17) and other healthy foods increased 16% (95% CI = 10, 23). These results should be interpreted with caution as the review found significant heterogeneity across study results (I^2=98.5%), and in sub-group analysis (I^2>98%). Sources of significant heterogeneity were identified as the direction of the price change (tax vs. subsidy), number of intervention components, intervention duration and study quality ($p<0.05$).

A second systematic review (von Phillipsborn et al., 2019) reported that a price reduction on lower calorie beverages (e.g., diet cola and water) sold in remote community stores, had a statistically significant positive effect on bottled water intake with an increase of 18% (95% CI = 1,37) during the 6-month intervention, although the effect was not maintained by 5 months post intervention. The results of the remaining three reviews (Ganann et al., 2014, Grech et al., 2015, Hansen et al., 2021) generally aligned with those of Afshin and von Phillipsborn, with Grech et al., 2015 further noting that price reductions were effective in both adults and children in consuming healthier food options.

Four reviews reported on the effectiveness of food taxation (e.g., price increases) to decrease unhealthy eating. Findings were consistent that taxes decrease measures of unhealthy eating. One review with a meta-analysis (Ashfin et al., 2017) reported on the effect of taxation on SSB and unhealthy food consumption. They reported a statistically significant effect such that for every increase of 10% in the price of unhealthy food, consumption decreased (-6% (95% CI = -4, -8)). Subgroup analysis by food type also showed statistically significant results; for every 10% increase consumption of fast food decreased (–3% (95% CI = -1,-5)), and SSB decreased (-7% (95% CI = -3,-10)).

Two other reviews reported on the effect of taxation on sugar-added foods (von Phillisborn et al., 2019, Pfinder et al., 2020) with similar findings. One review (von Phillpsborn et al., 2019) looked at the effectiveness of taxation on SSB sales in community stores and reported a statistically significant decrease in sales with a reported overall mean difference (MD): -19% (95% CI = -33, -6), however these results should be interpreted with caution as high heterogeneity was reported (I^2= 89%). Sub-group analysis on the amount of tax levied at specific timepoints suggests that the tax amount is likely a greater factor than the length of time a tax is imposed; a tax increase of 3-4% at 6 months reduced sales MD: -9.34 (9% CI = -15.21, -3.47). However, at 12 months a tax increase of 10-25% was effective at reducing sales; MD: -24.74 (95% CI = -28.89, -20.58). Similar results were reported by (Pfinder et al., 2020) who found statistically significant reductions in SSB consumption, with a reported SMD = -4% (95% CI = -0.07, -0.01).

One review (von Phillipsborn, et al., 2019) included data from a price intervention study conducted in 20 remote, socio-economically deprived Indigenous community settlement stores which were the only commercial source for food and beverages within 20 kilometers. No

comparative data (e.g., to other population groups, or in non-rural areas) is provided, thereby limiting the interpretation of these results. The authors suggest the reason for the increase in low-calories SSB and water purchases were likely due to the customer responsiveness to discounts on bottled refrigerated items because many in these communities do not have access to refrigerated beverages, further noting that the quality of drinking water can at times be variable. No other reviews reported on differential impacts among diverse populations.

None of the included reviews reported on the cost effectiveness of food pricing policies.

Table 8: Food Pricing

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food prices (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Review author's assessment on quality of included studies
Ganann, R., Fitzpatrick-Lewis, D., Ciliska, D., Peirson, L.J., Warren, R.L., Fieldhouse, P., . . . & Wolfenden, L. (2014). Enhancing nutritional environments through access to fruit and vegetables in schools and homes among children and youth: a systematic review. *BMC Research Notes, 7*, 422.	To examine the effects of interventions delivered in schools and other nutritional environments designed to increase fruit and vegetable availability for 5 to 18-year-olds.	August 2011 (1997-2011)	Population: Children aged 5 to 18 years. Interventions: Fruit and vegetable prices were reduced by 50%.	1 study • 1pre-post test Total sample size = 3,366	NR	The effect of price on healthy food consumption (e.g., fruit, baby carrots and salads) was measured at 3 pricing timepoints: Fruit (mean pieces/week); p=0.0005 • Baseline: 14.4 ± 14.0 • Low price period: 63.3 ± 14.2 • Return to regular price period: 26.1 ± 14.3 Carrots (mean packets/week); p=0.01 • Baseline: 35.6 ± 49.0 • Low price period: 77.6 ± 49.2 • Return to regular price period: 42.0 ± 49.2 Salads (mean servings/week); p=0.85 • Baseline: 14.6 ± 9.5 • Low price period: 16.0 ± 9.6 • Return to regular price: 16.0 ± 9.6	-	Weak
Grech, A. & Allman-Farinelli, M. (2015). A systematic literature review of nutrition interventions in vending machines that encourage consumers to make healthier choices. *Obesity Reviews, 16*(12), 1030-41.	To determine the efficacy of nutrition interventions (e.g., healthier options in vending machines) to improve diet.	2014 (1981-2014)	Population: General population in worksites (2), schools (4) Intervention: Price reductions in healthy food items.	5 studies: • 1 RCT • 2 c-RCTs • 2 non-randomized crossover trials Total sample size NR	NR	Pricing interventions in vending machines were effective in increasing the purchase of healthier food items (not defined) among both children and adults. A dose-response was evident with the largest price reductions increasing sales volume of healthy items the most (data NR). Price incentives >10% were effective in producing a positive change in vending machine sales for both children and adults (data or statistical measures NR).	-	4/5 (80%) studies were assessed as having low risk of bias. 1 / 4 (20%) studies were assessed as having moderate risk of bias.

Afshin, A., Peñalvo, J.L., Del Gobbo, L., Silva, J., Michaelson, M., O'Flaherty, M., . . . & Mozaffarian, D. (2017). The prospective impact of food pricing on improving dietary consumption: A systematic review and meta-analysis. *PLOS ONE, 12*(3), e0172277.	To evaluate the prospective effect of changes in food prices on dietary consumption.	June 201 (1992-2014)	Population: General population children and adults. Intervention: Change in the price of foods or beverages due to taxation, subsidies, or other factors.	30 studies (26 included in the meta-analysis): • 7 RCT • 16 non-randomized crossover trials • 7 prospective cohort	NR	A 10% reduction in the price of healthy foods via subsidy resulted in statistically significant increased consumption of certain foods: • Healthy foods: 12% (CI = 95% CI = 10,15); 22 studies, I^2= 98.5%* ○ fruits & vegetables: 14% (95% CI = 11,17); 9 studies, I^2= 99.1%* ○ other healthy foods: 16.34% (95% CI = 10, 22.63); 10 studies, I^2= 98.4%* A 10% increase in the price of unhealthy foods via increased tax resulted in statistically significant decreased consumption of certain foods: • Unhealthy foods: -6% (CI = 95% CI = -4, -8); 15 studies, I^2= 65.2% ○ fast food: -3% (95% CI = -1, -5); 3 studies, I^2=0% ○ sugar-sweetened beverages (SSBs): -7% (95% CI = -3, -10); 5 studies, I^2=75.7% *Differences between the type of subsidies offered, intervention duration and intervention components were identified as a significant source of heterogeneity (p<0.05). Results should be interpreted with caution, given high heterogeneity.	Type of food	Only high-quality studies were included.

von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2006-2017)	Population: General population (hospitals excluded). Interventions: Government increase on SSB price in chain restaurants; price discounts for low-calorie beverages.	7 studies; • 3 RCTs • 1 c-RCT • 3 interrupted time-series	Community stores in remote Indigenous communities	Pooled estimates on the effect of price increases on SSB sales show a statistically significant decrease in sales; Mean Difference (MD): -19% (95% CI = -33, -6); 3 studies; I^2=89%. The effect size increased with temporal price increases: • At 6 months the price increased 3-4%; MD: -9.34 (95% CI = -15.21, -3.47), I^2=N/A • At 12 months the price increased 10-25%; MD: -24.74 (-28.89, -20.58), I^2=88.77% A 20% pricing discount on low-calorie SSB and water in remote community stores led to an increase in SSB consumption: • At 6 months intake/capita: 6% (-3,15) • At 12 months intake/capita: 6% (95% CI = -7,21) However, a statistically significant increase in bottled water intake was reported during the first 6 months of the intervention 18% (95% CI = 1, 37) although the effect was no longer observed 5-months post intervention.	-	Moderate
Lhachimi, S.K., Pega, F., Heise, T.L., Fenton, C., Gartlehner, G., Griebler, U., . . . & Katikireddi, S.V. (2020). Taxation of the fat content of foods for reducing their consumption and preventing obesity or other adverse health outcomes. *Cochrane Database of Systematic Reviews, 9,* Cd012415.	To assess the effects of taxation of the fat content in food on the consumption of total fat and saturated fat, energy intake, overweight, obesity and other adverse health outcomes in the general population.	February 2020 (2013-2015)	Population: General population of Denmark. Intervention: Taxation of fat content of foods.	3 studies: • 1 interrupted time-series • 2 observational Total sample size: 2000 households, 1293 supermarkets. Number NR	NR	A government-imposed tax led to a statistically significant reduction in total fat consumption of 41.8 g/week/person in a household, p<0.001. Sales of saturated fat foods decreased: • Minced beef: -4.2% • Cream: -5.8% (statistical measures NR)	-	Very low

Hansen, K.L., Golubovic, S., Eriksen, C.U., Jørgensen, T. & Toft, U. (2022). Effectiveness of food environment policies in improving population diets: a review of systematic reviews. *European Journal of Clinical Nutrition, 76*(5), 637-646.	To assess the effectiveness of different food environment policies in improving population diets.	September 2021 (2010-2020)	Population: General population of any age; children: 0-17 years, adults: >18 years; gender and ethnicity. Intervention: Price increases for unhealthy food using tax; price decreases on healthy food using subsidies.	1systematic reviews (• 24 RCTs • 47 non-RCTs Total sample size NR	NR	Subsidies appear to be effective in altering purchases and/or intake of foods and beverages (e.g., SSB, fast foods, fruits and vegetables, low-fat products, and salads). Changes in intake appear to be sensitive to price change the larger the tax or subsidy applied; a 1% decrease in the price of fruits and vegetables was associated with >1% increase in consumption (data NR).	-	Low to moderate
Pfinder, M., Heise, T.L., Hilton Boon, M., Pega, F., Fenton, C., Griebler, U., . . . & Lhachimi, S.K. (2020). Taxation of unprocessed sugar or sugar-added foods for reducing their consumption and preventing obesity or other adverse health outcomes. *Cochrane Database of Systematic Reviews, 4*(4), Cd012333.	To evaluate the effects of taxation on unprocessed sugar or sugar-added foods on their general consumption, the prevalence and incidence of overweight and obesity, and the prevalence and incidence of other diet related health outcomes.	October 2019 (2015)	Population: General population. Intervention: Taxation of foods exceeding a specific sugar threshold value.	1 observational study Total sample size = 40,210 households	NR	Taxing foods with added sugar resulted in a statistically significant decrease in consumption of 4%; Standard Mean Difference (SMD): -0.040 (95% CI = -0.07,-0.01)	-	Very low

Abbreviations:
BMI: Body Mass Index
c-RCT: Cluster Randomized Control Trial
MD: Mean Difference
N/A: Not Applicable
NR: Not Reported
RCT: Randomized Control Trial
SMD: Standard Mean Difference
SSB: sugar-sweetened beverage

Food Retail

Key Findings

- There is evidence that farmers' markets result in little to no effect on fruit and vegetable consumption in low-income areas (low certainty, GRADE).
- There is evidence that creating positive changes to the food retail environment (e.g., placing unhealthy snacks and beverages farther away from check-out and less concentrated placement throughout stores) results in decreases in snack food selection, energy intake from unhealthy foods and sales of SSBs (low certainty, GRADE).
- There is evidence that default healthy menu choices results in a large effect on SSB sales to children (low certainty, GRADE).
- There is evidence that planning restrictions on store placement in urban areas results in no reduction in SSB sales (low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of food retail interventions for both healthy and unhealthy eating are needed.
- While 2/3 of the included reviews reported on differential effects among diverse populations, no meaningful conclusions can be drawn given the lack of comparator. This highlights the urgent need for primary studies to collect and report diversified data.

Three syntheses reported on the effectiveness of food retail interventions to increase healthy eating and/or reduce unhealthy eating in the general population. Most of the interventions were those involving choice architecture (e.g., the context in which a choice is framed and its influence on food selection). Food retail interventions were categorized using the WHO NOURISHING framework. Within this framework, food retail interventions fall under food environment policy area; set incentives and rules to create a healthy retail and food service environment and are categorized by sub-policy areas: retail type, planning restrictions on food outlets, creating a healthy food service environment (e.g., food signage, proximity to unhealthy foods and in-store presentation) and offering healthy food options as a default in food service outlets.

Table 9: GRADE Summary of Findings for Food Retail interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of randomized and/or non-randomized studies	1	⊕⊕◯◯ Low[1]	• **Food retail type** (e.g., farmers markets) results in little to no difference in increasing healthy eating (e.g., fruit and vegetable consumption, and bottled water sales).
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	2	⊕⊕◯◯ Low[1]	• **Creating a healthy food retail environment** (i.e., signage, cues, proximity, density, reduced availability) results in decreases in unhealthy eating (e.g., kcal consumed, sales of unhealthy food and SSBs) slightly. • **Default healthier beverage choices** result in decreases in unhealthy eating (e.g., SSB consumption) by a large amount. • **Planning restrictions** have little to no effect on decreasing unhealthy eating (e.g., SSB sales).
[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence.				

Two reviews (Woldenden et. al., 2020, von Phillipsborn et al., 2019) reported on the effectiveness of food retail interventions (e.g., retail and food service environments) on measures of healthy or unhealthy eating.

One umbrella review reported on the effectiveness of food retail outlets (e.g., farmers' markets and supermarkets) and choice architecture interventions (e.g., food signage and in-store presentation) to increase fruit and vegetable consumption. Narrative results were mixed; one review suggested that farmers' markets increased fruit and vegetable intake among market users, whereas a second review reported that farmer's markets in lower income communities had mixed effects on fruit and vegetable intake. The authors suggest that new supermarkets may also have a negative effect on fruit and vegetable intake as supermarket consumers have equal access to unhealthy in-store food items (e.g., pre-packaged foods). Results on the effectiveness of choice architecture interventions were unclear, however the authors conclude that cues in supermarkets were effective at increasing fruit and vegetable consumption (data NR) (Wolfenden et al., 2021).

Two reviews (von Phillipsborn et al., 2019, Hansen et al., 2021) reported on the effectiveness of healthier food service environments to decrease measures of unhealthy eating. Across reviews, interventions reported positive effects for decreasing unhealthy eating. For example, one umbrella review (Hansen et al., 2021) described the effectiveness of reduced availability, density (e.g., the number of units in a defined area) and proximity (e.g., physical distance between the product and the consumer) of unhealthy foods in food retail outlets. Reduced availability had a statistically significant effect on the consumption of unhealthy foods

(Standard Mean Difference (SMD) = -1.13 (95% CI = -1.90, -0.37)). Similarly, increased physical proximity (e.g., the farther away a product is placed from a set point) resulted in statistically significant moderate decreases in snack food selection (SMD = -0.65 (95% CI = -0.84, -0.36)) and energy intake from snack food (SMD = -0.60 (95% CI = -0.84, -0.36)). Energy intake was also reduced when the placement density of the food and drink options were altered (-0.55 (95% CI = -1.27, -0.18)). The authors conclude that the farther away a product is placed, the lower the energy intake from that food product (data NR). A second review (von Phillipsborn et al., 2018) also found positive, yet small effects for supermarket interventions, demonstrating the effectiveness of in-store promotion of healthier beverage options to decrease SSB sales. These interventions were effective in increasing sales of bottled water at check-out by (3 units/day/store (95% CI = 1,9)).

A second review (Von Philipsborn et al., 2018) reported on the effect of offering default healthier beverage options in food service outlets. One study reported on the effectiveness of default heathy beverage choices in children's menus (e.g., water, low-fat milk, 100% fruit juice). This multi-site trial took place in a controlled environment (e.g., an amusement park) where choice was restricted to park supplied beverage products. SSBs were available upon request, however they were not listed in the menu. At the six-year follow-up point, SSB sales had decreased 68% (statistical measures NR).

One review reported on the effect of planning restrictions on food outlets in high urban and remote rural areas. The intervention had no effect on sales during the 8-month follow-up period.

Differential impacts due to place of residence were reported in two of the three reviews (von Phillipsborn et al., 2018, Wolfenden et al., 2021), however no meaningful conclusions on the impact of food retail strategies could be drawn given the lack of comparator. Without any contextualization or further analysis, it is unclear as to why these differences exist. No further reviews reported on differential impacts among diverse populations.

None of the included reviews reported on cost or cost-effectiveness of food retail interventions.

Table 10: Food Retail

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food retail (total, by design) and sample size	PROGRESS-Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Author stated quality of included studies
von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2006-2017)	Population: General population (hospitals excluded). Interventions: Any intervention implemented at an environmental level (e.g., limiting availability, price increases, menu options, in-store promotion and government incentives) reporting effects on direct or indirect measures of SSB intake or health outcome.	6 reviews; • 2 c-RCT • 1 non-RCT • 2 interrupted time series • 1 controlled before-and-after study Total sample size NR	SES (urban, remote rural)	A broad range of retail interventions were evaluated on their effectiveness to lower SSB consumption. Heathier default beverages (e.g., low-fat milk, water or 100% fruit juice) in children's menus (at all 185 restaurants and concession stands) at Walt Disney World were effective in reducing SSB purchases by 68% at six-year follow-up (statistical measures NR). • Customers could still request a SSB alternative, but the default beverage was one of the healthier choices (listed above). Supermarkets offering in-store promotion (e.g., improved placement, signage and multi-placement throughout the store) of water and diet beverages to promote healthier options (e.g., reduce SSB consumption): • in-aisle SSB sales/day/supermarket: -11L/day (95% CI = -63,40) • in-aisle low-calorie SSB sales/day/supermarket: -2L/day (95% CI = -10,6) • in-aisle water sales/day/supermarket: +7 L/day (95% CI = -48,62) • checkout cooler low-calorie SSB sales/supermarket: +0.2 units/day/supermarket (95% CI = -5,1) • check-out cooler bottled water sales increased 3 units/day/supermarket (95% CI = 1,9). Community policy interventions intended to reduce SSB sales in high urban areas and remote communities had no effect on sales during the 8-month intervention period (data NR).	-	Low certainty

Wolfenden, L., Barnes, C., Lane, C., McCrabb, S., Brown, H.M., Gerritsen, S., . . . & Yoong, S.L. (2021). Consolidating evidence on the effectiveness of interventions promoting fruit and vegetable consumption: an umbrella review. *The International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 11.	To examine the effectiveness of strategies to promote fruit and vegetable consumption.	June 2020 (2012-2019)	Population: Children and/or adults Intervention: Food environment policies to increase fruit and vegetable intake.	3 narrative reviews containing 13 single studies; • RCTs (number NR) • non-RCTs (number NR) • Observational (number NR) Total sample size NR	SES	Type of food retail outlets (e.g., supermarkets and farmer's markets) on healthy food consumption (measured through fruit and vegetable consumption) was evaluated with mixed results: • One review reported that farmers' markets increase fruit and vegetable intake among market users; • One review reported that farmers' markets in lower income communities had mixed effects with fruit and vegetable intake ranging from -0.70 to +0.70 cups/day (statistical measures NR); • Findings conclude that the addition of a new supermarket in a community may have a negative effect on fruit and vegetable intake as supermarkets offer both healthy foods (e.g., fruits and vegetables) and unhealthy foods (e.g., pre-packaged foods). Results on the effectiveness of choice architecture interventions (e.g., food signage, changes to food descriptions, presentation and verbal cues in cafeterias) was overall unclear, however information-based cues in supermarkets did increase fruits and vegetables sales (data NR).	-	High quality

Hansen, K.L., Golubovic, S., Eriksen, C.U., Jørgensen, T. & Toft, U. (2022). Effectiveness of food environment policies in improving population diets: a review of systematic reviews. *European Journal of Clinical Nutrition, 76*(5), 637-646.	To assess the effectiveness of different food environment policies in improving population diets.	September 2021 (2010-2020)	Population: General population of any age; children: 0-17 years, adults: >18 years; gender and ethnicity. Intervention: Direct provision of health goods (fruits and vegetables), competition and standards for school meals.	1 systematic review including meta-analysis: • 24 RCTs Total sample size NR	NR	Reduced availability of unhealthy foods in food retail outlets (e.g., shops, restaurants/cafeterias, office and vending machines in schools) resulted in statistically significant reductions target (unhealthy) foods by a moderate amount. Altering the density (defined as the availability) of snack food and drink options had a moderate effect on: • Energy intake from snack foods; Standardized Mean Difference SMD: -0.55 (95% CI = -1.27, -0.18) Altering proximity of snack food placement through increased distance (i.e., position within a store or altering the distance of the product from a set point) resulted in statistically significant reductions by a moderate amount: • Snack food selection; (SMD): SMD: -0.65 (95% CI = -0.84, -0.36); 12 trials • Energy intake from snack foods; SMD: -0.60 (95% CI = -0.84, -0.36) Physical proximity was shown to have a regressive effect (data NR); the farther away a product is placed, the lower the energy intake from that particular food product.		High quality

Abbreviations:
CI: Confidence Interval
c-RCT: Clustered Randomized Control Trial
NR: Not Reported
RCT: Randomized Control Trial
SES: Social Economic Status
SMD: Standardized Mean Difference
SSB: Sugar-Sweetened Beverages

Food Promotion

Key Findings

- There is evidence that mass media campaigns result in little to no effect on increasing fruit and vegetable consumption; the evidence is very uncertain (very low certainty, GRADE).
- There is evidence that mass media campaigns result in little to no effect on decreasing salt consumption; the evidence is very uncertain (very low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of food promotion interventions for both healthy and unhealthy eating are needed.
- Across reviews, no studies reported on differential effects among diverse populations, highlighting the urgent need for primary studies to collect and report diversified data.

Two syntheses reported on the effectiveness of food promotion interventions to increase healthy eating and/or reduce unhealthy eating in the general population. Food promotion interventions were categorized using the WHO NOURISHING framework. Within this framework, mass media interventions align with behaviour change communication policies and are categorized under the sub-policy area of public awareness and mass media. Both food promotion interventions tested were mass media campaigns. The effect of promotion was mainly concentrated on consumption of fruits and vegetables and salt.

Table 11: GRADE Summary of Findings for Food Promotion

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of non-randomized studies	1	⊕◯◯◯ Very low[1]	• **Mass media campaigns** may result in little to no effect on increasing healthy eating (e.g., fruit and vegetable consumption); the evidence is uncertain.
Unhealthy eating	Syntheses non-randomized studies	1	⊕◯◯◯ Very low[1]	• **Mass media campaigns** may result in little to no effect on decreasing unhealthy eating (e.g., salt consumption); the evidence is uncertain.

[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence, and this assessment was further downgraded to **very low** based on imprecise data.

One umbrella review (Wolfenden et al., 2021), which included one narrative review of five primary studies (Afshin, et al., 2017) reported on the effectiveness of food promotion interventions (e.g., mass media) on measures of healthy food consumption (e.g., fruit and vegetable consumption) among children and/or adults. Empirical results were not reported; however, the authors conclude that mass media campaigns may be effective as stand-alone approaches in improving consumption of fruits and/or vegetables.

Only one review (Hyseni et al., 2017) was identified that reported on the effectiveness of a nation-wide media campaign to reduce salt intake. During the four-year mass media campaign, salt intake of participants was measured through spot urinary sodium readings. Overall, sodium levels decreased from 6.3 grams/day to 5.4 grams/day representing a 13.5% (0.9 grams/day) reduction. The authors conclude that while consumption did decline, the contribution of the mass media campaign was unclear, but likely modest.

Differential impacts due to gender were reported in one review (Hyseni et al., 2017). The impact of a nation-wide media campaign was reported to be stronger among women than men. However, without any contextualization or further analysis, it is unclear as to why these differences exist. No other reviews reported on differential impacts among diverse populations.

None of the included reviews reported on the cost effectiveness of mass media interventions.

Table 12: Food promotion

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food promotion (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Review author's assessment on quality of included studies
Hyseni, L., Elliot-Green, A., Lloyd-Williams, F., Kypridemos, C., O'Flaherty, M., McGill, R., . . . & Capewell, S. (2017). Systematic review of dietary salt reduction policies: Evidence for an effectiveness hierarchy? *PLOS ONE, 12*(5), e0177535.	To explore the effectiveness of government regulations to reduce salt intake.	October 2015 (2012)	Populations: General population (excluding pregnant women). Intervention: Mass media salt reduction campaign	1 study: • 1 cross-sectional Total sample size NR	Gender	A mass media campaign intended to reduce salt consumption was effective in decreasing salt intake from 6.3 grams/day in 2003, to 5.4 grams/day in 2007 representing a 13.5% (0.9 grams/day) reduction over 4 years. The impact was reported to be stronger among women than among men (gendered data NR).	-	Fair
Wolfenden, L., Barnes, C., Lane, C., McCrabb, S., Brown, H.M., Gerritsen, S., . . . & Yoong, S.L. (2021). Consolidating evidence on the effectiveness of interventions promoting fruit and vegetable consumption: an umbrella review. *The International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 11.	To examine the effectiveness of strategies to promote fruit and vegetable consumption.	June 2020 (2012-2019)	Population: Children and/or adults Intervention: Food environment policies to increase fruit and vegetable intake.	1 narrative synthesis: • 5 non-RCTs Total sample size NR	NR	Mass media campaigns (e.g., TV commercials, print and radio ads) were evaluated and found to be potentially effective in improving the consumption of fruits and vegetables in adults and young people (data NR). The authors suggest that campaigns targeting fruits and vegetable consumption can be used as a stand-alone strategy.	-	Medium

Abbreviations:
NR: Not Reported
RCT: Randomized control Trial

Food Composition

Key Findings

- There is evidence that voluntary food reformulation interventions by beverage manufacturers result in small decreases in sales (kcal/capita/day) of SSBs (low certainty, GRADE)
- There is evidence that voluntary reformulation of foods containing TFAs results in small reductions in consumption of TFA (low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of food composition interventions for both healthy and unhealthy eating are needed.
- Across reviews, very few studies reported on differential effects among diverse populations highlighting the urgent need for primary studies to collect and report data for diverse populations in differing contexts.

Two syntheses reported on the effectiveness of food composition interventions to increase healthy eating and/or reduce unhealthy eating in the general population.
Food composition interventions were categorized using the WHO NOURISHING framework. Within this framework, food composition interventions fall under food environment policies and align with nutritional quality of the whole food supply policies, sub-policy voluntary reformulation of food products. This review includes voluntary reformation of food product interventions for trans-fatty acids (TFA) and sugar-sweetened beverages (SSBs).

Table 13: GRADE Summary of Findings for Food Composition interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Unhealthy eating	Syntheses of non-randomized studies	2	⨁⨁◯◯ Low[1]	• **Food composition via voluntary reformulation** results in decreases in unhealthy eating (e.g., SSB and TFA intake).
[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality.**				

Two reviews reported on the effectiveness of food composition interventions to decrease unhealthy eating (e.g., SSB and TFA intake).

A Cochrane review (von Philipson et al., 2018) examined the effects of voluntary industry participation in reformulating SSBs to contain less sugar (measured by energy consumption/capita/day) on consumer choice. Results indicate that voluntary reformulation was successful in reducing sugar consumption and SSB energy sold by a small amount (both measured by kcal/capita/day): sugar consumed decreased -14 kcal and overall SSB sales decreased -7 kcal/capita/day (statistical measures NR). Notably, this trend was observed over a four-year follow-up. The authors noted total sales decreases were less than expected. Similar reductions in sales were seen in an intervention by a major nation-wide retailer (Walmart),

who reduced added sugars in their beverage brand by 10%. Results at the three-year follow-up indicated that sales of the reduced calorie beverages reduced greater than expected ($p<0.01$).

A second systematic review (Hyseni et al., 2017) reported on the effectiveness of voluntary food reformulation interventions to modify TFA content in vegetable oils and margarine to less than 2%. The authors conclude that overall, voluntary reformulation resulted in a daily reduction in TFA intake of -1.5 grams; from 4.9 grams/day at baseline to 3.4 grams/day at three-year follow-up (statistical measures NR).

Differential impacts due to gender were reported in one review (Hyseni et al., 2017). The impact of food composition was reported to be stronger among women than men. However, without any contextualization or further analysis, it is unclear as to why these differences exist. No other reviews reported on differential impacts among diverse populations.

None of the included reviews reported on cost or cost-effectiveness of food provision policies.

Table 14: Food Composition

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to food composition (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Quality of included studies
Hyseni, L., Bromley, H., Kypridemos, C., O'Flaherty, M., Lloyd-Williams, F., Guzman-Castillo, M., . . . & Capewell, S. (2017). Systematic review of dietary trans-fat reduction interventions. *Bulletin of the World Health Organization, 95*(12), 821-830G.	To review interventions to reduce people's intake of dietary trans-fatty acids (TFA).	October 2017 (2006-2017)	Population: General population (excluding pregnant women) Intervention: Government requested reduction of TFA content in processed food.	1 study: • 1 controlled pre-post Total sample size >33,000	NR	A request to manufacturers to voluntarily reduce TFA content (<2%) in vegetable oils, margarine, and other pre-packaged foods (not defined) resulted in a reduction in consumption of TFA from baseline (4.9 grams/day) to 3.4 grams/day at 4-year follow-up. This represents a 30% reduction in TFA content in 4 years.	-	Good
von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSBs (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2014-2015)	Population: General population (hospitals excluded). Interventions: Voluntary beverage industry initiatives to improve the nutritional quality (e.g., reduced sugar content in packaged beverages) of the whole food supply.	3 studies: • 2 controlled interrupted time series • 1 controlled pre-post Total sample size >61,000	NR	16 major companies in the United Sates pledged to reduce the calories in their manufactured beverages over 4 years (collectively 1.5 trillion kcal). Compared to the control, companies that voluntarily pledged to reduce calories in beverages reported: • reduced energy content of beverages sold by -14kcal/capita/day compared to -3kcal/day not participating in the pledge. • reduced sales by -7kcal/capita/day (statistical measures NR). Purchases from companies participating in the pledge decreased less than expected, although the decrease was statistically significant (p<0.001). Results from a nation-wide retailer (Walmart) who pledged to reduce added sugars by 10% indicate that SSB sales decreased more steeply than expected at three-year follow-up (data NR); (p<0.01).	-	Very low

Abbreviations:
NR: not reported
SSB: sugar-sweetened beverages
TFA: Trans-Fatty Acids

Government Incentives

Key Findings

- There is evidence that local government interventions for low-income families result in increases in fruit and vegetable consumption among adolescents (low certainty, GRADE).
- There is evidence that federal government incentive interventions, with and without restrictions, result in decreases of sugar-sweetened beverage (SSB) consumption and sales slightly (low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of government incentive interventions for both healthy and unhealthy eating across population groups are needed.
- While there were a small number of studies that reported on differential effects among diverse populations, there were too few studies to draw meaningful conclusions. Additional rigorous studies among diverse populations and in diverse settings are needed.

Two systematic reviews reported on the effectiveness of federal and local government incentives to increase healthy eating and/or decrease unhealthy eating for people receiving government nutritional assistance. Government incentives were categorized using the WHO NOURISHING framework. Within this framework, government incentives align with economic tools and purchase incentives. This review includes government assisted economic tools to address food affordability and purchase incentives. These incentives were heterogenous; one review examined the effectiveness of government funding at the regional level to schools made up of students who were predominately socioeconomically disadvantaged (defined as having >50% of the study participants classified as socioeconomically disadvantaged) to increase healthy eating. A second review measured the effectiveness of additional cash transfers (e.g., funds via an electronic benefit card) to low-income individuals participating in the Supplemental Nutritional Assistance Program (SNAP) nutritional program.

Table 15: GRADE Summary of Findings for government incentive interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of non-randomized studies	1	⊕⊕◯◯ Low[1]	• **Local government incentives** result in increases in healthy eating (e.g., fruit and vegetable intake) in low-income adolescents.
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	1	⊕⊕◯◯ Low[1]	• **Federal government incentives** (with or without restrictions) result in decreases in unhealthy eating (e.g., SSB consumption and sales) slightly.

[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence.

One systematic review (Bel-Serrat et al., 2022) reported on the effectiveness of local government incentives on fruit and vegetable intake. Results of the review suggest that local funding incentives for adolescents from low-income households were effective at increasing healthy eating. One study reported results of a school-year-long intervention to provide free fruit and vegetables finding a statistically significant slight increase in consumption among adolescents in the free program compared to those who paid to participate in the program, or those who did not participate (data NR), $p<0.001$.

A second review (Von Philipsborn et al., 2018) investigated the effect of government incentives with and without purchasing restrictions on the consumption of SSBs. Results suggest that government incentives and restrictions are generally effective in reducing measures of unhealthy eating, however the effect sizes were small and may not be sufficient to impact overall health. The strategy was a large federal incentive program with incentive programs piggy-backed to existing government programs (e.g., SNAP program) and delivered via electronic cash transfers with a dedicated benefit card. Participants were given a 30% rebate on fruits and vegetables purchased which could then be used towards SNAP-eligible foods and beverages. The review found that those studies comparing differences between an additional $30 or $60 (USD) compared to no additional incentive reported a reduction (-5 grams/day (95% CI = -8, -2 and 95% CI = -8, -3)). Likewise, a similar study comparing intake with and without incentives showed a similar pattern in results. When there were restrictions without incentives, both intake decreased (-180 mL/day (95% CI = -388, -22)) and sales decreased (-0.4 USD (95% CI = -0.6, -0.3)) at three-month follow-up. When there were incentives, but no restrictions, sales decreased (-0.2 USD/day (95% CI = -0.3, -0.04)). And finally, with incentives and restrictions, both intake (-180 mL (95% CI = -338, -22)) and sales (-0.3 USD/day (95% CI = -0.5, -0.2)) decreased at three-month follow-up.

Both reviews reported results from communities with low socioeconomic status. One review (von Phillipsborn et al., 2019) included participants' experiences with stigma associated with use of the government assistance programs, specifically with use of the Electronic Benefit Transfer (EBT) card, a unique and easily identifiable debit card for those receiving government assistance programs. Respondents (n=2009) reported not feeling stigmatized using the rebate card, likely because the intervention was implemented automatically via electronic cash registers (Olsho et al., 2016). More studies are needed to understand the effect of these interventions on diverse populations in diverse settings.

None of the included reviews reported on the cost-effectiveness of government incentives.

Table 16: Government Incentives

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to government incentives (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Quality of included studies
von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB (e.g., non-diet soft drinks, regular soda, iced tea, sports drinks, energy drinks, fruit punch sweetened water and sweetened tea and coffee).	January 2018 (2006-2017)	Population: General population (hospitals excluded). Interventions: Federally funded cash incentives for buying fruits and vegetables and restrictions for buying sugar-sweetened beverages.	4 studies: • 3 RCTs • 1 controlled pre-post test Total sample size = 27,994	SES	Study participants were those receiving federal food assistance. Additional incentives (e.g., additional funds to purchase program approved healthy foods) with and without restrictions (e.g., benefit money could not be spent on food items not previously approved by the program). Differences between incentive amount and restriction category was measured with statistically significant positive effects reported when financial incentives were compared to no incentives received: Intake of sugar from SSBs with incentives and restrictions on consumption of SSBs: • $60 USD vs. no USD = -5 grams/day (95% CI = -8, -3) • $60 USD vs. $30 USD = 1 gram/day (95% CI = -3, 2) • $30 USD vs. no USD = -5 grams/day (95% CI = -8, -2) Results for intake of sugar from SSBs with incentives, without restrictions: • $60 USD vs. no USD = -0.5 grams/day (95% CI = -2, 1) • $60 USD vs. $30 USD = +1 gram/day (95% CI = -1, 3) • $30 USD vs. no USD = -2 grams/day (95% CI = -4, 1) Results from pre-post testing studies report decreases in SSB intake with some statistically significant effects noted: • with incentives and restrictions: -180 mL/day (95% CI = -338, -22) • with incentives (no restrictions): -108 mL/day (95% CI = -266, 50) • with restrictions (no incentives): -180 mL/day (95% CI = -388, -22)	-	Moderate

						Results from pre-post testing studies report statistically significant decreases in SSB sales: • with incentives and restrictions: -0.3 USD/day (95% CI = -0.5, -0.2) • with incentives (no restrictions): -0.2 USD/day (95% CI = -0.3, -0.04) • with restrictions (no incentives): -0.4 USD/day (95% CI = -0.6, -0.3)		
Bel-Serrat, S., Greene, E., Mullee, A. & Murrin, C.M. (2022). Theoretical and practical approaches for dietary behavior change in urban socioeconomically disadvantaged adolescents: a systematic review. *Nutrition Reviews, 80*(6), 1531-1557.	To assess strategies used in dietary interventions carried out with socioeconomically disadvantaged adolescents living in urban areas.	November 2021 (2003-2021)	Population: Adolescents aged 12-18 years in high income urban areas. Interventions: Regional funding for low-income/low-education level parents to provide fruits and vegetables to their families.	2 cross-sectional studies. Total sample size = 22,954	SES	Adolescents were part of a one-year government program to increase fruit and vegetable intake. Children from low-income households were eligible to participate for free, while children from higher income households could participate for a fee. At the end-of-school-year follow-up, a statistically significant difference was observed; students receiving free fruit and vegetables had greater intake of fruit and vegetable than students in the paid fruit program and those not taking part in the program, p<0.001. Students in the free program whose parents had low educational level(s), reported lower intakes of unhealthy foods (e.g., carbonated beverages, candy, chips) compared to those children from low parent education who were not part of the program (data NR).	-	Low
Abbreviations: RCTS: Randomized control trials NR: Not reported USD: United States dollar SES: Socioeconomic status SSB: Sugar-Sweetened Beverages								

Multi-Component Interventions

Key Findings

- There is evidence that multi-component interventions (e.g., a combination of at least two interventions) result in increases in fruit and vegetable consumption, although magnitude of effect is unknown (low certainty, GRADE).
- There is evidence that multi-component interventions result in a large reduction of sugar-sweetened beverage (SSB), salt, and trans-fat (TFA) consumption (low certainty, GRADE).
- Syntheses evaluating the cost-effectiveness of multi-component interventions for both healthy and unhealthy eating are needed.
- Across reviews, very few studies reported on differential effects among diverse populations, highlighting the urgent need for primary studies to collect and report diversified data.

Six syntheses reported on the effectiveness of multi-component incentive interventions to increase healthy eating and/or reduce unhealthy eating in the general population. Multi-component interventions were heterogeneous and categorized using the WHO NOURISHING Framework. Within this framework, multicomponent interventions align with any combination of food environment policies. Strategies that included an educational component were excluded.

Table 17: GRADE Summary of Findings for Multi-Component Interventions

Outcome	Studies included		Overall certainty in evidence (GRADE)	Comments
	Study design	n		
Healthy eating	Syntheses of non-randomized studies	1	⊕⊕◯◯ Low[1]	• **Multicomponent interventions** result in increases in healthy eating in workplaces.
Unhealthy eating	Syntheses of randomized and/or non-randomized studies	5	⊕⊕◯◯ Low[1]	• **Multicomponent interventions** result in decreases in unhealthy eating (e.g., salt, TFA and SSB) by a large amount.
[1]In the GRADE approach to quality of evidence, **observational studies,** as included in most syntheses, provide **low quality** evidence.				

Only one review (Naicker et al., 2021) reported on the effectiveness of multicomponent interventions to increase healthy food consumption among adults. Multicomponent interventions included increased food pricing and food provision (e.g., fruit and vegetable intake and limits on competition). Interventions were effective in increasing healthy eating in 16/17 (94%) workplaces (data NR).

Five reviews (Flodgren et al., 2020, McLaren et al., 2016, Hyseni et al., 2015, Hyseni, 2017, von Phillipsborn, 2019) reported on the effectiveness of multicomponent interventions to reduce

unhealthy food consumption. Findings were generally consistent across reviews that multi-component dietary interventions were effective in decreasing salt, TFA, and SSB consumption.

Multi-component interventions involving food reformulation, food labelling and/or food provision were effective at reducing salt intake in the general population. Two reviews (McLaren et al., 2016, Hyseni et al., 2015) reported small, yet statistically significant decreases in mean salt consumption (data NR).

National-level interventions to reduce TFA included a combination of food labelling and food reformulation interventions. At 20-year follow-up, TFA levels declined from 4.0 grams per day to 1.5 grams/day (Hyseni et al., 2017).

Community campaigns to reduce SSB included mass media and food provision (e.g., nutritional standards, food competition) interventions. Over a three year follow up, overall sales of SSB decreased by a net equivalent of (-1.6 L/day (95% CI = -2.0, -1.2)) (Von Philipsborn et al., 2018).

Differential impacts due to gender were reported in one review (Hyseni et al., 2017). The impact of a multicomponent intervention was reported to be stronger in men (-4.7 grams/day) than women (-4.0 grams/day; (statistical measures NR)). However, without any contextualization or further analysis, it is unclear as to why these differences exist. No other reviews reported on differential impacts among diverse populations.

None of the included reviews reported on cost or cost-effectiveness of multi-component interventions.

Table 18: Multi-component approaches

Reference	Primary objective of review	Search date (date range of included studies)	Review inclusion criteria	Number of included studies related to multi-component approaches (total, by design) and sample size	PROGRESS -Plus identified populations	Results (increase in healthy eating or decrease in unhealthy eating)	Subgroup analysis	Quality of included studies
McLaren, L., Sumar, N., Barberio, A.M., Trieu, K., Lorenzetti, D.L., Tarasuk, V., . . . & Campbell, N.R. (2016). Population-level interventions in government jurisdictions for dietary sodium reduction. *Cochrane Database of Systematic Reviews, 9*(9), Cd010166.	To assess the impact of population level interventions for dietary sodium reduction in government jurisdictions worldwide.	January 2015 (2006-2015)	Population: General population. Intervention: Food reformulation and food provision.	9 studies; all studies were cross-sectional studies. Total sample size >34,227	NR	A study of national structural policy changes (e.g., food reformation and food provision) resulted in a mean reduction in salt intake (grams/day from pre-intervention to post-intervention: 3 countries using multicomponent interventions showed a statistically significant reduction in unhealthy eating (i.e., mean salt intake/person) ranging from: • Finland: -1.15 grams/day (95% CI = -1.69, -0.61) • France: -0.46 grams/day (95% CO = -0.63, -0.29) • Ireland: -0.35 grams/day (95% CI = -0.52, -0.18) Results from the Netherlands showed no effect (not statistically significant): 0.00 grams/day (95% CI = -0.5, 0.5) A Swiss national initiative showed a statistically significant mean increase of 0.80 grams/day (95% CI = 0.19, 1.41), however the authors note that the pre-intervention data point was several years prior to the initiation of the interventions.	-	Very low

Hyseni, L., Elliot-Green, A., Lloyd-Williams, F., Kypridemos, C., O'Flaherty, M., McGill, R., . . . & Capewell, S. (2017). Systematic review of dietary salt reduction policies: Evidence for an effectiveness hierarchy? *PLOS ONE, 12*(5), e0177535.	To explore the effectiveness of government regulation to reduce salt intake.	October 2015 (1997-2015)	Populations: General population (excluding pregnant women). Intervention: Food labelling, mass media campaigns, food composition.	15 studies: • 11 reviews • 2 pre-post test • 1 cross-sectional • 1 comprehensive Total sample size >55,000	Gendered differences	Multicomponent reviews involving both upstream and downstream interventions, including a combination of food composition, food labelling and mass media campaigns were found to have greater reductions in mean salt intake across the entire population (statistical measures NR): • Japan: from 1960-1970, mean salt intake fell from 13.5 g/day to 12.1g/day overall. From 1972 to 2000, mean salt decreased from 14.5/day to 10.6 g/day (overall -3.9 g/day daily reduction). • Finland: from 1978 to 2007, mean salt intake reduced by approximately 4g/day (see gendered results). • United Kingdom: daily mean salt decreased from 9.5g/day to 8.1g/day (overall -1.4g/day daily reduction).	Reduction in mean salt intake in Finland were greater in men (-4.7 g/day) compared to women (-4.0 g/day)	2/15 (13%) studies were assessed to be good quality. 9/60 (60%) studies were assessed to be fair quality. 4/15 (27%) studies were assessed to be poor quality.
Hyseni, L., Bromley, H., Kypridemos, C., O'Flaherty, M., Lloyd-Williams, F., Guzman-Castillo, M., . . . & Capewell, S. (2017). Systematic review of dietary trans-fat reduction interventions. *Bulletin of the World Health Organization, 95*(12), 821-830G	To review interventions to reduce people's intake of dietary trans-fatty acids.	October 2017 (2006-2017)	Population: General population (excluding pregnant women). Intervention: Food composition, food reformulation, food labelling, food retail.	4 studies: • 2 cross-sectional • 2 (study design NR) Total sample size = 1,656	NR	Multicomponent interventions achieved the greatest reductions in unhealthy eating in trans-fatty acids (TFA) across entire populations: • two Canadian studies on TFA in breastmilk found that food reformulation and food labelling resulted in reductions in TFA intake from 2.0 grams/day in 2009 to 0.7 grams/day in 2011 in one study, and from 4.0 to 2.2 grams/day in the second study. • one study measured TFA in blood samples before and after food labelling and voluntary reformulation on TFA in restaurants. TFA levels decreased 58% over 9 years. • one study included food labelling and voluntary reformation by the food industry. TFA dropped 3 from 4.5 grams/day to 1.5 grams/day over 20 years.	-	Fair quality

von Philipsborn, P., Stratil, J.M., Burns, J., Busert, L.K., Pfadenhauer, L.M., Polus, S., . . . & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews, 6*(6), CD012292.	To assess the effects of environmental interventions (excluding taxation) on the consumption of SSB and sugar sweetened milk and health outcomes, and on any reported unintended consequences of adverse outcomes.	January 2018 (2006-2017)	Population: general population (hospitals excluded). Interventions: Food provision, Mass media.	8 studies Total sample size NR	NR	A multicomponent community intervention to reduce SSB consumption involving food provision and a mass media campaign resulted in statistically significant reductions in consumption of SSBs. Overall SSB sales/product and store decreased by -1.6 L/day (95% CI = -2.0, -1.2) Specific to drink type, sports drinks decreased -0.4L/day (95% CI = -1.5, 0.7) and fruit drinks decreased -1.5L/day (95% CI = -2.0, 0.9).	-	Moderate
Flodgren, G.M., Helleve, A., Lobstein, T., Rutter, H. & Klepp, K.-I. (2020). Primary prevention of overweight and obesity in adolescents: An overview of systematic reviews. *Obesity Reviews, 21*(11), e13102.	To summarize recent evidence on the effects of interventions aimed at preventing overweight and obesity in adolescents.	November 2019 (2008-2019)	Population: Adolescents aged 10-19 from disadvantaged backgrounds. Interventions: Food provision (school), food price.	1 systematic review: • 4 RCTs Total sample size = 897	SES	Multi-component interventions including food provision and food pricing interventions did not change dietary behavior at median 7-month follow-up (values NR).	-	Low

Naicker, A., Shrestha, A., Joshi, C., Willett, W. & Spiegelman, D. (2021). Workplace cafeteria and other multicomponent interventions to promote healthy eating among adults: A systematic review. *Preventive Medicine Reports, 22*, 101333.	To evaluate evidence for the effectiveness of workplace cafeteria and other supporting multicomponent interventions to promote healthy eating and reductions in health risks among adults.	July 2019 (1997-2019)	Population: Adults at least 18 years old. Intervention: Increases in food price, increased food composition and food provision.	17 studies • RCTs (values NR) • pre-post test (values NR) Total sample size = NR	NR	16/17 (94%) studies demonstrated small to moderate effects on the increase of fruit and vegetable intake as a result of multicomponent workplace interventions. Of those that were effective, most studies used interventions targeting food provision. Improvements in fruit and vegetable intake, and improved dietary intake were reported (data NR). 13/17 (76%) of multicomponent studies used cafeteria-based interventions, the remaining 4 used a combination of interventions inside and outside the cafeteria environment.	-	6/17 (11%) studies were assessed to be good quality. 11/17 (89%) studies were assessed as inconclusive.
Abbreviations: NR: Not reported CI: Confidence interval L: Litre RCTs: Randomized control trials SES: Socio economic status SMD: Standard mean difference SSB: Sugar sweetened beverages								

Discussion

This review set out to identify policy interventions that improve healthy eating and/or reduce unhealthy eating as a strategy to reduce cancer incidence in Canada. This review is organized according to the policy domains identified in the World Health Organization's (WHO) NOURISHING framework, with results limited to the food environment domains organized broadly as: food labelling, food provision, food prices, food retail, food promotion, food composition and multi-component interventions. Multi-component interventions were a combination of at least two of the identified policy domains. Interventions involving an education component were not included. Across the domains there is variation in the amount of evidence available; most of the evidence is concentrated in the food labelling, food provision and food pricing domains.

Summary of results

This review found evidence that food environment policies such as food provision in schools, food labelling initiatives and food retail policies are effective in increasing healthy eating and/or decreasing unhealthy eating.

Food provision initiatives in schools were effective in increasing healthy eating and decreasing unhealthy eating, both by varying amounts. For example, direct food provision resulted in small increases in fruit and vegetable consumption and small to moderate decreases in unhealthy eating, such as SSB consumption. Similarly, improved school meal standards were also effective in both increasing healthy eating and decreasing unhealthy eating. Improved standards had a large effect in increasing healthy eating including fruit, vegetable and water consumption, and a small effect on decreasing consumption of energy from fats, saturated fats and SSBs. Limiting food competition in schools was effective in decreasing unhealthy eating, specifically reducing consumption of unhealthy snacks and SSBs, both by a small amount. Notably, this review found that provision of universal school meals increased food security by a large amount.

Food labelling initiative were also successful in both increasing healthy eating and decreasing unhealthy eating. For example, front-of-package labelling resulted in large increases in healthy eating (e.g., selecting a healthier option) and small decreases in unhealthy eating. Nutrition labelling and SSB labelling were both effective at decreasing unhealthy eating, both by moderate-to-large amounts, especially when additional contextual information was provided to the consumer.

Food retail interventions were effective in decreasing unhealthy eating. For example, creating a healthier food retail environment, such as increasing the proximity and decreasing the density placement of unhealthy food items in-store, resulted in decreased unhealthy eating such as unhealthy snack foods and SSBs by a small amount. A promising intervention is offering default healthier beverage choices for children which resulted in a decrease of SSB consumption by a large amount.

Multi-component interventions, many of which involved food labelling and food provision are promising, resulting in large decreases in unhealthy eating.

These findings align with priorities identified by the WHO in both 2014 and 2021 (WHO, 2014a) where they determined the most important nutrition policy priority areas were: school food and nutrition policies (WHO, 2021a), food labelling policies (WHO, 2021b), food marketing policies (including in-store marketing placement) (WHO, 2021c) and food fiscal and pricing policies (WHO, 2021d).

The findings of this review offer an update to a previous review aimed at identifying evidence-informed healthy eating policy actions for local, provincial, and territorial governments (Canadian Partnership Against Cancer, 2019). This current review limited inclusion to syntheses of high methodological quality and used a modified GRADE approach to provide an overall certainty in findings. Findings for food pricing including government incentives, food composition and multi-component reviews were generally in line with previously reported findings.

Contextualizing results

The certainty of evidence included in this review ranges from low to very low, with a majority of the evidence being low certainty. Given the challenges inherent in evaluating policy interventions assessed at the population level, findings are not likely to change as new evidence emerges, thus, the current body of evidence is the strongest evidence to inform policy decisions. Recognizing that policymakers must act on the best available evidence, the WHO Handbook for Guideline Development provides guidance for making recommendations when the quality of evidence is low. In the context of public health recommendations, the WHO balances the certainty of evidence with additional factors (e.g., burden of disease, an intervention's accessibility, feasibility, and acceptability; social context; the extent of current suboptimal practice and the intervention's impact on health inequities). For example, the beneficial effects of food reformulation are low certainty, but the harm of doing nothing favours a very high value being placed on the consideration to avoid harm. This results in strong recommendations in favour of the less harmful comparator (WHO, 2014b). Given this balance of considerations, policymakers can formulate recommendations based on the best available evidence even in instances where the best is of low certainty.

We recognize that nutrition studies are as complex as the individuals who participate in them. As the body of nutrition literature evolves, our understanding of the factors involved in diet and nutrition evolves as well. Researchers are now starting to understand that interpersonal variability (e.g., diversity among people) is high across individuals even when they consume the same standardized foods or meals (Vitolins, 2021), making any conclusions on diet and nutrition broad, at best.

Differential Effects among Diverse Populations

This review highlighted several gaps in the evidence base of the food environment domain. Evidence on differential impacts for diverse populations is very limited. Further, in the few

instances in which data is provided, it is mainly restricted to gender and lacks sufficient context to draw meaningful conclusions. This body of literature also lacks evidence on how to include consumers with differing characteristics into policy solutions. For example, food labelling was identified as an effective strategy to communicate the healthfulness of foods to consumers. However, it is unclear how vision-impaired consumers would be able to access this information. Food subsidies were identified as effective in both increasing healthy eating and decreasing unhealthy eating, however qualifying for subsidy programs is often a complicated process involving forms and providing financial information. Individuals with language barriers, seniors with low-technical skills or those in precarious work may have significant challenges in accessing these subsidies given these barriers. Similarly, our analysis found very little cost-effectiveness evidence. Moving forward research efforts should focus on evaluating the effectiveness of interventions for diverse populations in diverse settings and rigorously evaluating the cost-effectiveness evidence of nutrition policies.

Food Security

Closely related to diet, is food security. Two syntheses in this report identified universal school meals as an effective tool to increase food security among children. The COVID-19 pandemic has exacerbated existing food security challenges across Canada with a reported 14.6% of Canadians experiencing household food insecurity (HFI) in May 2020, an increase from 10.5% from 2018 (Statistics Canada, 2020a). Those challenges are particularly significant for Canadian families as 19.2% of households with children reported food insecurity compared to12.2% of those living with no children (Stats Can, 2020). Those at the greatest risk of (HFI) were working age households (those aged 18-44) with reported HFI ranging from 18%-26%, and vulnerable households; those who had lost their job or had to stop working due to the pandemic (range: 24%-34%), and those with job insecurity (26%) (Idzerda et al., 2022). Feedback from individuals with lived experience being food insecure highlighted the challenge of healthy eating, commenting that the long-term benefits of healthy food choices is secondary to choosing foods that will satiate in the short-term.

Impact of COVID-19

None of the included syntheses reported on the impact of the COVID-19 pandemic on healthy eating and/or unhealthy eating, or diet in general. Emerging Canadian population level-data on the effects of the pandemic reported that Canadians increased their consumption of junk food and sweets by 27% at the beginning of the pandemic. One month follow-up data reveal that this consumption rate continued to increase to 35% (Statistics Canada, 2020b). Notably, these effects were higher for adults living with one or more children. A recent Canadian study found that adults living with a child had a greater odds of consuming junk food and sweets (OR: 1.69 CI = 1.09, 2.60), than those without any children in the household (Andreacchi et al., 2022). Further research will be needed to understand if these effects were limited to the course of the pandemic and if these eating behaviours will have a lasting influence on the diet of the children in the household.

Implication for research and practice

The lack of data on differential impacts, emerging data on food security and the impact of COVID-19 highlight the urgent need for effective policy interventions to mitigate the effects of the COVID-19 pandemic, especially for working age households, families and those already vulnerably employed. Findings from the World Bank COVID-19 crisis response echo this sentiment suggesting that the pandemic has reversed two decades of improved food and nutrition security globally, with children being particularly vulnerable to future negative impacts (World Bank, 2021). Action at numerous levels, from cross-sector supply chains to new targeted policy guidance on how to increase healthy eating and decrease unhealthy eating may be necessary to mitigate continued impacts of the pandemic.

Conclusion

The findings of this review offer an update on potential strategies that could help increase healthy eating and/or decrease unhealthy eating. As the body of evidence on the benefits of healthy eating and the risks of unhealthy eating on cancer incidence is still evolving, it is nevertheless imperative to act on what is already known. Further rigorous research with diverse population data from multiple settings is needed in addition to novel nutrition intervention research to help policy and decision makers understand what interventions result in the most equitable cancer reduction outcomes in both the short and long term.

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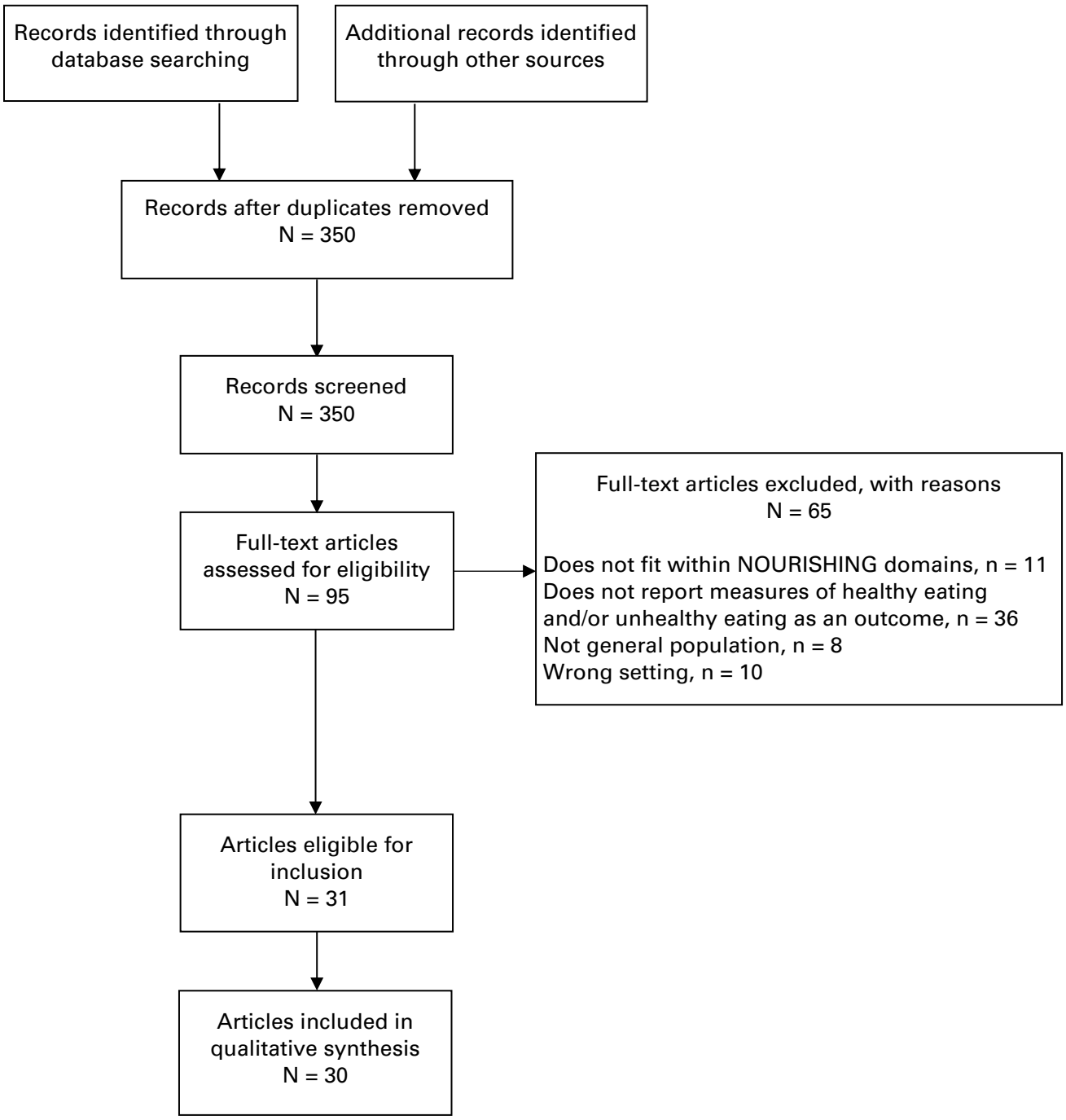
Figure 1: PRISMA 2009 Flow Diagram



Appendix 1: Full search strategy

On May 31, 2022, the following database was searched using the search terms and parameters below.

Database	Search parameters
Health Evidence™	Date = Published from 2012 to 2022 Review Quality Rating = Strong (8 to 10 / 10) Population = Adolescents (13-19 years), Adults (20-59 years), Grade school aged (5-12 years), Seniors (60+ years) Topic Area = Nutrition Setting = City / Regional / Provincial / State / National, Commercial Site, Community, Day Care Centre, Religious institution, School, Worksite