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Differential exposure to, and potential impact of, unhealthy advertising to children by socioeconomic and ethnic groups: A systematic review of the evidence

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ABSTRACT

Background: Children's exposure to advertising of unhealthy food and non-alcoholic beverages that are high in saturated fats, salt, and/or sugar is extensive and increases children's preferences for, and intake of, targeted products. This systematic review examines the differential potential exposure and impact of unhealthy food advertising to children according to socioeconomic position (SEP) and/or ethnicity.

Methods: Nine databases (health, business marketing) and grey literature were searched in November 2019 using terms relating to "food or drink", "advertising" and "socioeconomic position or ethnicity". Studies published since 2007 were included. Article screening and data extraction were conducted by two independent reviewers. Quality of studies were assessed using the Newcastle-Ottawa quality scale.

Results: Of the 25 articles included, 14 focused on exposure to unhealthy food advertising via television, nine via outdoor mediums and two via multiple mediums. Most studies (n=19) revealed a higher potential exposure or a greater potential impact of unhealthy food

advertising among ethnic minority or lower SEP children. Few studies reported no difference (n=3) or mixed findings (n=3).

Conclusions: Children from minority and socioeconomically disadvantaged backgrounds are disproportionately exposed to unhealthy food advertising. Regulations to restrict unhealthy food advertising to children should be implemented to improve children's diets and reduce inequities in dietary intake.

INTRODUCTION

The consumption of an unhealthy diet is a leading risk factor for morbidity and mortality (1) and a key risk factor for weight gain and obesity (2). Children whose families experience greater socioeconomic disadvantage, whether from lower income, education or from living in socioeconomically disadvantaged neighbourhoods, are more likely to be overweight or obese compared to those living with less socioeconomic disadvantage (3). Similarly, risk of excess weight gain across the life course varies according to ethnicity. For example, the rate of weight gain has shown to be significantly greater for Black children in Brazil (4) and in the USA (5) compared with white children. On the other hand, the risk of weight gain has been found to be lower for Asian American children compared to white American children (6).

Children's exposure to advertising of unhealthy foods and non-alcoholic beverages, which are high in saturated fats, salt, and/or sugar, is extensive around the world and has been shown to increase children's preferences for, and intake of, targeted products (7-9). Several studies have reported variations in the exposure of food advertising across socioeconomic and ethnic groups, with some studies reporting higher exposure of unhealthy food advertising to ethnic minorities (10) and more vulnerable socioeconomic groups (11, 12), whilst others reported no difference (13). Estimated differences regarding the influence of unhealthy advertising of food products on food preference, purchase and consumption between socioeconomic and ethnic subgroups is also unclear (14).

Whilst numerous reviews have synthesised the evidence on the extent of unhealthy food and beverage advertising and its impact on children, there has been no systematic review to date examining the differential potential exposure and impact of this type of advertising by socioeconomic position (SEP) or ethnicity. Understanding any such differences will be important for policy making to ensure equity is a core consideration in the prioritisation of policies to improve population nutrition and weight.

Here we aimed to systematically review the literature and synthesise the evidence on the differential potential exposure to, and impact of, unhealthy food and non-alcoholic beverage advertising to children (across all mediums) according to indicators of SEP and/or ethnicity. The focus on children recognises the World Health Assembly 2010 endorsement of a set of recommendations on the marketing of foods and non-alcoholic beverages, specifically to children (15).

METHODS:

This systematic review was reported according to the PRISMA guidelines (16)(Table S1) and the protocol for was registered prospectively with PROSPERO (CRD42018093127).

Search strategy

To identify articles examining differences in exposure to, and potential impact of, advertising of unhealthy food and beverages by SEP and ethnicity or race, we systematically searched nine electronic databases covering a range of relevant topics including health,

business, communications, sociology and psychology from 2007 up until November 2019. Databases included MEDLINE, Business Source Complete, CINAHL, Global Health, SocIndex, Informit Business Collection, Informit Families & Society Collection, Informit Health Collection and Embase. We additionally searched Emerald Insight but scanning of the first 500 results revealed that it was unlikely that any new relevant articles would be picked up (results from this search not included).

Search terms were selected for each of the following overarching search topics 'food & drink' (e.g. food), 'advertising' (e.g. advertis*) and 'socioeconomic position or ethnicity/race' (e.g. income, race), which were combined using the operator 'AND'. Within the broader search topics, more specific search terms were combined with the operator "OR". Twenty-one terms, across these three topics, were included, with adjustments made for each database (see Table S2 for EBSCO Medline specific terms). The three key search topics were also applied to multiple grey literature sources, including government websites, ProQuest and Trove. Whilst we were interested in the exposure and impact of unhealthy food advertising specifically to children, we did not specify the term 'children' in our search strategy. This decision was made to ensure we also captured studies that quantified the extent of unhealthy food advertising in settings that children are exposed to in everyday life (e.g. outdoor billboard advertising). Reference lists of all included articles, and other relevant review articles identified, were additionally scanned for relevant studies. Citations of included articles were screened (forward screening) to identify newly published articles.

Following the search process and removal of duplicates, article titles and abstracts were initially screened by one of two researchers, excluding those that were deemed not to be relevant. The remaining full-texts were screened by both researchers against pre-determined eligibility criteria (see inclusion criteria below). Disagreements over the inclusion or exclusion of a full-text article were resolved by engaging a third author, who also read the article, to reach consensus. The PRISMA flowchart in Figure 1 outlines the complete literature search process and results.

Inclusion criteria

Two authors independently read the full-text of each article deemed potentially relevant based on title and abstract content and assessed it against the inclusion and exclusion criteria. Articles were included if they (i) described studies of primary research, (ii) defined children (<18 years) as their study population or measured the extent of advertising in settings where children are likely to be exposed (e.g. neighbourhood outdoor advertising) (iii) investigated the exposure to, or potential impact of, food or beverage advertising across any medium (e.g. television, outdoor etc.) (iv) focused on unhealthy advertising or distinguished between healthy and unhealthy food advertising (v) included analyses of socioeconomic or ethnic/racial differences, using any indicator, in the potential exposure to, or impact of, food or beverage advertising, and (vi) were published in English since 2007 (to contain the number of identified articles and to capture studies that use relatively recent data, reflecting more contemporary advertising practices). As we were interested in the

exposure and impact of unhealthy food advertising to children, studies involving only adults (>18 years) were excluded.

Data extraction and synthesis

Using a pre-defined data extraction template, we extracted key aspects of each included study. This included author details, title, publication date, study objective, location, time-period, study population (sample size and population demographics), socioeconomic indicators (SEP/ethnicity), methods, advertising medium(s), and key findings. Two authors extracted data for each included study, and a third author was used to reach a consensus if agreement could not be reached.

Studies were grouped into three categories based on whether they evaluated differential potential exposure to, or impact of, food and beverage advertising by (i) SEP, (ii) ethnicity or (iii) both. Within each of these categories, studies were further grouped by advertising medium to allow for differences across the mediums to be elucidated and discussed. Finally, findings were summarised according to three key outcomes:

- 1) potential advertising impact, in terms of influence on children's behaviour and/or weight status;
- 2) absolute unhealthy food advertising exposure (e.g total number of unhealthy food advertisements depicted (n) or advertising space (m²)), and;
- 3) proportional unhealthy food advertising exposures (e.g unhealthy food advertisements as a proportion of all food advertisements (%)).

Quality appraisal

Quality appraisal was conducted for all included articles using the Newcastle-Ottawa scale (17). This tool includes 14 questions to assess the risk of bias for observational studies. Using these questions, each study was scored 0 (lowest methodological quality) to 9 (highest methodological quality) stars across the three domains: selection, comparability and outcome. The scores were then summed across all domains and categorised as good quality (3 or 4 stars in selection domain *and* 1 or 2 stars in comparability domain *and* 2 or 3 stars in outcome domain); fair quality (2 stars in selection domain *and* 1 or 2 stars in comparability domain *and* 2 or 3 stars in outcome domain); poor quality (0 or 1 stars in selection domain *and* 0 or 1 stars in comparability domain *and* 0 or 1 stars in outcome domain).

We did not exclude any studies based on their quality score, rather we reported the overall rating for transparency and to assess the robustness of review conclusions.

RESULTS

Study selection

A total of 37,657 articles were identified through database searching. Following removal of duplicates, 24,117 articles underwent title and abstract screening. Of these, 184 articles were considered eligible for full-text screening. Twenty-five articles met the inclusion

criteria and were included in the review, with four identified from grey literature sources (organizational reports) and/or reference list searching (Figure 1).

Study characteristics

A summary of the 25 included studies examining the differential potential exposure and/or impact of unhealthy food advertising to children according to SEP (n=7), ethnicity (n=11) or both SEP and ethnicity (n=7) is provided in Table 1. Nineteen studies were conducted in the United State of America (USA) (12, 14, 18-34), three were conducted in Australia (13, 35, 36), two were conducted in England (11, 37) and one was conducted in New Zealand (38). With the exception of two cohort studies (18, 19) and one randomized controlled trial (RCT) (25), all studies were cross-sectional study design. All studies included data collected between 2002 and 2016. Of the 25 articles, ten were rated as 'good' quality and 15 were rated as 'fair' or 'poor' quality (see Table 1). Studies receiving a 'fair' or 'poor' quality rating were most commonly downgraded for a combination of not adequately reporting the control of confounders when estimating a relative risk for the exposure-outcome relationship, for using self-reported outcome measurements, or for failing to report the length of follow-up time considered appropriate for outcome measurement for longitudinal studies.

Of the 14 studies that assessed unhealthy food advertising according to SEP, five focused on television advertising, eight on outdoor advertising, and one assessed multiple mediums (e.g billboards and posters, temporary advertising at special events, advertisements on outdoor

furniture, and signs on buildings). Of the 18 studies that assessed unhealthy food advertising according to ethnicity, 12 focused on television advertising, four on outdoor advertising, and two assessed multiple advertising mediums. With respect to studies that examined differential outcomes by SEP, 11 reported on absolute advertising exposure, six on advertising exposure as a proportion of all (or all food) advertising, and two on the potential impact of unhealthy food advertising. Among studies that examined differential outcomes according to ethnicity, 12 reported on absolute advertising exposure, seven on advertising exposure as a proportion of all (or all food) advertising, and three on the potential impact of unhealthy food advertising. Figure 2 summarises the (combined) differences in the potential exposure to, and impact of, unhealthy food and/or beverage advertising across mediums, stratified by SEP and ethnicity.

Differences in absolute exposure to unhealthy food advertising

Seventeen studies (11, 12, 14, 21, 23, 26, 27, 29-38) estimated differences in total exposure to unhealthy food advertising via television (n=8) (11, 12, 14, 23, 29, 32-34), outdoor advertisements (n=8) (21, 26, 30, 31, 35-38), or a mix of multiple mediums (n=1) (27) according to SEP (n=5) (11, 35-38), ethnicity (n=5) (14, 23, 30, 32, 33) or both SEP and ethnicity (n=7) (12, 21, 26, 27, 29, 31, 34). Overall, ten of twelve studies (SEP) and nine of 12 studies (ethnicity) indicated greater potential absolute exposure to unhealthy food advertising for children from lower SEP and for ethnic minority children when compared to indicators representing higher SEP and ethnic majorities.

Differences by SEP

Of the twelve studies (11, 12, 21, 26, 27, 29, 31, 34-38) estimating the difference in total exposure to unhealthy food advertising according to SEP, four focused on television advertising (11, 12, 29, 34), seven on outdoor advertisements (21, 26, 31, 35-38) and one on advertising through multiple mediums (27).

With respect to television advertising (11, 12, 29, 34), all studies found significant negative associations between household income, parent education or parent occupation and total exposure to high sugar and fast food advertisements. In one of these studies from the UK (11), exposure to total food and unhealthy food advertising was 2.1 times greater among the least, compared to most, affluent viewers.

Five of the seven cross-sectional studies assessing outdoor advertising reported significant differences in absolute exposure by SEP in England (37), New Zealand (38) and the USA (21, 26, 31). In England (37), the total number of outdoor advertisements and total outdoor food advertising space devoted to unhealthy foods was significantly greater in less affluent neighbourhoods compared to the most affluent neighbourhoods. Similarly, a study conducted across four New Zealand schools found that the school with the highest social deprivation was surrounded by a greater number of food advertisements classified as unhealthy within 2kms of the school (20 advertisements) compared to the school classified as mid-low deprivation (0 advertisements) (38). The first study conducted in the USA found a significant negative association was found between area-level median household income

and total food and beverage advertisements (OR=1.70, 95% CI 1.11–2.61) and soda advertisements (OR=2.14, 95% CI 1.32–3.47) in supermarkets/grocery stores in the USA (26). The second study conducted in the USA found that low-income neighbourhoods had more ads and greater square-foot of advertisement space compared to high-income neighbourhoods (21). The third US study reported that advertisements for ‘unhealthful’ foods and beverages were more common in stations located in areas characterized by greater poverty, lower levels of educational attainment (31).

Two Australian studies (35, 36) found that the majority of outdoor food and beverage advertising was for unhealthy products, but found no significant differences in total outdoor advertising exposure according to area-level socioeconomic disadvantage. In another study, mixed findings were found, with adolescents whose parents had high-school education or less, reporting that they had seen or heard sugar sweetened beverage advertisements (across any medium) once or more times daily compared to adolescents whose parents were college graduates (OR=2.2, 95% CI 1.04, 4.7), but no differences were reported between adolescents from varying household incomes (27). Further, this study also reported mixed findings for socioeconomic differences in the amount of advertising across other food and beverage categories.

Differences by ethnicity

Of the 12 studies (12, 14, 21, 23, 26, 27, 29-34) examining differences in the total exposure to unhealthy food advertising by ethnicity, seven focused on television advertising (12, 14, 23, 29, 32-34), four on outdoor advertisements (21, 26, 30, 31) and one on advertising through multiple advertising mediums (27). -

With respect to television advertising, consistent findings across all studies indicated that total exposure to unhealthy food advertising was higher among Black compared to White children in the US. One study (23) reported that total food advertisement exposure on TV was 64% higher for pre-schoolers and 49% higher for adolescents who were Black, compared to their White counterparts. The higher absolute exposure to food advertisements among Black youth was evident across all food categories examined (classified as healthy or unhealthy). A similar finding was observed by another study (14) where children and adolescents who were Black were exposed to 70% more food-related television advertisements in total (covering food categories of fast food and other restaurants, candy, soda and sugary drinks, savoury snacks, diet soda and drink mixes, and gum and mints), compared to those who were White. Within food categories, children who were Black were exposed to at least twice the total number of advertisements for candy, gum- snacks and sugary drinks, compared to children who were White. Another US study found that a greater number of advertisements for products considered to be of poor nutritional content were seen by Black compared to White children (albeit a small magnitude of difference) (33) and another reported that total fast-food advertisement exposure was greater for African-American adolescents, given that they watched more

television (32). Consistent ethnic differences in total exposure to unhealthy television advertising were also reported for all three remaining studies when examining specific unhealthy food categories including fast food (12), and high sugar cereals and cereals, snacks, sweets and beverages (29, 34).

The four studies examining total unhealthy food advertising exposure in outdoor settings in the US also consistently reported ethnic differences. Of these, two reported that total unhealthy food advertisements or advertising space was most dense in low-income Latino and/or African-American neighbourhoods compared to White neighbourhoods (21, 31). Another study also reported greater total unhealthy food and beverage advertisements on the exterior property of food retailers in Hispanic neighbourhoods compared to White neighbourhoods, however the association between ethnic community and unhealthy food advertisements was no longer significant after controlling for median household income (26). Another study reported greater advertisement space featuring unhealthy foods in White communities (9266 square feet) compared to African American (6619 square feet) and Latino (8102 square feet) communities (30). Mixed findings were found for differences in self-reported prevalence of soda, fruit drink, sports drink and energy drink advertisements (any mediums) across ethnic groups (non-Hispanic White, non-Hispanic Black, Hispanic and other/multiracial), depending on the food category and ethnic group (27).

Difference in the exposure to unhealthy food advertising as a proportion of total advertising or total food advertising

Twelve studies (11, 13, 20, 23, 24, 28, 30-32, 35-37) examined the difference in exposure to unhealthy food advertising as a proportion of either total advertising or total food advertising, either via television (n= 6) (11, 20, 23, 24, 28, 32), outdoor advertisements (n= 5) (30, 31, 35-37) or multiple mediums (n= 1) (13) and according to SEP (n= 5) (11, 13, 35-37), ethnicity (n=6) (20, 23, 24, 28, 30, 32) or by both SEP and ethnicity (n=1) (31). This included several studies that reported on exposure to both total unhealthy food advertising (reported above) and relative exposure as a proportion of all or all food advertising.

Differences by SEP

Of the five studies (11, 13, 35-37) that estimated proportional differences in unhealthy food advertising according to an indicator of SEP, two were conducted in Australia (35, 36). These studies found that the proportions of outdoor advertisements that were for unhealthy and/or fast foods were significantly higher in low compared to the high SEP neighbourhoods (42% of total food advertisements were for unhealthy foods in low SEP areas vs. 25% in high SEP areas, $p<0.001$ (35) and 48% of total advertisements in the most disadvantaged areas were for fast-food vs. 19% in the least disadvantaged areas, $p=0.003$)(36). Similarly, one study conducted in the USA reported that the proportion of advertisements for “less-healthy” foods and beverages were more common in stations located in residential areas characterised by greater poverty and lower levels of educational attainment (31). On the

other hand, three studies (11, 13, 37) conducted in England and Australia, found no difference in the proportional exposure to unhealthy food advertisements via television, outdoor and multiple mediums (i.e. billboards and posters, temporary advertising of special events, advertisements on outdoor furniture, and signs on buildings) in neighbourhoods considered to be of high and low SEP.

Differences by ethnicity

Of the seven studies that estimated differences in the proportion of advertising that was for unhealthy foods across ethnic groups, five focused on television advertising (20, 23, 24, 28, 32) and two on outdoor advertising (30, 31), with all studies conducted in the USA. Of the studies focussing on television advertising, two reported a greater proportion of unhealthy food advertisements on networks targeting Black and Spanish-speaking children compared to the sample mean and English-speaking channels, respectively (20, 28). In contrast, two studies reported mixed results (23, 24) and one found no differences (32) in the proportion of unhealthy food television advertisements across ethnic groups. In relation to outdoor advertising, both studies identified a greater proportion of advertisements or advertisement space for unhealthy foods and beverages in Black and Latino compared to White neighbourhoods (30, 31).

Differences in the potential impact of unhealthy food advertising by SEP and ethnicity

In total, four studies examined variations in the potential impact of unhealthy food advertising to children according to SEP or ethnicity. This included one study that examined differential impacts according to a measure of SEP (18), two according to ethnicity (22, 25) and one that included both SEP and ethnicity indicators in their analysis (19). Three (18, 19, 25) examined the potential impact of unhealthy food advertising via television and one study (22) assessed multiple advertising mediums, including television, magazines, radio, internet and/or billboards. Overall, findings from these studies were mixed.

Differences by socioeconomic position

Of the two longitudinal observational studies that examined differences in the potential impact of unhealthy advertising on children with varying SEPs (18, 19), one (18) reported no significant effect modification with self-reported household income on the relationship between television food advertisement receptivity and overweight status in the US. The second study (19) reported a significant positive association between both soft drink and fast food advertising (regular carbonated soft drinks, fast food, cereals) and consumption of soft drinks and fast food among elementary school children in the US. Whilst there was no difference in the association between television advertising and soft drink consumption for children from medium or high, compared to low, SEP households, the association between television advertising and fast food consumption was weaker for children from middle and high SEP households, compared to children from low SEP households.

Differences by ethnicity

Three studies (19, 22, 25) assessed differences in the potential impact of unhealthy food advertising on children according to ethnicity. Of these, one cross-sectional study (22) examining the relative difference in the potential impact of unhealthy food advertising via multiple mediums (such as television, magazines, radio, internet or billboards) found that children who were non-Hispanic Black had a 1.72 higher odds (95% CI 1.19, 2.48) of being highly susceptible to advertisements (based on an "Advertisement Susceptibility Index" derived from three survey questions) compared to non-Hispanic Whites. In a randomized controlled trial (25), children ate 45% more snack foods when exposed to cartoons with food advertising promoting snack and breakfast foods of poor nutritional quality, compared to children who were not exposed. Results from this study did not differ between White non-Hispanic, Black non-Hispanic, Hispanic, Asian and other or mixed ethnicity children. In a third study (19), the association between television advertising exposure to regular carbonated soft drinks, fast food and cereals and self-reported soft drink consumption was weaker for Asian adolescents ($p < 0.001$) compared to non-Hispanic White adolescents. The association between television advertising and soft drink consumption did not differ between Hispanic Black or Hispanic and non-Hispanic White children. The positive association between television advertising and fast food consumption was stronger for non-Hispanic Black ($p < 0.001$) and Hispanic ($p < 0.05$) compared to non-Hispanics White children.

DISCUSSION:

This is the first systematic review to synthesise the evidence describing potential socioeconomic and ethnic inequities in the differential exposure to, and impact of, unhealthy advertising to children. We found strong and consistent evidence that children from socioeconomically disadvantaged and ethnic minority backgrounds are disproportionately exposed to advertising of unhealthy food and non-alcoholic beverages. Evidence of the differential impact of unhealthy food and beverage advertising is mixed, albeit from relatively a small evidence base (n=4 studies).

Of particular concern was the finding that ethnic minority children are likely to be disproportionately exposed to a greater proportion of unhealthy food advertising, suggesting targeted advertising practices, often on television networks targeting Black and Spanish-speaking children or Black and Hispanic neighbourhoods in the USA. For children with a low SEP, these differences in unhealthy food advertising as a proportion of total advertising (or total food advertising), were less consistent compared to results reflecting absolute (or total) unhealthy food advertising exposure. However, our results suggest that measuring exposure to food advertising as a proportion of total (or total food) advertising may mask important differences in absolute exposure to unhealthy food marketing. For example, in the study by Adams et al (2011) (11), whilst there was no difference in the proportional exposure of unhealthy food and beverage advertising on television between children from the most and least affluent households, *absolute exposure* to unhealthy food advertising was higher for children from less compared to more affluent households. Similar

findings were found in another study by the same authors examining outdoor advertising in the UK - little difference in the nutritional content of advertised foods was observed between the most and least affluent areas, but total advertising space was greatest in the least affluent areas (37). For television advertising, the higher absolute exposure to unhealthy food advertising align with the relatively consistent findings in the literature that ethnic minority children or children from families with a lower SEP spend a greater amount of time watching television (39-42). For outdoor advertising, a greater total exposure of advertising in lower SEP and ethnic minority neighbourhoods may reflect targeted advertising by corporations, cheaper advertising rates (43) or a higher density of stores and fast food outlets (44, 45). This has important policy implications, which suggest that strategies that aim to reduce total television viewing time and/or reduce the total amount of outdoor advertising may also reduce inequalities in exposure to unhealthy food advertising. However, given the high volumes of unhealthy food advertising that children are exposed to, reported in this review and other studies (46), regulatory action to limit unhealthy food advertising should also be pursued as a priority.

We did not find any studies that examined differential exposure to, or impact of, unhealthy food advertising through digital media platforms. Whilst several studies have monitored advertising of unhealthy products by major food and beverage brands and companies online (47-49), there is very little evidence describing children's exposure to digital marketing of unhealthy food and beverages. This is because the majority of advertising that children are exposed to through digital devices is highly targeted and personalised, yet the process of

collecting this data from children is highly complex and ethically sensitive. With the rise of digital and social media platforms, the World Health Organization has recently identified a critical need for tools to monitor children's exposure to, and engagement with, unhealthy advertising online (50, 51). As these tools are developed, it will be essential that socioeconomic and ethnic differences are rigorously monitored.

For all children, the potential impact of unhealthy food and beverage advertising on their preferences for, and intake of, targeted products is clear (8). Our systematic review importantly adds to this evidence by identifying that unhealthy food and beverage advertising may also contribute to persistent inequities in childhood nutrition and weight. It is plausible that higher volumes of unhealthy food advertising may reinforce social norms related to unhealthy eating and more strongly shape desire and preference for unhealthy foods and beverages over the long term. However, there is very little evidence to suggest higher volumes of unhealthy food advertising leads to greater consumption of unhealthy food and greater weight gain. An Australian study (52) found that online ('advergame') food advertising combined with television advertising resulted in children consuming more snacks after food advertising exposure, compared with children that were exposed to television food advertising only, with no later compensation at lunch. Whether this is related to cumulative food advertisement exposure or the engaging nature of online food advertising is not clear (52).

Global action and governance to reduce children's exposure to unhealthy food and beverage advertising is critical. The moral imperative of governments to ensure that children develop healthily and that mass media do not promote harmful products to children, regardless of SEP or ethnicity, is explicitly articulated in the United Nations Convention on the Rights of the Child (53). In 2010, Member States unanimously endorsed the recommendations of the World Health Organization for protecting children from the marketing of harmful foods and non-alcoholic beverages (15). Whilst several jurisdictions have implemented statutory bans on television advertising of unhealthy food and beverages (54), many of these are limited by insufficient broadcast time periods and loop-holes in regulatory definitions. Globally, government regulation across other forms of advertising mediums has been, at best, underwhelming (54, 55) and industry self-regulation has been largely ineffective (56, 57). Evidence from tobacco control illustrates the need for comprehensive restrictions (58), or advertising will simply shift to other unregulated mediums (59).

The strengths of our review include the comprehensive systematic search of both academic and grey literature, adherence to the PRISMA guidelines and extraction of all relevant data by at least two authors. The generalisability of our review is limited by the limited contexts of included studies (19 of the 25 conducted in the US) and the limited type of advertising mediums (with the majority focussed on television advertising). Further, we limited our review to focus on the equity indicators of socioeconomic position and ethnicity (covering five of the eight PORGRESS+ indicators) to contain the volume of articles retrieved and to

synthesise the evidence on the most commonly addressed equity indicators within National food and obesity strategies (unpublished data), however we may have missed important differences across other indicators, including gender, religion and social capital. Lastly, although we identified five studies that assessed the potential impact of unhealthy food and beverage advertising for children across indicators of ethnicity and SEP, all but one (25) were based on observational data. This limits our ability to draw any causal inference between exposure of unhealthy food and beverage advertising and food intake, and associated differences across socioeconomic and ethnic groups.

Despite limited evidence examining the differential impact of unhealthy food and beverage advertising according to the SEP and ethnicity among children, this systematic review supports leading recommendations for governments to restrict this type of marketing to children. Not only is such action likely to improve population diets and weight over the long-term, but our findings indicate that it may also reduce dietary and weight inequalities. Future monitoring of unhealthy food advertising should measure both relative and absolute exposure, to understand if the higher volume of unhealthy food advertising for lower SEP and ethnic minority groups is a result of targeted industry practices or a result of a greater exposure to all types of advertising. Future research should also focus on the differential exposure of unhealthy marketing on digital media platforms to inform more comprehensive policy actions to regulate and protect children from the promotion of harmful products.

Our review demonstrates that children from ethnic minority and socioeconomically disadvantaged backgrounds are disproportionately exposed to unhealthy food advertising. Regulations that protect children from the harmful exposure of unhealthy food and beverage advertising are likely to improve population diets and reduce inequalities in diet-related morbidity and mortality across the life-course.

Figure 1: PRSIMA flow chart

Figure 2. Differences in the exposure to, and potential impact of, unhealthy food advertising across mediums, stratified by ethnicity and SEP

Table 1: Study characteristics (n=25 studies)

Article/ Country/ Study design	Year/s of data collection	Relevant study question	Setting(s)	Sample size/ Population demographics (age, gender, SEP, ethnicity)	Indicators of SEP/ ethnicity	Data collection methodologies	Advertising medium (s)	Food and/or beverage classification method	Key results (by SEP/ethnicity)	Risk of Bias
Adachi-Mejia et al (2011), USA, Cohort study (18)	2002-2005	To determine if adolescent receptivity to food advertisements is a predictor of adolescent overweight	Public school	2,281 adolescent-parent pairs; Sex: 50.3% male, Age: 70% 11 or 12 years old, 34% household income >\$40,000 per year, 31% parents have high school diploma or less	SEP: Parent reported annual household income	Written survey, parent phone interview, child phone interview	TV	Less healthy products classified as energy dense and/or nutrient poor foods, including: sugar-sweetened beverages, alcoholic beverages, coffee, candy, sweet snacks or desserts, fast food restaurants, high sugar cereals/ breakfast foods, processed meats, and chips and crackers	Impact: No effect modification of household income on the relationship between receptivity to food TV advertisements and adolescent overweight.	Good
Adams et al (2011), UK, Cross sectional (11)	One week in July 2009	To quantify socioeconomic differences in exposure to TV advertising and the type and nutritional content of advertised foods	TV broadcastin g region in North East England	n=607,867 advertisements, n=496 panel of viewers, n= 11903 participants for channels broadcast nationally on terrestrial television and n=11192 on other platforms; Age: aged 4 years and older SEP: 4 social grades	SEP: Based on occupation of the chief income earner in the household in which viewers lived	Broadcast data derived from an TV viewing research panel	TV	Unhealthy foods defined as being high in fat, salt and/or sugar using the UK Food Standards Agency's Nutrient Profiling Model. Energy density (including % from protein, carbs, sugars, fats, saturated fat), sodium density, and fibre density.	Relative exposure: The proportion of all advertising for food was slightly lower among least affluent viewers compared to most affluent viewers (OR=0.98, 99% CI 0.95, 1.00). No difference in the proportion of unhealthy food advertisements between the most and least affluent viewers. Absolute exposure: Total exposure to all food and unhealthy food advertising was 2.1 times greater among the least compared to most affluent viewers.	Poor

Adams et al (2011), England, Cross sectional (37)	October-December 2009	To explore differences in the prevalence of outdoor food advertising, and type and nutritional content of advertised foods, according to SEP	Outdoors, in city boundaries of study area	1371 advertisements	SEP: Area-based indicator of deprivation	Observational	Outdoor	Unhealthy foods defined as being high in fat, salt and/or sugar using the UK Food Standards Agency's Nutrient Profiling Model. Energy density (including % from protein, carbs, sugars, fats, saturated fat), sodium density, and fibre density.	Relative exposure: The proportion of (all) advertisement space devoted to unhealthy foods was significantly higher in middle vs least affluent tertiles (but absolute unhealthy advertisement space was greatest in least affluent areas). Absolute exposure: Total (all) advertising and total food advertising space was significantly higher in the least affluent, compared with the middle and most affluent, tertiles.	Poor
Andreyeva et al (2011), USA, Longitudinal (19)	Advertising data in 2002, 2003 and 2004; Consumption and weight data in 2002 and 2004	To examine how the association between children's exposure to TV advertising and consumption of fast food and soft drinks differs by ethnicity and SEP	Schools	9,760 children; 57% non-Hispanic White, 51% male, Mean age: 11 years old, SES: 20% low SEP, 20% high SEP	Ethnicity: self-identified by parents SEP: self-reported occupation, education, income of parents	Children's exposure to food advertising from Nielsen media data on annual gross rating points for spot marketing and advertising to children aged 6-11 years (matched to food consumption data from the ECLS-K longitudinal study of kindergarteners)	TV	Unhealthy food categories included ready-to-eat cereal, regular carbonated soft drinks, dietary carbonated soft drinks, and quick service restaurants – chosen as these categories were identified as important contributors to children's diet and also most often marketed to children.	Impact: Association between TV advertising (regular carbonated soft drinks, fast food, cereals) and soft drink consumption: Less for Asian ($p<0.001$) compared to White non-Hispanic. No difference between Black non-Hispanic, Hispanic or 'Other' and White non-Hispanic. No difference between medium or high SEP compared to low SEP households. Impact: Association between TV advertising (regular carbonated soft drinks, fast food, cereals) and fast food consumption: Greater for Black non-Hispanic ($p<0.001$) and Hispanic ($p<0.05$) compared to White Non-Hispanic households. Weaker for middle and high SEP compared to low SEP households.	Good
Bell et al (2009), USA, Cross sectional (20)	2005-2006	To describe food advertised on networks serving youth and children and to	TV stations	216 hours recorded TV; 1,130 food commercials, 10 English-language TV channels, 2 Spanish-language TV channels	Ethnicity: Based on English- or Spanish-language TV networks	Observational from TV recordings	TV	Unhealthy food categories including: alcohol; cereals; chips/crackers; ready-meal convenience food; dairy;	Relative exposure: Fast food advertisements were more common on Spanish-language TV (46.7% of all food advertisements) compared to the entire sample (28.4%).	Poor

		compare advertisements on English- and Spanish-language networks		airing during high children viewing times (weekday afternoons (3-6pm) or Saturday morning (7-10am))				fast-food restaurants; fats; fruits/vegetables/100% juices; grains; nutritional supplements; proteins; sugar-added drinks/sodas; sweets; and other	Advertisements on a network aimed at Black youth were significantly more likely to be for fats and oils (4.8% of all food advertisements compared to 1.5% in the entire sample); fruit, juices and vegetables (4.8% vs 1.7% for entire sample) and SSBs (13.1% compared to 6.5% for entire sample). No difference in the proportion of food advertisements for fast food on the network targeting Black youth compared to the entire sample.	
Cassady (2015), USA, Cross sectional (21)	2015	To investigate whether there are disparities in the distribution of unhealthy product advertisements by neighbourhood income and ethnicity	16 zip codes, categorised by income and ethnicity	171 health related outdoor advertisements; zip codes: 8 high income White, 1 high income White/Asian, 3 low income White, 4 low income Latino/African American, 9 high income, 7 low income, 11 White, 5 multiracial	SEP: Zip codes selected from income strata above and below the median Californian household income of \$61,400 Ethnicity: Majority ethnic group within each zip code	Observational	Outdoor	Healthy foods were those aligned with the Dietary Guidelines for American. Unhealthy were high-calorie, low-nutrition foods and beverages such as sugary beverages and fast food.	Absolute exposure: Low-income Latino and African-American neighbourhoods had more absolute food and beverage advertising compared to low- and high-income White neighbourhoods. Unhealthy food advertisement space was most dense in low-income Latino and African-American neighbourhoods. Low-income neighbourhoods had more unhealthy ads and greater square-foot of unhealthy ad space compared to high-income neighbourhoods.	Poor
Cervi (2017), USA, Cross sectional (22)	2014	To investigate how susceptibility to advertisements affects consumption of SSBs and whether this relationship differs between non-Hispanic White and non-	Data from the Family Life, Activity, Sun, Health, and Eating (FLASHE) study	765 non-Hispanic Black and non-Hispanic White; 51% female, 51% aged between 14 and 15 years, 80% non-Hispanic White, 20% non-Hispanic Blacks	Ethnicity: Self-identified as White non-Hispanic, Black non-Hispanic, Hispanic, Asian and other or mixed ethnicity	Survey with advertising susceptibility based on an "Advertisement Susceptibility Index" derived from three survey questions	TV, magazine, radio, internet or billboards	Focused on sugar sweetened beverages, which included sodas; sweetened fruit drinks, energy drinks; and sports drinks.	Impact: High advertisement susceptibility was associated with daily SSB consumption (OR 1.73 95% CI 1.21, 2.47). Non-Hispanic Blacks had 1.72 higher odds of being highly susceptible to advertisements (95% CI 1.19, 2.48) compared to non-Hispanic Whites.	Good

		Hispanic Black adolescents								
Dalton et al (2017), USA, Cross sectional (12)	April 2013 - March 2014	To determine whether exposure to child-targeted fast food TV advertising is associated with young children's fast food intake	Paediatric and Women, Infants, and Children (WIC) clinics	548 parents (Women) visiting Paediatric and Women, Infants, and Children (WIC) clinics; Mean age: 4.4 years, 51% female, 59% Latino, 52% had a household income of US\$50,000 or less, 48% of parents had "high school or less" education. In Manchester and Nashua, 82% and 79% were non-Hispanic Whites with median household incomes of US\$54,320 and US\$65,671 respectively	Ethnicity: Self-identified as White, non-Hispanic White SEP: parent education and household income	Self-reported survey	TV	Three fast-food chains that were reported by Kantar Media as advertising on children's television; McDonald's, Subway and Wendy's.	Absolute exposure: Exposure to McDonalds, Subway and Wendy's advertisements was significantly negatively associated with income and parent education and positively associated with non-White ethnicity (differences in the association between fast food advertisement exposure and food intake by race or SEP were not examined).	Fair
Fleming-Milici et al (2013), USA, Cross sectional (24)	2010	To quantify the amount of food and beverage advertising viewed by Hispanic youth on Spanish- and English-language television and compare it with the amount of food and beverage advertising viewed by non-	Homes	Sample size not reported; Hispanic and non-Hispanic pre-schoolers (2-5 years), children (6-11 years), and adolescents (12-17 years)	Ethnicity: self-identified race of the designated head-of-household	Nielsen panel data (Ad*Views database, gross rating points collected to measure the number of advertisements viewed over time)	TV	All products were assigned to food categories most heavily marketed to youth as defined in guidelines proposed by the Interagency Working Group on Food Marketed to Children. Categories were; fast food restaurants; breakfast cereals; other restaurants; candy; prepared food and meals; snack food; dairy products; fruit juice and noncarbonated beverages; carbonated regular	Relative exposure: Hispanic children exposed to a significantly higher proportion of advertisements for breakfast cereals (18% of all food advertisements) compared to non-Hispanic children (16%). Hispanic pre-schoolers exposed to a significantly lower proportion of advertisements of pre-prepared foods and meals (7% of all food advertisements) compared to non-Hispanic pre-schoolers (8%). No differences between Hispanic and non-Hispanic Youth for all other (n=13) food categories.	Fair

		Hispanic youth						beverages; baked goods; energy and sports drinks; fruits and vegetables; frozen and chilled desserts; carbonated diet beverages; all others		
Fleming-Milici (2018), USA, Cross sectional (23)	2008-2012	To measuring TV viewing times and TV food and beverage advertisements viewed by children – comparing exposure by network type (Black-targeted, child-targeted and youth-targeted)	Homes	Sample size not reported (representative sample, as determined by Nielsen); Age group: pre-schoolers (2–5 years), children (6–11 years) and adolescents (12–17 years)), ethnicity: Black and White youth	Ethnicity: self-identified race of the designated head-of-household	Nielsen panel data (Ad*Views database, gross rating points collected to measure the number of advertisements viewed over time)	TV	Food categories of fast food restaurants; breakfast cereals; other restaurants; candy; prepared food and meals; snack food; dairy products; fruit juice and noncarbonated beverages; carbonated regular beverages; baked goods; energy and sports drinks; fruits and vegetables; frozen and chilled desserts; carbonated diet beverages; all others	<p>Absolute exposure: Black pre-schoolers and adolescents saw 64% more food advertisements and Black children saw 49% more ads compared to White counterparts (with breakfast cereals, candy, fast-food and other restaurant ads accounting for almost 60% of all food ads viewed for all youth).</p> <p>Youth-targeted networks contributed the most to food advertisements viewed by Black and White adolescents.</p> <p>Relative exposure: Although Black youth viewed more advertisements than White youth for all food and beverage categories, the proportion of food advertisements viewed differed significantly for only two categories: candy represented a significantly higher proportion of advertisements viewed by Black children compared to White children. Whilst breakfast cereals represented a significantly lower proportion.</p>	Fair
Harris et al (2015), USA, Cross sectional (14)	2012-2014	To identify targeted marketing for food and beverage products	Homes	267 brands (representative sample, as determined by Nielsen)	Ethnicity: Determined by Nielsen, using specific ethnic TV channels	Observational	TV	Foods sold by major food companies including McDonald's USA; Yum! Brands; Doctor's Associates; Wendy's; 3G Capital; Roark Capital Group; dineEquity; Sonic; Darden Restaurants; General Mills, Inc; Pepsi Co, Inc; Kraft Foods; Kellogg	<p>Absolute exposure: Advertising of brands in six categories (fast food and other restaurants, candy, soda and sugary drinks, savory snacks, diet soda and drink mixes, and gum and mints) was significantly more likely to be targeted to Hispanic and/or Black consumers compared to White consumers, while four categories (including generally healthier dairy, juice and water, and fruit and vegetable brands) were</p>	Poor

								Company; The Hershey Company; Mars, Inc; Nestle USA; Campbell Soup Company; Coca-Cola Company; Dr Pepper Snapple Group; Tyson Foods; Mondelez Global, LLC; ConAgra Foods, Inc; Unilever United States; Post Foods, LLC; The Dannon Company; Ferrero USA, Inc	significantly less likely to be targeted to Hispanic and/or Black consumers. Black children and teens viewed 70% more food-related TV advertisements in total compared to White children and teens. This included 2.2 times more advertisements for candy and gum and 90% more advertisements for snacks and sugary drinks compared with White children.	
Harris (2009), USA, Randomised control trials (25)	2009	To test the hypothesis that exposure to food advertising during television viewing may contribute to obesity by triggering automatic snacking of available food	Schools	118 students; Median age: 8.8 years, 62% were normal weight. Trial 1a: participants were 95% white, trial 1b: participants were 61% white	Ethnicity: Self-identified as White non-Hispanic, Black non-Hispanic, Hispanic, Asian and other or mixed ethnicity	Randomised control trials, weighing the amount of food consumed after either (a) exposure to cartoons with food advertising or (b) exposure to cartoons without food advertising	TV	Snack and breakfast foods considered to be of poor nutritional quality and shown to be the most commonly shown on children's TV including: (a high-sugar cereal, waffle sticks with syrup, fruit roll-ups, and potato chips).	Impact: Children who were exposed to the cartoon with food advertising (promoting snack and breakfast foods of poor nutritional quality) ate considerably more (45% more) goldfish crackers while watching compared to children who were not exposed, with no difference between White non-Hispanic and ethnic minority children.	Good

Isgor (2016), USA, Cross sectional (26)	2010-2012	To examine the prevalence of outdoor food and beverage advertisements on the exterior and property of food retailers in relation to community demographic and socioeconomic characteristics	Food retailers within school enrolment zones	8021 stores; 69% of stores located in non-Hispanic White neighbourhoods, average median household income was approximately \$57,500	<p>Ethnicity: Majority of non-Hispanic Black, Hispanic, non-Hispanic other</p> <p>SEP: Median household income of the community in which the store was located</p>	Observational	Outdoor	Food advertisements for all foods and beverages, food and beverage price promotions, fruits and vegetables, and regular (non-diet) soda	<p>Absolute exposure: Significant association between community median household income and prevalence of food and beverage advertisements: Higher prevalence of any food and beverage advertisement (OR=1.70, 95% CI 1.11, 2.61), food and beverage price promotion advertisements (OR=1.92, 95%CI 1.22, 3.01), and regular soda advertisements (OR=2.14, 95% CI 1.32, 3.47) in low-income compared to high-income community supermarkets/ grocery stores.</p> <p>No independent ethnic association with exterior food retail marketing. After controlling for median household income, the association between community ethnicity and food advertisements was no longer significant.</p>	Good
Kelly et al (2008), Australia, Cross sectional (13)	2007	To describe the volume and nature of outdoor food advertisements and factors associated with outdoor food advertising in the area surrounding primary schools	The area within a 500m radius of each school	9,151 advertisements	SEP: Area-based marker of deprivation	Observational	Outdoor - Billboards, posters, outdoor furniture, signs on buildings	Coded into three major groups to align with The Australian Guide to Healthy Eating; core foods (consumption recommended to meet daily requirements); non-core foods (foods that are surplus to daily requirements), and; miscellaneous drinks (tea and coffee)	Relative exposure: No difference in the proportion of all food advertisements that are for non-core products between areas considered to be of high and low SEP.	Fair
Kumar (2015), USA, Cross sectional (27)	2012	To examine the prevalence of overall self-reported exposure to soda, fruit drink, sports drink and energy drink advertisements	Homes	847 (n=726 soda) adolescents; 51% male, 55% non-Hispanic White, 40% with a college graduate parent, 32% family income \$35,000-\$74999	Ethnicity: Self-identified as non-Hispanic White, non-Hispanic Black, Hispanic and other/multiracial	Questionnaire	All mediums that are seen/heard	Four categories: sugar sweetened beverages, soda, fruit drinks, sports drinks, and energy drinks	<p>Absolute exposure: Adolescents whose parents had high-school education or less were more likely to report seeing/hearing SSB advertisements one or more times daily compared to adolescents whose parents were college graduates (OR=2.2, 95% CI 1.04, 4.7).</p> <p>No significant associations between household income or ethnicity and self-reported SSB</p>	Good

		and sociodemographic associations			SEP: Parents education, family income				advertising exposure. However, mixed findings were observed across other food and beverage categories.	
Kunkel (2013), USA, Cross sectional (28)	2009	To evaluate compliance with a food marketing industry self- regulatory program	Homes	171 food advertisements	Ethnicity: Spanish-or English- language TV channels	Observational	TV	Categories included; sugared snacks; salted snacks; sugared beverages; sugared cereals; pastries/waffles; pasta; fast food/restaurants; dairy; fruits/vegetables/100% fruit juice, and; pre-packaged lunches. Applicable products were considered “sugared snacks” or “sugared cereals” if sugar was one of the first three ingredients listed. Drinks were considered “sugared beverages” if they included added sugar. Products were also categorised according to the U.S. Department of Health and Human Services food rating system (Go, Slow, Whoa). Go foods are products rich in nutrients and relatively low in calories. Slow foods are higher in fat, added sugar, and calories than Go foods, and should be consumed sometimes. Whoa foods are high in calories and low in nutrients. They are highest in fat and added sugar and should be	Relative exposure: A lower rate of advertising for food and beverage products on Spanish- language channels compared to English- language channels but 84.2% of all foods and beverages advertised during Spanish-language children's shows were classified in the poorest nutritional category, compared with only 72.5% on English-language channels.	Poor

								consumed on special occasions.		
Longacre, (2017), USA, Cross sectional (29)	2013	To examine differential exposure to high-sugar breakfast cereal advertisements on 11 different children's TV channels	Women, Infants, and Children (WIC) clinics	548 parents of 3-5-year-old children; 52.7% of children lived in a household with an annual income of \$50,000 or less, mean age was 4.4 years, 51.6% female, 72.5% were non-Hispanic White, 48% had parents that had completed "high school or less" education	Ethnicity: Parent-reported child ethnicity (non-Hispanic White and Other) SEP: Household income and parental education	Parent-reported TV viewing channel and time for children	TV	Ten sugared-breakfast-cereals that were top-ranked for advertising targeted at children according to the Rudd Center for Food Policy and Obesity. Sugar content ranged from 9g to 13g per ounce of cereal.	Absolute exposure: Pre-school aged children's high sugar cereal advertisement exposure was positively associated with non-White race ($p<0.001$) and inversely associated with household income ($p=0.021$) and parent education ($p<0.001$).	Good
Lowery et al (2014), USA, Cross sectional (30)	2012	To examine associations between the content of outdoor advertising and neighbourhood ethnic and socioeconomic composition	Neighbourhoods/zoned communities	7 regions; One African American neighbourhood, one Asian American neighbourhood, one White neighbourhood, one Latino American, one Latino American Youths neighbourhood, one Latino American Poverty Risk neighbourhood, and one Latino American neighbourhood with Multiple Risks	Ethnicity: 2010 Census data on neighbourhood ethnicity	Observational	Outdoor	Categorised by applying an analytical construct derived from previous research regarding risk associated with specific types of harmful advertising content, as well as a focus on at-risk and sensitive populations such as children, women, individuals prone to addiction and substance abuse, and those inclined toward violent or antisocial behaviour.	Relative exposure Within 1000 feet of each community, the proportion of advertisement space featuring unhealthy food options was highest in the African American and Latino communities compared to the White community. Absolute exposure: The absolute unhealthy food advertisement space was greatest for the White community - 6619 square feet of advertisements (18.6%) for the African American community; 8102 square feet of advertisements (11.7%) for Latino community and 9266 square feet of advertisements (9.0%) for White community.	Poor

Lucan (2017), USA, Cross sectional (31)	2012	To determine how placement of advertisements for foods and beverages related to subway ridership and to the demographics, dietary intake, and prevalence's of diet-related conditions	Subway stations	1586 print advertisements; Median subway station demographics were 66% Hispanic, 35% poverty, 40% not graduating high school	<p>Ethnicity: Area surrounding the stations based on racial/ethnic composition</p> <p>SEP: Area surrounding the stations based on a range of indicators including poverty rates, and high-school graduation rates</p>	Observational	Outdoor	Categorised as “more-healthy” items (fruits, vegetables, whole grains, nuts) and “less-healthy” items (prepared fast foods and pre-packaged processed items) according to the Dietary Guidelines for Americans. Beverages were categorised as “more-healthy” items (water and milk) and “less-healthy” items (alcohol and sugar-added drinks). Diet drinks and juices were neither “more-healthy” nor “less-healthy”.	<p>Absolute exposure: Advertisements for foods and beverages were more common in stations located in areas characterized by greater poverty, lower levels of educational attainment, and greater percentages of Hispanic residents.</p> <p>Absolute and relative exposure: The number and proportion of advertisements for “less-healthy” foods and beverage, specifically those in Spanish language, were more common in stations located in residential areas characterised by greater poverty, lower levels of educational attainment and greater percentages of Hispanic residents.</p>	Poor
Powell et al (2014), USA, Cross sectional (34)	2003-2007	To understand the patterns of geographically-based food and beverage product TV advertisements seen by children and adolescents according to ethnicity and SEP	Homes	The 87 largest Nielsen full-disclosure Designated Market Areas (DMAs); Median income: \$50,000, Ethnicity: 58% White, 16% Black, 20% Hispanics	<p>Ethnicity: Calculated using 1990–2011 Bridged-Race Population Estimates produced by the U.S. Census Bureau</p>	Observational	TV	Categorized into; cereal; sweets; snacks; Beverages; other food products; fast-food restaurants; and full-service restaurants. Examined subcategories of beverages were sugar-sweetened versus non-sugar sweetened beverages, and regular versus diet soda. The sugar-sweetened beverage category included soda, fruit drinks, bottled water with added sugar, isotonic drinks (sports drinks), and other sugar-sweetened drinks.	<p>Absolute exposure: Designated Market Areas (DMAs) with higher proportions of Black populations were associated with greater exposure to television advertisements in all food categories (total foods and beverages; cereal; beverages; sweets, snacks, other, fast food restaurants), except full-service restaurant advertisements.</p> <p>No association between children's or adolescents' exposure to food and beverage TV advertisements and the percentage of Hispanic youth for any of food/beverage category.</p> <p>Higher DMA-level median household income was associated with lower exposure to advertisements for cereals, snacks, sweets and beverages, for both children and adolescents.</p> <p>Children's exposure to SSB advertisements (but</p>	Good

									not non-SSB) advertisements was higher in DMAs with higher proportions of Black children in the population and lower in higher-income DMAs.	
Powell et al (2007), USA, Cross sectional (33)	2003-2004	To examine the nutritional content of food advertising seen by American children and adolescents	TV channels	451 advertisements marketed at those aged 2-11 years; 613 advertisements marketed those aged 12-17 years	Ethnicity: self-identified ethnicity of the designated head-of-household	Observational	TV	The energy, fat, saturated fat, sugar, fibre and sodium contents, and percentage of energy from fat, saturated fat, and sugar for advertised foods were determined. Foods were classified as high in fat and saturated fat by using the standards devised by the US Department of Agriculture. Cut-points for sugar, sodium, and fibre were derived from the recommendations contained in the dietary reference intakes report from the National Academy of Sciences.	<p>Absolute exposure: For children aged 2 to 11 years, small differences in the nutritional content of food advertisement exposure was observed, with a poorer nutritional profile of advertisements for Black compared to White children.</p> <p>For children aged 12 to 17, slightly larger differences in nutritional content across ethnicity, with a higher exposure to advertisements with a poorer nutritional profile among Black compared to White children.</p> <p>Across all food products, the proportion of advertisements viewed that were high in sugar, fat or sodium was higher for Black compared to White adolescents, though differences were small (88.8% vs 91.1%).</p>	Good
Powell et al (2007), USA, Cross sectional (32)	2003-2004	To examine the distribution of TV food advertising exposure among adolescents according to ethnicity across seven broad food categories	Homes	267,189 and 253,885 30-second advertisements on the top-rated shows for White and African American adolescents, respectively; White and African American adolescents aged 12-17 years	Ethnicity: White or African American	Observational	TV	Broadly classified into; food products; non-fast food restaurants, and; fast-food restaurants. Further categorised into; fast-food restaurants; cereals; candy; regular soft-drinks; candy bars; non-fast food restaurants; chewing gums; fruits drinks; snacks; isotonic drinks; yoghurt; potato chips; milk; cookies; frozen waffles; tortilla chips; frozen entrees; snack bar; crackers; prepared entrees;	<p>Absolute exposure: Advertising exposure to food products was 14% (3.4 %-points) higher for African-American adolescents compared to White adolescents.</p> <p>Total fast-food advertisement exposure was greater for African-American adolescents due to greater total TV watching</p> <p>Relative exposure: The proportion of all food advertising for fast-food was similar for African-American (21.5% of all food advertising) and White (23.6% of all food advertising) adolescents.</p>	Poor

								fruit juices; pastry; condensed; soup; drink mix, and; pasta dinners.		
Sainsbury (2017), Australia, Cross sectional (35)	2016	To determine the level of public exposure to unhealthy food and beverage advertising on train stations, and if the amount and type of food and beverage advertising varies by SEP	Train stations	178 stations; 6,931 advertisements, 36% low SEP	SEP: Area-based marker of deprivation	Observational	Outdoor	Categorised as; core (bottled water; soups, salads and sandwiches; breads; vegetables and vegetable products, and; low-fat milk, yoghurt, custard and cheese); discretionary (snack foods; sugar-sweetened drinks; intense-sweetened beverages; alcohol; high fat savoury biscuits; fast food restaurants; ice cream and iced confection; HFSS spreads, oils and sauces; fruit juice and fruit drinks, and; full cream milk, yoghurt, custard, dairy desserts and cheese), and; miscellaneous	<p>Absolute exposure: No difference in the mean number of unhealthy food and beverage advertisements by area.</p> <p>Relative exposure: Proportion of advertising for discretionary foods highest in low (41.9%) compared to medium (18.4%) and high (25.2%) SEP areas (p < 0.001).</p>	Good

								(tea and coffee; supermarkets; nutritional supplements, and; brand-only advertisements).		
Settle (2014), Australia, Cross sectional (36)	2013	To examine the prevalence of outdoor food advertising at tram, bus and train public transit stops across the least and most socioeconomically disadvantaged areas	Public transport stops	233 food advertisements at 558 public transit stops audited across 20 sampled suburbs; 10 suburbs of least disadvantage, 10 of most disadvantage	SEP: Area-based marker of deprivation	Observational	Outdoor	Classified into; cold beverages; hot beverages; snack foods; fast food; breakfast cereal; fruits and vegetables; dairy; other food products, and; food stores. Food categories were further sub-divided, though results were only presented within the cold beverages category; regular soft drink; diet soft drink; energy drink; sports drink; flavoured milk; fruit juice; iced tea; water, and; alcohol.	<p>Absolute exposure: Total number of advertisements did not significantly differ between the least- and most-disadvantaged areas.</p> <p>Advertisements for fast food restaurants, flavoured milk (8% vs. 25%, $p=0.028$) and fruit juice (2% vs. 20%, $p=0.004$) were more common in the most-disadvantaged areas. Similar numbers of advertisements for snack foods were found in the least disadvantaged (17%) and most-disadvantaged (16%) suburbs.</p> <p>Relative exposure: Advertisements for diet soft drinks (as a proportion of all advertised beverages) were significantly more frequent in least-disadvantaged areas compared to the most-disadvantaged areas (57% of all beverage advertisements vs. 25%, $p=0.002$).</p>	Fair
Walton et al (2009), New Zealand, Mixed methods (38)	2008	To document the community food environment surrounding primary schools	Neighbourhoods surrounding primary schools	4 schools, 792 students; 35% highest deprivation groups, 35% Maori ethnicity	SEP: Decile of deprivation calculated by Department of Education	Observational	Outdoor	Categorised, based on energy, fat and sodium levels, according to the Food and Beverage Classification System for Schools, into; 'everyday'; 'sometimes', or; 'occasional'.	<p>Absolute exposure: The school with the highest social deprivation characteristics had a greater number of food advertisements classified unhealthy (foods for 'occasional consumption') within a 2km buffer zone of the school (20 advertisements) compared to the school classified as mid-low deprivation (0 advertisements).</p>	Poor

TV: Television; SEP: Socioeconomic Position; SSBs: Sugar sweetened beverages; DMA: Designated market area

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