



Contemporary Approaches for Monitoring Food Marketing to Children to Progress Policy Actions

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Abstract

Purpose of Review Protecting children from unhealthful food marketing is a global priority policy for improving population diets. Monitoring the nature and extent of children's exposure to this marketing is critical in policy development and implementation. This review summarises contemporary approaches to monitor the nature and extent of food marketing to support policy reform.

Recent Findings Monitoring approaches vary depending on the stage of progress of related policy implementation, with resource implications and opportunity costs. Considerations include priority media/settings, marketing techniques assessed, approach to classifying foods, study design and if exposure assessments are based on media content analyses or are estimated or observed based on children's media use.

Summary Current evidence is largely limited to high-income countries and focuses on content analyses of TV advertising. Ongoing efforts are needed to support monitoring in low-resource settings and to progress monitoring to better capture children's actual exposures across media and settings.

Keywords Marketing · Food · Beverage · Monitoring · Policy · Child

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Introduction

Obesity and dietary risks are among the leading causes of worldwide mortality [1]. In children aged 5–19 years, the global prevalence of obesity increased by almost tenfold since 1975, from less than 1 to 5.6% in girls and 7.8% in boys in 2016 [2]. This rapid acceleration affirms the importance of environmental influences on children's body weight, including their food environments.

Industrialisation and globalisation of food systems, together with urbanisation and increased wealth, have altered food production and consumption patterns [3], leading to an increasingly processed global diet [4]. Global trade and foreign direct investment have enabled globalisation of food markets, concentrated by transnational food corporations. These corporations have untold resources for marketing strategies and political power to foster favourable policy conditions to ensure continued economic growth [5].

Children are vulnerable to, and targeted by, food marketing. Their vulnerability relates to their underdeveloped cognition and impulse control, whereby with age, children develop the necessary skills to understand the persuasive intent of marketing (~8 years), critically evaluate marketing (~12 years) and

exhibit behavioural control to self-regulate consumption of marketed foods (post-young adulthood, if ever) [6]. Children are an important consumer segment: they influence household purchases [7]; make independent purchases; and make brand and product evaluations that persist throughout life [8]. Information on marketing expenditures directed to children are elusive; however, US data show that fast-food companies spent US\$3.4 billion on TV advertising in 2019 when the top six fast-food brands were responsible for > 70% of TV advertisements viewed by children [9].

Protecting children from unhealthful food marketing is a global priority policy for the prevention of obesity, dietary risks and related non-communicable diseases [10, 11]. Children's food marketing exposure is linked to their food and food-brand attitudes, purchases and consumption and weight outcomes [12••]. The impact of marketing is a function of its reach and frequency and persuasive power, including content and design [13]. Policy recommendations call on governments to gather, or support the collection of, evidence on marketing exposure, power and impacts to inform policy formulation [11]. Governments should also take a leadership role in establishing a system for monitoring policy compliance and evaluating policy impacts [11]. Yet evidence on children's exposure to, and the power of, food marketing from low- and middle-income countries remain scarce [12••] stifling policy development [14]. Where policies are implemented, monitoring compliance has been marred by methodological difficulties and inadequate resources [14].

Standardised protocols for monitoring food marketing have been developed to facilitate comparisons across time and place and build capacity in low-resource contexts. The International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring and Action Support (INFORMAS) is a global network that aims to monitor, benchmark and support policy actions to improve food environments, including food marketing. At its inception, the INFORMAS undertook a review of methods to monitor children's exposure to food marketing [15]. Subsequent INFORMAS protocols have been adopted/adapted in almost 30 countries (as at 2020) and facilitated cross-country comparisons of television (TV) food advertising [16•]. This review aimed to update the INFORMAS foundation paper by reviewing contemporary approaches to monitor food marketing since 2013. It seeks to guide governments and researchers in designing food marketing monitoring frameworks and research studies to progress policies to protect children from unhealthful food marketing.

Monitoring Across the Policy Cycle

While acknowledging the complexities of policy processes and the limitations of representing this as a policy 'cycle' [17], here, we use the stage heuristic model to illustrate the

purposes of monitoring relevant to policy progress. This model delineates policy processes into four stages of agenda setting, followed by policy formulation, implementation and review. The objective of monitoring and the approach used are specific to each stage. Failure to account for the specific monitoring objective will have resource implications and potential population health consequences, as policies are delayed or issues with implementation are undetected.

Where the intention of policy actions is to identify, describe and analyse the problem, relatively limited local monitoring data may be sufficient (Table 1). In jurisdictions where local data on food marketing are lacking, other available evidence can be gathered to highlight the need for the policy, such as population-level information on children's nutrition and health status. This is considered alongside the extensive global evidence on food marketing exposure, power and impacts (e.g. [12••, 18, 19]). The generation of limited new local evidence can then demonstrate the comparability between global monitoring evidence and the local context. These local data may indicate the occurrence of food marketing to children and confirm the wide-ranging media, settings and marketing techniques used. Recommended approaches for capturing these data include:

1. The use of small samples of media/settings. For example, Barroso and colleagues analysed food advertising during TV broadcast periods attracting child audiences [20]. Data were captured from 7:30–10:00 on Saturday mornings for six channels, across 6 weeks.
2. Capturing data using crowdsourcing, to elicit examples of observed food marketing. Crowdsourcing has been used to generate evidence on other aspects of food environments, including price and labelling [21, 22]. Through a bespoke mobile application/website, contributors can upload marketing images, with meta-data embedded in digital photographs allowing identification of time and place.
3. Identifying case examples of local marketing campaigns from food company reports or webpages. Boelsen–Robinson et al. collated data on marketing techniques used by leading food brands by auditing company-owned social media pages, websites and applications [23]. Industry databases of marketing campaigns are available (e.g. World Advertising Research Centre), although they require paid subscriptions.

In contrast, detailed assessments of media are resource- and time-intensive and incur opportunity costs of delay as policy is stalled, while data are collected. Detailed assessments of TV advertising have typically captured many hundreds of hours of broadcasting, spanning most of the day, many channels, across months or even a year. Such detailed assessments of marketing on single media (often

Table 1 Objectives of, and approaches to, food marketing monitoring across stages of the policy cycle

Stage of policy progress	Policy actions at this stage	Objective of monitoring food marketing	Recommended approaches for data gathering or generation
Agenda setting	Identify, describe and analyse the problem	To raise awareness of the need to protect children from unhealthy food marketing in the local context To demonstrate the use of wide-ranging media and settings through which children are exposed to food marketing and the marketing techniques used	<p>Gather information from:</p> <ul style="list-style-type: none"> ● Population surveys of child nutrition and health status ● Any local monitoring studies of food marketing exposure, power and impacts on children ● Global evidence on food marketing exposure, power and impacts on children <p>Generate new information (as needed) using:</p> <ul style="list-style-type: none"> ● Small samples of media and settings, to give an indication of marketing exposures and power ● Crowdsourced data from children or parents, to give examples of marketing exposures ● Case examples of industry marketing campaigns, to give an indication of the media, settings and marketing techniques used, including emerging trends
Policy formulation	Develop policy options and strategies, negotiate and formulate the policy	To gather data on food marketing exposure and power, to serve as a baseline for future evaluations of policy impact To inform the policy parameters, including the priority media, settings and marketing techniques to be restricted	<p>Gather information from:</p> <ul style="list-style-type: none"> ● Any local monitoring studies of food marketing exposure, power and impacts on children that align with the monitoring approaches outlined in policy's Monitoring and Evaluation Framework <p>Generate new information (as needed) using:</p> <ul style="list-style-type: none"> ● Detailed assessments of food marketing exposure and power across priority media and settings
Policy implementation	Implement and enforce the policy	To assess policy compliance and enable policy enforcement	<p>Generate new information using:</p> <ul style="list-style-type: none"> ● Ongoing monitoring to detect potential policy violations in media and settings in which marketing is restricted ● A system of public complaints to identify potential policy violations
Policy review	Monitor policy compliance, evaluate policy impact, report on outcomes	To evaluate the impact of the policy on reducing children's exposure to food marketing and its persuasive power	<p>Generate new information using:</p> <ul style="list-style-type: none"> ● Repeat detailed assessments of food marketing exposure and power across priority media and settings, using the same methods and measures as baseline (used during policy formulation)

TV) syphon resources and may impede evidence on other media and settings. This can propagate narrow policy debate focused on single media, rather than applying comprehensively across media as recommended in global mandates [11]. However, such detailed assessments may be required by some governments before the policy can be designed. Regardless of the scope of data collection, efforts should seek to capture marketing across media and settings to guide comprehensive policies.

At later stages of policy progress, detailed assessments of marketing across media and settings are required to evaluate the impact of policies on reducing marketing exposure and power. This includes gathering existing data or collecting new data prior to policy implementation to provide baseline information and repeating data collection using the same methods and measures after policy implementation. The UK Office of Communications captured data on child exposures to TV food advertising prior to (2005) and following (2008, 2009) the implementation of regulations [24]. Similarly, detailed assessments of TV food advertising were undertaken in Chile, comparing rates of unhealthful food advertising before and 1 year after the implementation of regulations [25]. To guide the monitoring approach, a Monitoring and Evaluation Framework is ideally developed during policy formulation to accompany the future policy. This would outline priority media/settings, the frequency of data collection and key indicators.

During policy implementation, ongoing monitoring is necessary to assess compliance and enforce the policy. Monitoring should involve ongoing collection of data on policy violations by trained data collectors using standardised forms. Such a system is recommended in the WHO and UNICEF NetCode protocols for monitoring marketing of breast-milk substitutes [26].

Regarding policy review, attribution of any changes in the outcomes is challenging due to the absence of a counterfactual or control group. Before–after studies and interrupted time series studies can mitigate this challenge, with the latter preferred to account for underlying secular trends.

Assessing Food Marketing Exposure

There is a spectrum of approaches for quantifying children's food marketing exposure (Table 2). This includes methods that:

1. Assess *potential* marketing exposure by undertaking content analyses of media/settings frequently accessed by children.
2. Combine content analyses with information on children's use of media/settings to give *estimated* marketing exposures.

3. Assess *actual* marketing exposures through observations and real-time data capture.

A review of studies assessing children's food marketing exposure identified 118 studies published in 2009–2020 [12••]. Most studies had assessed *potential* exposure and were conducted in high-income countries and almost half focused on TV advertising. More recent studies assessed children's potential marketing exposure in online social media (e.g. [33, 34]). Social media attracts huge audiences of young users and applies immersive techniques to integrate marketing in online content [35]. Studies quantifying children's potential exposures to food marketing online have typically identified food brand social media pages most popular with children using social media analytics or the top selling food brands' pages. Content was then assessed for themes of appeal to children (e.g. humour) and the use of persuasive marketing techniques (e.g. interactive games). These studies highlight the marketing techniques used by food brands on popular social media and suggest potential targeting of children, given the marketing appeals used and the audience profile.

Studies assessing children's estimated or actual exposure to food marketing are less common but may provide a more convincing account of children's marketing environments. *Estimated* exposure is assessed by comparing analyses of media content against data on children's media use. Data on media use may be available for a group (e.g. media audience/viewership data) or for individuals (e.g. media diaries, questionnaires). In the UK Government's evaluation of its 2007 regulations restricting TV advertising of foods high in fat, sugar and salt (HFSS), average daily audience data for children were obtained for each half hour timeslot [24]. This was multiplied by the number of HFSS advertisements for timeslots to derive 'HFSS impacts' (views). For online media, studies have accessed information on hours of brand content watched by users from social media analytics data [36]. In some streaming sites, livestream video content with embedded marketing is uploaded to 'streamers' (curators) pages. In one study, data on the number of hours of exposure to food branded content on the top 100 streamers' pages were used to estimate hours of exposure to branded messages by users [36].

Studies assessing *actual* exposure to food marketing have observed children's exposure to online marketing in study settings [37]; asked children to contribute image/video data of their environments [38] or media use [39•] for later screening for marketing content by researchers; and asked children to contribute images of marketing they observed on specific media [40]. These studies have mostly assessed online media. Online marketing uses behavioural targeting, whereby marketing exposure varies depending on individuals' characteristics and preferences [35]. Two

Table 2 Methods for quantifying children's food marketing exposure

	Methodology	Considerations for data collection	Considerations for data interpretation
<i>Potential exposure</i>	Content analyses of selected media to derive exposure to, and power of, food marketing overall or during specific media segments. ^a For example, assess the rate (ads/hour) of TV food advertising during peak viewing times for children [27]	<p>Ethics approval is usually not required as human subjects are not involved</p> <p>Sampled media/settings and media segments should represent those that are most popular with, or frequently accessed by, children. These may be identified using commercial audience/ratings/readership data or through small surveys with the target audience to assess media habits (ethics approval required for this latter approach)</p> <p>The nature and extent of marketing varies over time, with seasonal variations (e.g. [28]) and secular trends in marketing expenditures across media [29]. With consideration to available resources, the media sample should be representative of marketing over time (e.g. captured at multiple time points)</p> <p>Consider variations in potential exposures across population groups by including media for specific language groups (e.g. channels, print media), in specific locations (e.g. local channels) or in places where specific groups of children gather (e.g. places of religious worship)</p>	<p>Data are indicative of the marketing that children are potentially exposed to, should they access the media segments assessed</p> <p>For online media, marketing content is individually tailored to children based on their unique online profile [30]. Content analyses of paid advertising (e.g. banner ads) on websites or social media newsfeeds are not recommended as these vary between individuals</p>
<i>Estimated exposure</i>	Combine content analyses of selected media with information on children's use of media and settings. For example, pairing content analyses of media with children's media use diaries	<p>Ethics approval is required if human subjects are involved</p> <p>Data are captured on the nature and extent of food marketing across media and settings, according to the above content analyses (as for estimating children's potential marketing exposure)</p> <p>To collect information on children's media use from individual children, a representative sample should be recruited. Consider a spread of socio-economic position and geographic location (e.g. to represent urban and regional/rural populations). Children may complete media diaries or answer questionnaires about media use. Media diaries are a more valid measure of media use than global time estimates from questionnaires [31]. However, estimates of media use from questionnaires are improved when respondents are asked about media use during specific time periods, rather than on a 'typical day' [32]. For younger children (< 12 years), caregiver assistance is required to complete measures of media use</p> <p>Alternatively, data on media use may be derived from audience or viewership data, where this is available for child populations</p>	<p>To derive estimates of marketing exposure, information on the nature and extent of marketing in media segments is compared to children's reported interaction with the media segment, or the number of children accessing the media segment. For example, if the rate of food advertising broadcast on a specific TV channel between 6 and 8 pm is 5 ads per hour and a child watches 1.5 h of TV during the media segment, their estimated exposure to food marketing is 7.5 ads</p> <p>Estimated marketing exposures can be derived for a specific media/setting or cumulatively across media and settings</p>
<i>Actual exposure</i>	Includes direct observations of children's exposures to food marketing by researchers or real-time data capture of marketing exposure by children. For example, (1) observing children's online food marketing exposure in a laboratory setting, (2) recording of marketing by children at the time of exposure, such as through screen capture, photographs or diaries	<p>Child recall is not recommended as a measure of actual exposure. Marketing need not be consciously processed nor retrospectively recalled for it to be impactful [19]</p> <p>IP addresses are used by marketers to target marketing to households. Laboratory-based studies that use common devices to observe children's actual exposures to online media food marketing will exclude IP targeted marketing. Children should be logged into their own online accounts to see other behaviourally targeted marketing directed to them</p> <p>Children's real-time capture of marketing exposure is likely to be more accurate when data are captured for everything that they see (automatic photos or screen capture) and the researcher screens the data for instances of marketing. AI systems are being applied to facilitate the process of screening media for marketing content. Alternatively, children can take photos or screenshots of marketing that they identify on media/settings. This requires training of participants on the scope of marketing of interest</p>	<p>External validity of the findings may be impacted by the narrow timeframe of marketing exposure that can be captured and the high respondent burden, leading to exclusion of some population groups</p> <p>For studies that require children to manually record marketing that they see on media/settings, imperfect recognition of marketing and recording errors by participants are likely to lead to an underestimate of actual exposures. Some types of marketing may be particularly underreported, such as promotions shared through social media networks, as these may not be identified as marketing in the same way as other, more explicit, advertising</p>

^a Media segment refers to broadcast times, channels, stations, sites, locations or publications

studies that applied very different media sampling derived remarkably similar assessments of children's online food marketing exposure. One Canadian study captured video data of children's mobile devices for 10 min on two social media applications with researchers present [37]. Another Australian study asked children to record their mobile screen anytime they went online over 3 days [39]. Canadian children were projected to see 189 food marketing instances per week, compared to 168 in Australia. The smaller time sampling of online media may provide robust estimates of usual exposures.

Most studies have assessed exposure to food marketing across the general child population [12]. However, some evidence suggests that low socio-economic and ethnic minority groups may have greater exposures [18]. Study populations should be sampled to allow marketing exposures to be assessed for population sub-groups (by sex, socio-economic status, ethnicity).

Assessments of estimated and actual exposure to food marketing can be used to:

1. Quantify children's exposure to marketing at a single point in time, with sub-group analyses to compare socio-demographic groups or across media/settings (cross-sectional studies).
2. Combine with measures of food marketing impacts (e.g. dietary intakes) to analyse associations between marketing exposure and impacts (cross-sectional studies).
3. Follow children over time to prospectively assess relationships between marketing exposures and impacts (cohort studies).
4. Repeat measures periodically to assess changes to food marketing exposures as a result of policy implementation (time series designs).

Utilising Commercial Data for Marketing Exposures

Licensed data from companies that collect information on marketing frequency, exposure or expenditure can provide timely data from extended geographical areas (national), over time (annualised) and access to data that would otherwise be unavailable (expenditure). Historical data may allow time-trend analyses. However, costs are typically high. Data availability varies between countries, between companies providing such services and for different media. Data are widely available for TV (e.g. Numerator, Nielsen) and online (e.g. Brandwatch). Companies' data platforms and metrics can be complex to understand, and specific data for children may be unavailable. The availability and format of data should be confirmed prior to signing any licencing contracts and any limits on publishing. Interpretation of data

on marketing expenditure, as a proxy for potential marketing exposure, requires caution. Relative differences in marketing expenditure between media do not necessarily indicate less marketing activities, as the cost of marketing on digital platforms may be lower than other broadcast media [41].

Assessing Food Marketing Power

To assess the power of child-targeted food marketing, past research has largely used cross-sectional methods or content analyses. Studies have mostly been conducted in high-income countries like the USA (e.g. [42–47]), Australia (e.g. [23, 34, 48, 49]) and the UK (e.g. [50, 51]). Most studies focus on TV advertising and, to a lesser extent, online marketing, product packaging or in-store promotions.

Food companies use an array of creative techniques to target youth. The strategies designed to resonate with youth are common across media platforms and include celebrity or sports endorsements, promotional characters, nutrition and health claims, themes of humour, competitions and advergames [12]. The marketing techniques used in online media may be particularly impactful on reducing young people's ability to distinguish marketing from other content and in encouraging brand engagement. In one trial assessing recognition of food advertisements on Instagram and traditional media (print, TV), adolescents were more likely to incorrectly identify Instagram advertising, suggesting the subtlety of such marketing to escape recognition [52]. Another experiment showed that adolescents preferred and engaged more with Instagram food advertisements with higher 'likes', reinforcing their preference towards popularity norms [53].

New research has revealed the marketing power of social media influencers [40, 50, 54, 55]. Now a US\$10 billion industry, the use of influencers to promote brands is a striking online trend [54]. The power of influencer marketing is driven by the parasocial relationships that develop between influencers and consumers [56], whereby consumers perceive brand endorsements like advice from friends [57, 58]. Adolescents' parasocial relationships with influencers have been positively associated with their purchase intentions [57]. British children's exposure to influencers promoting unhealthy foods significantly increased their intake of unhealthy foods [59].

Assessing the Healthfulness of Promoted Foods

Classifying the nutritional quality of marketed foods is necessary at each stage of the policy cycle for highlighting the imbalance in the promotion of more/less healthful foods;

identifying specific foods to be restricted; and for detecting non-compliance with policy that restricts marketing of unhealthful foods. Nutrient profiling models have been developed by all six WHO Regional Offices for classifying foods that should be restricted from marketing to children. The models apply threshold criteria for energy and negative nutrients per 100 g/ml for food categories, with different systems considering regional food supply and cultural eating practices. Many monitoring studies have applied these nutrient profiling models since their publication from 2014 [12••]. Other nutrient profiling models used in research studies and government policies have included the UK Government nutrient profile model [60], INFORMAS food classification system for food promotion monitoring [61], the Chilean Government system for classifying foods high in energy and negative nutrients [62] and national dietary guidelines [63]. There is some disagreement in the classification of food healthfulness between these systems [64] and technical issues with their application (Table 3). The nutrient profiling model used in monitoring should align with the population dietary patterns, national nutrition guidelines and related national policies for improving population nutrition.

Case Studies of Frameworks for Evaluating the Impact of Policies

Canada

In 2015, Health Canada introduced a multi-pronged food policy to improve Canadian diets, including restricting unhealthful food marketing to children [66]. Subsequently, the *Child Health Protection Act*, which proposed restricting unhealthful food marketing directed to children under 13 years across most media and settings, was introduced in the senate [67] but failed to pass. Recently, a similar bill was introduced in the House of Commons [68]. Despite this legislative uncertainty, Health Canada is committed to monitoring food marketing. In 2018, Health Canada commissioned a food marketing monitoring framework and has supported Canadian researchers to undertake this work, including through the development of consistent approaches for categorising foods as unhealthful and for identifying marketing techniques that are ‘directed to children’. The monitoring framework proposes annual monitoring across six geographic regions for TV, digital media, retail environments, schools, packaging and sponsorship of child sport/events. It outlines a focus on children under 18 years and proposes examining food marketing indicators of frequency of potential exposure and actual exposure (for online media); power (marketing techniques used); company outcomes (marketing expenditures, food sales); and child food intakes. The framework extends monitoring beyond the parameters of the

draft legislation, to include older ages and all settings. This enables the identification of unintended policy consequences on other population groups and settings as marketing inevitably shifts to less-regulated contexts.

The UK

In 2024, the UK Government will implement restrictions for advertising HFSS food and beverages on TV up to 9 pm and in paid advertising online by UK operating businesses [69]. Online marketing restrictions apply to display, video and in-game advertising, advergames and advertorials, social media advertising and influencer marketing. The restrictions exclude owned media, brand advertising, audio-only advertising, small and medium enterprises and transactional content. The restrictions were announced in the context of a UK Government ambition to halve childhood obesity by 2030. While the provisions are not limited to media that is targeted to, or preferentially consumed by children, the restrictions are inextricably linked to efforts to reduce childhood obesity. This is reflected in the evaluation framework, which seeks to measure change in children’s actual exposure (online) and estimated exposure (TV). Monitoring other exposures to HFSS marketing (outdoor streetscape, cinema, radio) and brand advertising, which are not subject to the new restrictions, will identify any migration to less-regulated media and brand-only promotions. The planned evaluation consists of (i) repeat cross-sectional survey to determine media use behaviours in a representative sample of 5–16 year olds; (ii) monitoring of marketing across media; (iii) purchase of TV advertising exposure data; and (iv) use of screen capture methodology to measure actual exposure to online advertising in a subsample of children. The protocol will allow sub-group analyses by sociodemographic group (area-level deprivation, ethnicity).

Harnessing Artificial Intelligence to Rationalise Data Handling

A key barrier to regular, comprehensive monitoring of food marketing is the resource-intensive task of collecting and analysing huge volumes of data. For example, a study by Kelly et al. collected 3 days of screen capture from 95 children to monitor actual exposure to food marketing online [39•]. This resulted in 272 h of video, which researchers viewed to identify and classify instances of food marketing. The volume of data and, therefore, the resources required to analyse it mean studies are confined to small samples, limited media or are unlikely to be regularly repeated. Consequently, governments have no indication of how marketing exposures vary over time or between population groups, nor if policy responses have been effective.

In the current era of risk surveillance and data analytics, rapid advances in computing power, and capture and analysis of big data, have enabled the application of artificial intelligence (AI) technologies to solve complex health problems in an autonomous or semi-autonomous manner. As AI technologies become more accessible and affordable, it presents an opportunity to shift from manual to automated/semi-automated methods of data collection and analysis of food marketing data. Machine learning, the application of a set of algorithms to analyse large amounts of data, is ideally suited. Deep learning algorithms can be applied to automatically identify and classify visual imagery captured in photos or videos. Palmer et al. developed a deep learning workflow to automatically extract and classify outdoor advertising of unhealthy commodities, including foods, in Liverpool, UK [70]. Geotagged images (> 25 K) were collected via cycling with a GoPro camera and, when processed, enabled automated visualisation of unhealthy advertising clustering by area-level deprivation. Key challenges include the huge number of advertised food products and brands to be identified and classified for algorithm training and the ever-changing nature of advertisements across place and time. Optimising algorithmic performance by reducing misclassification (false positives and false negatives) will be important.

Avatar technologies have been used for monitoring food marketing through digital devices. The UK Advertising Standards Agency used avatars to simulate the online profiles and browsing activities of children [71]. The avatars browsed 210 websites and 87 YouTube channels over a 2-week period, revealing 2.3% of 41,030 advertisements captured breached advertising rules for HFSS foods. The regulator subsequently contacted companies to remove advertisements. These methods hold great promise for monitoring regulatory compliance as data can be automatically collected on an ongoing basis, although data collection is limited to platforms that do not require user login.

Monitoring in Low-Resource Settings

Evidence from low-resource settings focus on *potential* marketing exposure. In lower- and upper-middle-income countries, advertising on TV has been the principle media of concern in China [72, 73], Kyrgyz Republic [74], Lebanon [75], India [76], Malaysia [77], Russia [78], Sri Lanka [63] and Thailand [79] and in multi-country comparisons from these countries [80, 27]. Monitoring protocols have originated from WHO Europe [81] and INFORMAS (57), with most studies recording at least 16 h of broadcasting per channel for two weekdays and two weekend days [72–74, 77, 78, 80]. Some recordings focussed on children's programming [79] or non-school hours [75]. The persuasive power of TV food advertising was investigated, including the use of promotional characters, premium offers, nutrition claims and programme sponsorship [63, 72–79]. Monitoring of online media included content analyses of food company accounts on Instagram [82], Facebook [83], YouTube [84] and country-specific websites of transnational food companies [85]. Social media analytics (SocialBlade, Socialbakers) were used to determine popular pages/channels. Data were captured across 1–4 months, and marketing content was assessed for visual depictions, corporate social responsibility activities, child-targeted images and taste appeals [82–85]. Fewer studies monitored food marketing in, or around, settings where children gather. These studies from Indonesia [86], Mongolia and the Philippines [87] captured information on the content and placement of outdoor advertising around schools, sports/recreation centres and places of worship. KoBoCollect, an open-source mobile application with satellite coordinates and photo uploading features, facilitated fieldwork [86]. Nutritional quality of promoted foods was classified according to INFORMAS food categories [72, 73, 77, 79, 84], WHO regional nutrient profiling models [74, 75, 78, 27], UK Government nutrient profile model [85] or local policy [63, 76].

Table 3 Issues with applying nutrient profiling models for classifying the nutritional quality of marketed foods and potential solutions

Issues with applying nutrient profiling models to food marketed data	Potential solutions
Unclear how to classify promotions for food companies that do not depict a specific food product	Classify the healthfulness of food companies based on the nutritional profile of their top selling products
Unclear how to classify promotions when multiple branded products are depicted	Take the average nutrient profiling score or simple majority of product classifications across all promoted products
Missing data on the nutritional composition of foods due to the absence of mandatory nutrition labelling	Data may be imputed from nutrient composition databases (e.g. unbranded versions of similar foods) or similar products from neighbouring countries from food company webpages
WHO models do not apply to foods for children ≤ 36 months	Adopt recommendations of the <i>International Code of Marketing of Breast-Milk Substitutes</i> and subsequent World Health Assembly resolutions to preclude all marketing of all formula for < 36 months. Complementary foods should align with Codex Alimentarius standards (see [65])

Monitoring was facilitated by low personnel costs for recording and coding [81] and technical support and training provided by external experts [74, 78, 80, 87]. Complementary research to support policy progress has included investigating local barriers to, and facilitators of, food marketing policy. Such policy analyses have been conducted in Iran [88], Malaysia [89], Nepal [90], the Philippines [91] and Thailand [92]. Interviews with key stakeholders and/or document analyses were typical methods, requiring minimal resources.

Conclusions

This review highlights the large body of global evidence monitoring unhealthful food marketing to children. These studies undoubtedly provide necessary information to define the extent of the problem and have progressed policy debate such that food marketing restrictions are identified by international health agencies as a priority policy to support population health. However, current evidence is mostly limited to high-income countries and focuses on detailed monitoring of potential exposures to TV and, increasingly, online media. Consequently, this evidence may constrain policy debates to restricting marketing on limited media (TV) and fails to reveal the true extent of marketing that children see to provide a compelling case for policy reform. Efforts are needed to support governments and researchers in low- and middle-income countries to undertake monitoring with technical support for protocols and training. Monitoring approaches should evolve to better capture children's estimated and actual exposures, across media and settings. Evidence on the impacts of marketing on children's diet-related outcomes is also important. The negative impacts of unhealthful food marketing on child outcomes are well established and provide the mandate for governments to overcome political pressures from food companies and enact regulations to protect children's health.

Compliance with Ethical Standards

Conflict of Interest The authors declare they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

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