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The influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children—A systematic review

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Summary

Children are increasingly exposed to food and beverage marketing, but little is known about the specific effects of marketing through media most used by children. This study aims to systematically review the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children. Seven databases were systematically searched for English peer-reviewed quantitative and qualitative scientific studies on the effects of marketing of unhealthy products through social media or advergaming on a range of diet-related outcomes in children. Risk of bias was assessed with tools specific for the different study designs. Twenty-six studies were included, of which 20 examined the effect of food and beverage marketing through advergaming and six through social media. Most studies had a high risk of bias. The results suggested that unhealthy food and beverage marketing through social media and advergaming has a significant effect on pester behaviors, food choice, and food intake of children. The studies demonstrate that unhealthy food and beverage marketing through media popular with children significantly impacts different diet-related outcomes. Combined with existing evidence on this effect in other settings, this review provides clear evidence of the need for policies targeting screen-based marketing.

KEYWORDS
advertising, commercial, digital, obesity

1 | INTRODUCTION

The global increase in childhood obesity[1] coincides with the marked increases in the food and beverage industry's budget for marketing aimed at children.[2] Of the various ways in which commercial determinants influence health,[3] *marketing and preference shaping* is used especially often to target children and adolescents.[4] From a marketing perspective, this makes sense because children are more susceptible to media and marketing influences than adults, and once a child has developed a preference for a food or brand, they may remain a lifelong buyer.[5] Indeed, several systematic reviews demonstrated the effectiveness of food marketing through different media channels, for example, television or the

Abbreviations: BMI, body mass index; HFSS, high in fat, salt and sugar; kcal, kilocalories; RCT, randomized controlled trial.

Internet, on children's food attitudes, preferences, and consumption.[6–8] This is problematic as most marketing efforts focus on the promotion of foods and beverages high in fat, salt, and sugar (HFSS).[9]

Food and beverage marketing aims to influence individuals' food preferences, purchases, and consumption by using persuasive techniques.[10] Children's attention is grasped by hedonistic appeals, rather than by health and nutritional information.[11] Children are especially influenced by the use of premiums, competition, collectibles, celebrity endorsers, or cartoon characters, as they increase engagement and the recall of marketing communications, positively impact attitude towards the brand and therefore increase purchase (requests).[12–16]

The increased digitalization of food environments has also led to a rise in digital forms of marketing, for example, through search engines, websites, mobile apps, email, digital and display advertising, and social media.[17,18] Digital marketing has several advantages over traditional marketing as it has a potentially much greater audience, the content is continuously available and it can be personalized based on online consumer profiles.[19] Children's online activities mainly consist of social networking, watching videos and listening to music, instant messaging, school work, and playing online games.[20–22] As such, marketing via social media and online games closely aligns with their activities. Social media is an umbrella term for Internet-based applications, in which users can generate and share content.[23] Through social media companies can interact with their customers directly, promote their product, and boost brand loyalty.[24] In "advergaming," which is advertising in games, commercial messages are embedded in the game-play, which blurs the lines between persuasion and entertainment.[25,26] Advergames attempt to make the games playful and involving, so children will return to the brand's website and play the game multiple times.[27]

There is an increasing number of publications on the influence of these new forms of food and beverage marketing on diet-related outcomes in children. For example, both advergames promoting food and influencers promoting food on social media lead to an increase in energy intake in children.[28,29] A very recently published review suggests that social media may have some degree of influence on adolescents' food choices.[30] However, there is no systematic evidence synthesis of the influence of social media and advergames to date, while previous reviews have indicated the need for a review on the effects of these increasingly popular media.[31,32] As food and beverage marketing through social media and advergames is likely to be increasingly exploited in the nearby future, it is important to understand its effects on the dietary behavior of this vulnerable age group.[33] Therefore, this study aims to systematically review the evidence base to date on the influence of food and beverage marketing through social media and advergaming on diet-related outcomes, such as food intake, food purchases and obesity risk, in children. It is expected that the marketing of HFSS products will lead to higher (intent to) purchasing and consumption of HFSS products and higher disease risk.[34]

2 | METHODS

This is a systematic literature review of peer-reviewed English-language scientific articles on the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children. This review is written according to the most recent PRISMA guidelines for systematic reviews.[35] The review protocol was prospectively registered in the PROSPERO International Prospective Register of Systematic Reviews before performing the searches (registration number: CRD42021236364, available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021236364).

2.1 | Search strategy and study selection

To identify all relevant publications, we conducted systematic searches in the bibliographic databases PubMed, Embase.com, Web of Science (Core Collection), APA PsycInfo (Ebsco), International Bibliography of the Social Sciences, IBSS (ProQuest), and Business Source Elite (Ebsco) from inception up to March 19, 2021, in collaboration with a medical information specialist (RV). The following terms were used (including synonyms and closely related words) as index terms or free-text words: "Diet, Food, and Nutrition," "Social media," "Marketing," "Advertising," and "Children." In addition, the references of the identified articles were searched for relevant publications. Duplicate articles were excluded. Articles in all languages were accepted during the search. The full search strategies for all databases can be found in the supporting information (Tables S1–S6).

The search was performed and duplicates were removed by a medical information specialist (RV). All de-duplicated titles and abstracts retrieved from the search were screened for eligibility by two authors independently (CMM and JDM), according to the criteria for inclusion and exclusion, using the semi-automation tool Rayyan.[36] Afterwards, CMM and JDM independently assessed all full texts for inclusion. Differences in judgement were resolved through a consensus procedure. Studies were included if they met the inclusion criteria as stated below.

2.2 | Inclusion and exclusion criteria

The following criteria were used for inclusion and exclusion of studies:

- Study population: studies with a population aged 17 or under were eligible for inclusion;
- Exposure: studies were included if the marketed products were HFSS foods or beverages, and excluded if the only marketed products were healthy food and beverages, other non-food products or alcoholic beverages, as children are not a legal target group for this commodity. In addition, the marketing exposure had to occur through social media or advergaming. This includes social

networks, media sharing networks, social blogging networks, discussion networks and gaming sites, but not email and instant messaging.[37] Non-online marketing was also excluded;

- Control: no specific criteria were used for control conditions. Any type of control was eligible for inclusion, such as a different marketing medium, no exposure to marketing, non-food items and healthy food marketing, and so forth;
- Study outcome: we considered a broad spectrum of diet-related outcomes, such as food purchase (requests), food intake and diet-related disease risk. Outcomes such as product preference, recall and attitude were excluded, as they are not specific dietary behavior which could directly lead to the intake of unhealthy products;
- Study characteristics: only peer-reviewed scientific studies describing primary studies, written in English were eligible for inclusion. As such, opinion papers, letters to the editor, systematic, scoping or narrative reviews, and commentaries were excluded;
- Study design: studies of both quantitative and qualitative design were eligible for inclusion.

2.3 | Data extraction

Upon study selection, CMM and JDM extracted data from each article independently (see Table 1).

2.4 | Quality assessment

CMM and JDM independently evaluated risk of bias of the included studies. The revised Cochrane Collaboration risk of bias tool was used to assess the experimental studies through five domains.[38] The overall risk of bias assessment corresponded with the worst risk of bias in any of the domains. Additionally, if four or more domains were judged to be at moderate risk of bias, the overall risk of bias was high.

The observational studies were assessed using the Newcastle-Ottawa Scale.[39] For a low risk of bias, studies needed 3–4 stars in the selection domain, 1 star in the comparability domain, and 2 (case–control) or 3 (cohort) stars in the outcome domain. For moderate risk of bias, the studies needed 2 stars in the selection domain, 1 star in the comparability domain, and 2 (case–control) or 3 (cohort) stars in the outcome domain. Studies with 0–1 stars in the selection domain, or 0 stars in the comparability domain, or 0 (case–control) or 1 (cohort) stars in the outcome domain were assessed as high risk of bias.

The included qualitative studies were assessed with the Critical Appraisal Skills Program (CASP).[40] The Cochrane handbook for systematic reviews advises against calculations of total quality scores for qualitative research.[41] Therefore, the risk of bias assessment was described narratively.

The risk of bias assessments were taken into consideration when evaluating the results of this review.

2.5 | Data synthesis

Meta-analysis was not possible due to heterogeneity in exposures and outcomes. Studies that considered similar outcomes were grouped for narrative synthesis, stratified by advertising medium. After data extraction, the outcomes were categorized by proximity to obesity. The outcomes ranged from most distal to most proximal to health as follows: purchase/pester intentions or purchase requests, hypothetical food or beverage choice (e.g., choosing a product from images), actual food or beverage choice (i.e., taking a product such as a can of soda), food or beverage consumption (e.g., food intake in grams or kilocalories), and measures of weight (e.g., changes in BMI). The distinction between hypothetical and actual choice was important

TABLE 1 Description of data extracted from studies included in the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children

Criterion	Data extracted
First author	Name
Year of publication	Year
Study design	E.g., (non-)randomized controlled trial, cohort study, case–control study, cross-sectional study, interview study, focus group.
Number of participants	Number of participants
Participant age	0–17 years of age (range, *M*, *SD*)
Setting	Country
Marketing medium	Social media or advergaming
Food or beverage type	Type(s) of food or beverage shown in advert
Marketing exposure	Description of the exposure/intervention (experimental and qualitative research)
Method	Description of the study method (observational research)
Control condition (experimental studies)	Description of the control condition
Main outcome	Food intake, purchasing, disease development, etc.
Main result	Significant association (effect size) between marketing and diet-related outcome

as making an actual food choice better reflects how the study subjects would act in a real-life setting rather than choosing a hypothetical product.

3 | RESULTS

3.1 | Study selection

The search yielded 4418 records after removing duplicates (Figure 1). A total of 4375 records was excluded based on title and abstract (of which 9 based on non-English language) and we screened the full-text of 43 records for eligibility. Nineteen records were excluded after the full-text screening, as they did not research children,[42–44] did not research marketing exposure,[45–47] did not research HFSS products,[48–50] only described the influence of social media or advergaming in combination with television or other online media,[51–55] or because the record was not a peer-reviewed scientific article presenting primary research.[56–60] The references of the included studies were checked for eligibility, from which two additional studies were identified and included. A total of 26 studies was included.

3.2 | Study characteristics

This systematic review comprises data of a total of 5471 children. Participants were between 4 and 16 years old. Most studies were conducted in Europe, the United States, or Australia ($n = 22$), other studies were conducted in Mexico, Iran, China, and India. All studies included both boys and girls, except for one, in which the participants' sex was not specified.[61] Six of the studies investigated the effect of unhealthy food and beverage marketing through social media and 20 investigated the effect through advergaming. The selection of studies consists of experimental studies ($n = 22$), observational studies ($n = 2$), and qualitative studies ($n = 2$), of which the study characteristics are shown in Table 2.

3.3 | Data synthesis

3.3.1 | Social media

Of the six studies that focused on the influence of food and beverage marketing via social media, two studies examined the influence on the outcome most distal to influencing health: purchase intentions (both

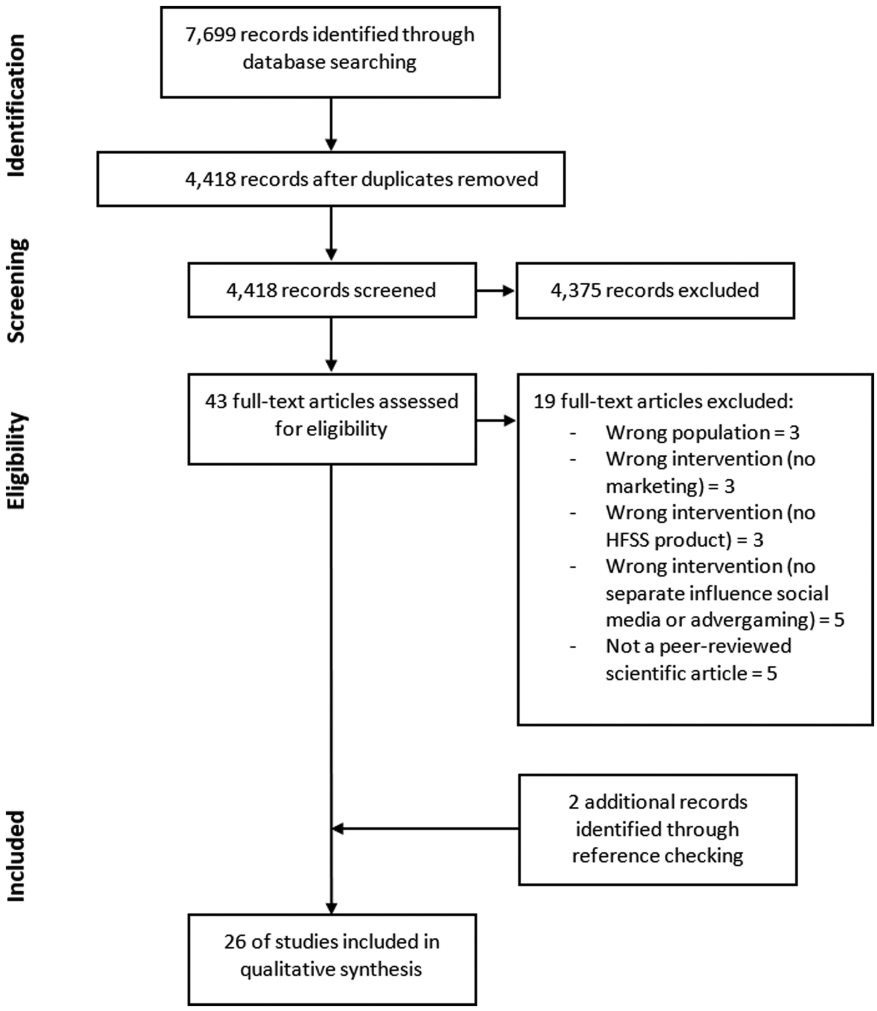

FIGURE 1 Flowchart of screening and selection procedure of studies for the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children

TABLE 2 Study characteristics of studies included in the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
Agante (2019)[62]	Non-randomized controlled trial	$N = 104$ Age range = 6–9 Mean age = not reported	Portugal	Advergaming	Pringles (potato crisps)	Experimental group 1: playing advergame on day 1, questionnaire on day 1 and a week later Experimental group 2: playing advergame 5 days in a row, questionnaire on days 1 and 5	Questionnaire without exposure to advergame	Brand and product category choice: after immediate exposure, 1 week after exposure and after repeated exposure	Both brand (Pringles: 58.6% vs. 20.6%, $p < 0.001$) and product (crisps: 34.3% vs. 11.5%, $p = 0.046$) were chosen more often after immediate exposure, when compared with control. One week after exposure, brand (63.9% vs. 20.6%, $p = 0.001$) and product (38.9% vs. 11.8%, $p = 0.034$) were still chosen more often in the first experimental group when compared with control. After repeated exposure, only brand was significantly chosen more often when compared with control (85.3% vs. 52.9%, $p = 0.015$).
Coates (2019)[28]	RCT	$N = 176$ Age range = 9–11 Mean age = 10.5 ± 0.7	United Kingdom	Social media (YouTube influencers on Instagram)	Unhealthy snacks (jelly candy and chocolate buttons)	Mock Instagram profiles of two popular YouTube vloggers promoting unhealthy snacks	Mock Instagram profiles of two popular YouTube vloggers promoting healthy snacks (carrots and grapes) or non-food items	Overall energy intake (kcal) and unhealthy snack intake	Exposure to unhealthy Instagram profiles led to 26% more kcal intake vs. non-food condition (448.3 vs. 357.1 kcal, $p = 0.001$) and 15% more kcal intake vs. healthy Instagram condition (448.3 vs. 388.96 kcal, $p = 0.05$). Exposure to unhealthy Instagram profiles led to 32% more unhealthy snack intake vs. non-food condition (384.83 vs. 292.24 kcal, $p = 0.001$) and 20% more vs. healthy condition (384.83 vs. 319.51 kcal, $p = 0.03$). There was no statistically significant difference in energy and unhealthy snack intake between the non-food condition and healthy Instagram condition.

(Continues)

TABLE 2 (Continued)

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
Coates (2019)[63]	RCT	$N = 151$ Age range = 9–11 Mean age = 10.32 ± 0.6	United Kingdom	Social media (YouTube vlogs)	McVitie's (chocolate digestive cookies)	Influencer marketing of McVitie's cookies, with or without an advertising disclosure	Influencer marketing of a non-food item	Cookie intake in kcal (McVitie's brand or alternative)	Children who viewed vlogs with a disclosure had a 12% higher overall snack intake than children exposed to non-food marketing, $F(2, 144) = 4.28$, 0.016, $\eta p2 = 0.06$. Children exposed to vlogs with a disclosure consumed 41% more marketed snack kcals than children exposed to non-food marketing (214.40 vs. 149.61 kcal, $p = 0.002$).
Dias (2011)[64]	RCT	$N = 231$ Age range = 7–8 Mean age = not reported	Portugal	Advergaming	Healthy and unhealthy snacks	Advergame including unhealthy snack marketing, followed by a questionnaire	Advergame including healthy snack marketing, followed by a questionnaire	Healthy snack selection (0–6 snacks)	70% of children exposed to the advergame including healthy snack marketing chose ≥3 healthy snacks. 63% of the children exposed to the advergame including unhealthy snack marketing chose ≥3 unhealthy snacks. 4.3% of children from the advergame including unhealthy snack marketing chose 6 healthy snacks vs. 15.5% of children from the advergame including healthy snack marketing ($p < 0.001$).
Esmaeilpour (2018)[65]	RCT[a]	$N = 330$ Age range = 6–11 Mean age = not reported	Iran	Advergaming	Healthy and unhealthy food	Healthy/unhealthy advertising × high/low entertaining media (5-min advergame/ 2 min of TV)		Unhealthy food choice frequency	Children exposed to unhealthy foods (through advergaming and TV) significantly chose more unhealthy foods than the children exposed to healthy foods ($M = 2.899$ vs. $M = 2.146$, $p < 0.001$). Exposure to unhealthy foods through advergaming led to choosing more unhealthy foods than exposure through TV ($M = 3.5$ vs. $M = 2.298$, $p = 0.003$).
Folkvord (2013)[29]	RCT	$N = 270$ Age range = 8–10	The Netherlands	Advergaming	Energy-dense snacks and fruit	Advergame promoting energy-dense snacks, fruits or non-food	No advergaming	Caloric intake of energy-dense snacks and fruit	Children exposed to both food advergames ate significantly more than the non-food group

TABLE 2 (Continued)

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
		Mean age = 8.9 ± 0.8							and the control condition (202 and 183 kcal vs. 130 and 106 kcal, $p < 0.01$). The children from the food advergame groups also ate significantly more energy-dense snacks than the children from the control group (170 and 150 kcal vs. 80 kcal, $p < 0.01$). When analyzing apple intake alone (instead of total fruit intake), the children from the energy-dense condition ate significantly more apples than the non-food and control conditions ($p < 0.05$).
Folkvord (2014)[66]	RCT[b]	$N = 261$ Age range = 7–10 Mean age = 7.7 ± 0.7	The Netherlands	Advergaming	Energy-dense snacks	Advergame promoting energy-dense snacks	Advergame promoting non-food items	Caloric intake (kcal)	Children in the energy-dense condition ate significantly more kcal compared to the non-food condition, 156.3 vs. 101.3 kcal, $F(1, 252) = 18.541$, $p < 0.01$.
Folkvord (2015)[67]	RCT[c]	$N = 92$ Age range = 7–10 Mean age = 8.4 ± 1.1	The Netherlands	Advergaming	Energy-dense snacks	Advergame promoting energy-dense snacks	Advergame promoting non-food items	Caloric intake (kcal)	Children who played the advergame promoting energy-dense snacks ate significantly more than children who played the advergame promoting non-food products (178.0 vs. 132.9 kcal, $p < 0.05$).
Folkvord (2016)[68]	RCT[d]	$N = 133$ Age range = 7–10 Mean age = 8.9 ± 1.0	The Netherlands	Advergaming	Energy-dense snacks	Advergame promoting energy-dense snacks	Advergame promoting non-food items	Caloric intake (kcal)	The main effect of type of advergame on intake (kcal) was not significant, $F(1, 129) = 0.10$, $p = 0.75$.
Folkvord (2017)[69]	RCT	$N = 562$ Dutch: $N = 211$ Age range = 6–11 Mean age = 9.0 ± 1.18	The Netherlands and Spain	Advergaming	Energy-dense snacks	Advergame promoting energy-dense snacks, with and without protective message	Advergame promoting non-food items, with and without protective message	Caloric intake (kcal)	The type of advergame influenced total snack intake among Dutch children, $F(1, 103) = 9.847$, $p = 0.001$, but not among Spanish children, $F(1, 170) = 0.061$, $p = 0.417$. Dutch children from the unhealthy advergame group ate significantly

(Continues)

TABLE 2 (Continued)

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
		Spanish: $N = 351$ Age range = 6–12 Mean age = 8.9 ± 1.68							more energy-dense snacks than children from the non-food advergame group (182.43 vs. 90.27 kcal, $p = 0.001$). The type of advergame only influenced the total snack intake among Spanish children in the age category of 9–12 ($p = 0.012$), where the energy-dense advergame led to higher intake than the non-food advergame (specific numbers not reported). The interaction effect of type of advergame*protective message was not significant on total snack intake among Dutch children, $F(1, 120) = 1.556$, $p = 0.107$, or Spanish children, $F(1, 346) = 0.439$, $p = 0.254$.
Folkvord (2020)[70]	RCT	$N = 132$ Age range = 13–16 Mean age = 14.1 ± 0.96	The Netherlands	Social media (Instagram)	Red pepper and energy-dense snacks	Instagram post promoting red peppers	Instagram post promoting energy-dense snacks or non-food items	Vegetable intake	There was no significant main effect of type of Instagram post on vegetable intake ($p > 0.05$). There was also no significant effect of condition on the consumption of individual vegetable types ($p > 0.05$ and BF10 = 0.095).
Hang (2008)[71]	RCT[e]	$N = 71$ Age range = 5–6 Mean age = not reported	China	Advergaming	7Up (soft drink)	Advergame promoting 7Up	Advergame without product placement	Beverage choice	56% of the children in the experimental group chose 7Up vs. 29% of the control group (chi-square = 5.296, $p < 0.05$)
Harris (2012)[72]	RCT	$N = 149$ Age range = 7–8 and 9–12 Mean age = 9.4	United States of America	Advergaming	Sweet snacks, fruit and vegetables	Advergame promoting unhealthy foods	Advergame promoting healthy foods or non-food items	Intake (in grams) of healthy, somewhat unhealthy and very unhealthy snacks	Children in the healthy condition consumed more healthy food compared to children in the unhealthy condition (86.2 vs. 57.7 g, $p = 0.02$). Children in the unhealthy condition consumed the most unhealthy foods and children from the

TABLE 2 (Continued)

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
									healthy condition the least (31.9 vs. 20.5 g, $p = 0.03$). Children in the control condition consumed amounts of healthy and unhealthy food that fell between the other conditions, but the differences were not significant ($p > 0.05$). There was no significant effect of condition on moderately healthy food consumed ($p = 0.58$).
Hernandez (2010)[73]	One-group pre-post test	$N = 128$ Age range = 10–15 Mean age = not reported	Mexico	Advergaming	Unhealthy snacks	Advergame 1: Ritz Bits sandwiches, Chips Ahoy!, Oreo and Fun fruits, with corporate snack brand Nabisco. Advergame 2: X-treme Jello, Chips Ahoy!, and Oreo with corporate snack brand name Jello.		Snack choice	65.6% of the adolescents selected the snack placed on the advergames, while 34.4% selected other brands.
Mallinckrodt (2007)[74]	Non-randomized controlled trial	$N = 294$ Age range = 5–8 Mean age = not reported	Australia	Advergaming	Froot Loops (cereal)	Advergame promoting Froot Loops	No advergame	Intentions to request brand	The exposure was not significantly associated with brand requests ($p = 0.54$).
Neyens (2017)[75]	RCT	$N = 940$ Age range = 6–14 Mean age = 9.8 ± 2.4	Belgium	Advergaming	Kellogg's Coco-Pops (sugared breakfast cereal) trough advergame or TV	Advergame or watching TV commercial promoting Kellogg's Coco-Pops	No advertising	Pester intent (4-point Likert scale from no intent to intent)	There was a significant association between advertising format and pester intent ($p = 0.044$). Pester intent was significantly higher in the advergame group, compared to the TV group ($M = 2.9$ vs. $M = 2.7$, $p = 0.014$), but not compared with the control group ($M = 2.83$, $p = 0.363$).
Pempek (2009)[76]	RCT	$N = 30$ Age range = 9–10	United States of America	Advergaming	Unhealthy or healthy snacks and beverages	Advergame promoting unhealthy snacks and beverages	Advergame promoting healthier	(Un)healthy snack and beverage selection (summary score 0–2 of snacks chosen)	Children in the healthy advergame condition selected more healthy snacks than those in the unhealthy condition, $M = 1.4$ vs.

(Continues)

TABLE 2 (Continued)

Experimental studies									
First author (year of publication)	**Study design**	**Participants**	**Country**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Control**	**Main outcome**	**Main result**
		Mean age = 9.5 ± 0.9					snacks and beverages		$M = 0.2$, $F(2, 24) = 6.23$, $p = 0.007$.
Putnam (2018)[77]	RCT[f]	$N = 132$ Age range = 4–5 Mean age = 4.8 ± 0.48	United States of America	Advergaming	Unhealthy snacks or healthy snacks	Advergame promoting healthy or unhealthy snacks	Advergame without snacks	Snack and beverage selection (healthy/unhealthy)	The treatment conditions did not have a significant effect on snack consumption when compared with the control group, and the two treatment groups did not significantly differ from each other either (chi-square = 2.11, $p = 0.35$).
Rifon (2014)[78]	RCT	$N = 276$ Age range = 5–10 Mean age = 7.3	United States of America	Advergaming	Froot Loops (cereal)	Advert exposure type: integrated, background or no advertising (control) × Exposure interaction: playing the advergame or watching a video of the advergame		Purchase requests (scale 0–5: definitely no to definitely yes)	There was a significant effect of exposure type and interaction with the game on purchase requests ($p = 0.037$). For the play condition, the background advertising led to the greatest purchase request and the control to the least. The integrated advertising was most effective on purchase requests in the watch group, followed by the control group. Overall, the watch group had greater purchase intentions than the play group.
Shefali (2015)[61]	One-group pre- post-test[g]	$N = 15$ Age range = 5–8 Mean age = not reported	India	Advergaming	Kentucky Fried Chicken (Fried chicken)	Advergame promoting fried chicken		Purchase request intention and product choice	When asked, 60% of the children wanted to eat the product after the game. The KFC brand was also preferred for consumption over other brands. When asked after playing the game, 60% of the children said they would ask their parents to buy KFC. Fifteen minutes later, when asked which food they would like to order, most of the children preferred other fast food brands.

TABLE 2 (Continued)

Experimental studies

First author (year of publication)	Study design	Participants	Country	Marketing medium	Food or beverage type	Marketing exposure/ intervention	Control	Main outcome	Main result
Smith (2020)[79]	RCT	$N = 156$ Age range = 7–12 Mean age = 8.7 ± 1.5	Australia	Advergaming	Gummy confectionery	Banner advertising, advergame or rewarded video advertising promoting gummy confectionery	Game without advertising	Brand choice and snack consumption (grams and kcal)	Children from the experimental conditions chose the advertised brand more often than the control condition, but only children from the rewarded video condition chose the brand significantly more often (64.1% vs. 19.5%, $p < 0.002$). Condition did not influence overall energy intake measured in grams, $F(3, 155) = 0.351$, $p = 0.78$, or calories, $F(3, 155) = 0.861$, $p = 0.46$.
Waiguny (2014)[80]	Non-randomized controlled trial	$N = 149$ Age range = 7–10 Mean age = not reported	Austria	Advergaming	Nesquik (instant cocoa)	Advergame promoting instant cocoa	No advergame	Pester intentions (PI) and pester behavior (PB): 0 coded as no preference, PI or PB and 1 is coded as preference, PI or PB.	PI was higher amongst children in the experimental condition than in the control group (0.55 vs. 0.08, $F = 35.431$, $p < 0.001$). PB also significantly differed per condition: PB was 0.41 in the advergame group and 0.15 in the control group ($F = 10.518$, $p = 0.001$).

Observational studies

First author and year of publication	Study design	Participants	Setting	Marketing medium	Food or beverage type	Method	Main outcome	Main result
Baldwin (2018)[81]	Cross-sectional survey	$N = 417$ Age range = 10–16 Mean age = not reported	Australia	Social media (Facebook and YouTube)	7 types of unhealthy foods and 5 types of unhealthy beverages	Survey on online food brand engagement	Weekly unhealthy food and beverage consumption scores (0–7 and 0–5)	Watching food and beverage brand videos on YouTube was significantly associated with higher intake scores for food ($B_{food} = 0.46$, $p = 0.015$), beverages ($B_{drink} = 0.34$, $p = 0.009$) and combined ($B_{combined} = 0.80$, $p = 0.003$) than for children who did not watch videos.

(Continues)

TABLE 2 (Continued)

Observational studies								
First author and year of publication	**Study design**	**Participants**	**Setting**	**Marketing medium**	**Food or beverage type**	**Method**	**Main outcome**	**Main result**
								There were no significant associations between unhealthy scores and any of the Facebook or other social media behaviors found.
Folkvord (2016)[82]	Cohort follow-up after RCT	$N = 218$ Age range = 10–12 Mean age = 11.13	The Netherlands	Advergaming	Energy-dense snacks or fruit	Choice of energy-dense snacks or fruit after an advergame featuring energy-dense snacks or fruit, or after no game two years prior	Weight status (BMI) two years (T2) after advergame-induced food intake (T1)	Energy-dense snack intake at T1 was not related to BMI at T2. Apple intake at T1 was associated with BMI in T2 in the energy-dense advergame group ($B = -0.33$, $p = 0.01$), but not when adjusted for baseline BMI.
Qualitative studies								
First author and year of publication	**Study design**	**Participants**	**Setting**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Main outcome**	**Main result**
Coates (2020)[83]	Focus groups	$N = 24$ ($n = 4$ per focus group) Age range = 10–11 Mean age = not reported	United Kingdom	Social media (YouTube vlog)	Nutella (chocolate spread)	Vlog containing Nutella marketing segment	Behaviors influenced by HFSS marketing	YouTuber videos are often consulted to inform future purchase decisions. Some children thought that influencer marketing is likely effective because viewers will wish to imitate the YouTuber's behavior. Many children believed they were affected by exposure to the influencer marketing campaign for Nutella. Some children displayed conscious motivation to resist the effects of marketing. However, the ability to resist the effect is questionable.
Thaichon (2016)[84]	Semi-structured interviews	$N = 30$ Age range = 11–16	Australia	Social media	Fast food	Snapshots of fast food marketing in	Intentions to eat unhealthy food	The children stated that appealing pictures create positive perceptions

TABLE 2 (Continued)

Qualitative studies								
First author and year of publication	**Study design**	**Participants**	**Setting**	**Marketing medium**	**Food or beverage type**	**Marketing exposure/ intervention**	**Main outcome**	**Main result**
		Mean age = not reported				social networking sites		of fast food consumption, which influences willingness to try advertised food. They also said that they tend to change their eating habits after repeatedly being exposed to social network advertisements.

Abbreviations: BMI, body mass index; kcal, kilocalories; RCT, randomized controlled trial.

[a]The influence of health knowledge activation (other main factor researched in study, but not of interest in this review).

[b]The influence of impulsivity (other main factor researched in study, but not of interest in this review).

[c]The influence of attentional bias (other main factor researched in study, but not of interest in this review).

[d]The influence of a go/no-go task to modify implicit approach reactions (other main factor researched in study, but not of interest in this review).

[e]The influence of mood (other main factor researched in study, but not of interest in this review).

[f]The influence of character awareness (other main factor researched in study, but not of interest in this review).

[g]The authors of this article state that the study design is qualitative. However, an experiment has been conducted. This study was included as an experimental study in this review.

through a qualitative design). The authors found that children use YouTube videos to consult their future purchase decisions and are affected by influencer marketing[83] and that repeated exposure to this influence can lead to higher willingness to try a product and therefore change in their eating habits.[84]

Four studies examined the influence on a more proximal outcome: food or beverage intake. Two experimental studies found that promotion of unhealthy snacks by a social media influencer led to higher snack intake[28,63] and another found no effect of the promotion of unhealthy snacks by a social media influencer on vegetable consumption.[70] One observational study found that watching food and beverage brand videos was associated with higher reported food and beverage intake.[81] Thus, three of the four studies found a significant effect in the expected direction, that is, that marketing increased intake of the marketed product.

3.3.2 | Advergaming

Of the 20 studies focused on the effects of food and beverage marketing through advergames, four studies focused on the outcome most distal to influencing obesity: pester intentions. One of these studies concluded that advergame exposure is associated with higher pester intentions and pester behaviour,[80] but two other studies found no such effect on brand request[74] or pester intentions.[75] Background advertising was most effective in heightening purchase requests after playing an advergame, while integrated advertising was most effective when watching an advergame being played.[78] Contrary to what was expected, watching an advergame being played resulted in more purchase requests than when playing the advergame. Thus, two of the four studies found a significant effect in the expected direction.

Four studies examined the effects of food and beverage marketing through advergames on hypothetical food or beverage choice. Two experimental studies found that children chose an unhealthy commodity promoted through the advergame significantly more often than the healthy alternative,[64,65] but one of these also found that the majority of children specifically selected the snack they were exposed to in the advergame, regardless of it being healthy or unhealthy.[64] One study concluded that the effect of advergames is even stronger a week after playing and may also be stronger after repeated exposure,[62] but another study found that exposure to an advergame only influenced snack choice for a short period of time.[61] Thus, all four studies found a significant effect in the expected direction.

Five studies examined the effects of food and beverage marketing through advergames on physical food or beverage choice. One study found that children chose an unhealthy commodity promoted through the advergame significantly more often than the healthy alternative,[71] while another found no such effect.[77] Two studies found that the majority of children specifically selected the snack they were exposed to in the advergame, regardless of it being healthy or unhealthy.[73,76] Lastly, one study only found a significant effect of advertising on actual brand choice through rewarded video advertising, but not through advergaming or banner advertising.[79] Thus, three of the five studies found a significant effect in the expected direction.

Seven studies examined the effects of food and beverage marketing through advergames on food or beverage consumption. Of those seven, four experimental studies concluded that unhealthy advergames significantly influenced children's energy-dense snack intake,[29,66,67,69] and two experimental studies found no such effects.[68,79] One of the four studies that did find a significant influence of advergames on energy-dense snack intake only found this influence in a part of the sample and concluded that the effect size was not lowered by adding a protective message.[69] Another study found that children have a higher intake of the marketed product they are exposed to, regardless of it being healthy or unhealthy.[72] Thus, five of the seven studies found a significant effect in the expected direction.

Finally, one study focused on the outcome most proximal to influencing health: measures of weight. The researchers found that snack choice after playing an advergame did not strongly influence BMI 2 years later.[82]

3.4 | Risk of Bias assessment

Tables 3, 4 and 5 show the risk of bias assessments of the experimental, observational and qualitative studies. Sixteen of the 22 experimental studies were classified as having a high risk of bias; the other six were classified as moderate risk of bias (see Table 3). Only four studies had a low risk of bias in the randomization process domain, as other studies did not use randomization, they did not provide information on allocation concealment or on baseline differences between intervention groups. All studies had a moderate risk of bias in the deviation from intended interventions domain, as no information was provided on the blinding of people delivering the intervention and the possible consequences. Seventeen studies had a low risk of bias in the missing outcome data domain, as only three had a moderate risk of bias and two studies had a high risk of bias due to a loss to follow-up higher than 5% or no information was provided on whether data was available for all participants which may have led to changes in the true value of the reported effect size. In the measurement of outcome domain, three studies had a low risk of bias, 14 a moderate risk of bias, and five a high risk of bias. The studies that had a high risk of bias in this domain either did not blind the outcome assessors or had an inappropriate method of measuring the outcome. In the selection of reported results domain only two studies had a low risk of bias due to the registration of the study protocol in an online database which showed a pre-specified analysis plan. The 20 other studies did not report on such a plan and were therefore assessed as having a moderate risk of bias. Support for these judgements can be found in the supplementary material (Table S7).

One of the observational studies was classified as having a high risk of bias as ascertainment of exposure and outcome were through self-report, there was no demonstration that the outcome of interest was not present at the start of the study and there was no statement of follow-up. The other study was

TABLE 3 Risk of bias assessments of the experimental studies included in the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children—Cochrane Collaboration Risk of Bias Tool

Author (date)	Randomization process	Deviation from intended intervention	Missing outcome data	Outcome measurement	Selection of reported result	Overall bias
Agante (2019)[62]	High	Moderate	Low	High	Moderate	High
Coates (2019)[28]	Low	Moderate	Low	Moderate	Moderate	Moderate
Coates (2019)[63]	Low	Moderate	Low	Moderate	Moderate	Moderate
Dias (2011)[64]	Moderate	Moderate	Low	High	Moderate	High
Esmaeilpour (2018)[65]	Moderate	Moderate	Low	Moderate	Moderate	High
Folkvord (2013)[29]	Moderate	Moderate	Low	Moderate	Low	Moderate
Folkvord (2014)[66]	Moderate	Moderate	Low	Moderate	Moderate	High
Folkvord (2015)[67]	Moderate	Moderate	High	Moderate	Moderate	High
Folkvord (2016)[68]	Moderate	Moderate	Low	Moderate	Moderate	High
Folkvord (2017)[69]	Moderate	Moderate	Moderate	Moderate	Moderate	High
Folkvord (2020)[70]	Moderate	Moderate	Low	Moderate	Moderate	High
Hang (2008)[71]	Low	Moderate	Low	Low	Moderate	Moderate
Harris (2012)[72]	Moderate	Moderate	Low	Moderate	Moderate	High
Hernandez (2010)[73]	High	Moderate	Low	Moderate	Moderate	High
Mallinckrodt (2007)[74]	High	Moderate	High	Moderate	Moderate	High
Neyens (2017)[75]	Moderate	Moderate	Low	Moderate	Moderate	High
Pempek (2009)[76]	Moderate	Moderate	Moderate	High	Moderate	High
Putnam (2018)[77]	Moderate	Moderate	Low	Low	Moderate	Moderate
Rifon (2014)[78]	Moderate	Moderate	Moderate	High	Moderate	High
Shefali (2015)[61]	High	Moderate	Low	High	Moderate	High
Smith (2020)[79]	Low	Moderate	Low	Moderate	Low	Moderate
Waiguny (2014)[80]	High	Moderate	Low	Low	Moderate	High

Note: Low risk of bias
Moderate risk of bias
High risk of bias

TABLE 4 Quality and risk of bias assessments of the observational studies included in the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children – Newcastle-Ottawa Scale

Cohort studies	Author (date)	Selection	Comparability	Outcome	Overall bias
	Baldwin (2018)[81]	Moderate	Low	High	High
	Folkvord (2016)[82]	Low	Low	Low	Low

Note: Low risk of bias
Moderate risk of bias
High risk of bias

classified as having a low risk of bias (see Table 4). Support for these judgements can be found in the supporting information (Table S8).

The quality assessments of the qualitative studies indicated that there were concerns in two of the three domains for both studies (see Table 5).

4 | DISCUSSION

With this systematic review we add to the growing evidence base on the commercial determinants of childhood obesity. Our narrative synthesis of the evidence suggests that marketing of unhealthy foods and beverages through social media and advergaming is effective in

TABLE 5 Quality assessments of the qualitative studies included in the systematic review researching the influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children - CASP domains

Author (date)	Section A	Section B	Section C
Coates (2020)[83]	This study clearly states its aims, for which a qualitative methodology is appropriate, as the research focuses on attitudes and understandings of influencer marketing and its behavioral effects. The research design, recruitment strategy and data collection methods were appropriate for this study (population). There was no prior relationship between the participants and the researcher, rapport was built before starting the main part of the research. Also, the children were assured there were no right or wrong answers.	The study was approved by the University of Liverpool Institute of Psychology, Health and Society Research Ethics Committee. No other ethical issues occurred. The thematic analysis was sufficiently rigorous. The transcripts were checked for mistakes and repeatedly read for familiarization. A second researcher provided feedback on the initial codebook and themes but did not individually code, which decreases credibility. The findings were clearly stated per theme and substantiated with quotes, which also increases credibility.	The results section states that this research provides valuable insight into the effects of online HFSS product marketing towards children. This is a short discussion section, which does not comprise the value of the study.
Thaichon (2016)[84]	The aim of this research is clearly stated. A qualitative interview design is appropriate for investigating the impact of online advertising via social network sites on children's intention to consume unhealthy food. The recruitment strategy is unclear. The authors don't mention the relationship between the children and the researcher.	The article does not mention any ethical considerations that have been taken into account. The findings are clearly stated through the themes that emerged from the interviews. Many quotes are provided to substantiate the findings, which improves credibility. The data analysis method was unclear, as the authors did not describe which author conducted the analysis. This decreases the study's credibility and dependability.	This study's findings have significant implications for policy makers and practitioners.

promoting requests for and purchase, choice and intake of unhealthy foods and beverages. Although the studies were heterogeneous in their outcome measures and effect sizes, the majority of studies found significant associations between exposure to advergames or social media marketing and diet-related outcomes. In addition, the two qualitative studies showed that children are aware that their eating behavior is influenced by unhealthy food and beverages through social media. Nevertheless, the findings must be seen in the light of the high risk of bias of most included studies.

Perhaps unsurprising, the findings from this review are in line with the findings from previous reviews focused on marketing in general,[7,85] screen-based marketing[6,7,85,86] and online marketing.[6] The combined evidence suggests that children's food preference, selection and intake is significantly affected by unhealthy food and beverage marketing. While a review that focused specifically on (pre) adolescents showed that television, print and Internet marketing had a small effect on food purchase and consumption,[32] studies that focused on these effects in adult populations showed inconclusive results.[6,31] This confirms that children are more susceptible to media and marketing influences.[5] Unlike other reviews, this article specifically focuses on the two most used media by children in which HFSS marketing is often present, for which the need has been indicated by previous reviews.[31,32] As online HFSS marketing methods are rapidly evolving, it is crucial to use the most recent synthesis of evidence to substantiate policy restrictions.

In real life, children are exposed to marketing communications throughout the day and it is likely that exposure from multiple settings and media accumulates over days, weeks and years.[87] This is problematic as many of the products marketed to children are unhealthy and repeated exposure may contribute to unhealthy habit formation.[88] Indeed, marketing influences from different sources amplify the effects of marketing through other media[89] and the commercial success of marketing builds precisely on these "mere exposure effects" (the effects of repeated exposure).[90] Although we were unable to capture these population-level effects of repeated exposure to unhealthy food and beverage marketing in the current review, our work on the individual responses to limited and framed unhealthy marketing provides a crucial link between the global food system drivers and the observed increases in obesity, diabetes and cardiovascular disease.[91]

The results should, however, be interpreted with caution as all studies had a moderate or high risk of bias, which decreases their quality and undermines the reliability of the results. The high risk of bias of many of the included studies was mainly attributable to lack of information about allocation concealment, blinding of personnel and trial registration. While studies potentially had a lower level of bias than the risk of bias assessment may suggest, lack of reporting on

these items leads to uncertainty about the level of bias. Cross-disciplinary reporting guidelines may be able to address these issues currently causing uncertainty about the strength of the evidence base.

4.1 | Strengths and limitations

There are several important considerations when interpreting the outcomes of this review. First, as the principal outcomes and effect measures from the included studies were diverse, conducting a meta-analysis was not possible. Due to this limited comparability between studies, it was not possible to calculate a weighted overall effect, as would have been possible when conducting a meta-analysis.

Second, studies assessing the effects of alcohol marketing were excluded, but it is likely that children are still exposed to such marketing. Even though in most countries it is not legal to target underage children with alcohol advertisements, a case study found that it is possible to subscribe to and view an alcohol brand YouTube channel with underage profiles.[92] Two other studies found that children are subjected to alcohol marketing multiple times a day, through product packaging and supermarkets, which normalizes alcohol in children's environments.[93,94] This suggests that alcohol marketing should be included in future reviews investigating unhealthy food and beverage marketing targeting children. Therefore, this is a limitation of the review process.

Third, it is possible that publication bias has occurred. Of the 24 experimental and observational studies included in this review, only one study found no significant results. This may be caused by researchers not publishing their research if it does not yield significant results. If so, the effects of HFSS marketing through social media and advergaming may be smaller than suggesting in this review.

An important strength of the review was the inclusion of different study designs. The included randomized controlled trials provided primary evidence of the highest level and the observational and qualitative studies added to the body of evidence. By including these different designs, it is certain that all available evidence is included in this review. Also, the confidence in the findings of this review is strengthened as the results of different study designs point to the same conclusion.[95]

Another important strength is that we were able to assess potential language bias as we did not restrict the search to English-language publications, but only excluded articles based on language during the selection process. Only nine articles were excluded based on language, therefore the risk of language bias is low.

Moreover, this is the first systematic review of marketing via the two most popular media among children on diet-related outcomes. Previous reviews have indicated the need for a review of these increasingly popular media.[31,32] Even though only six of the included studies focused on social media, it provides initial insights into the harmful effects of unhealthy food and beverage advertising through this type of medium. Together with the existing literature, this review provides evidence for the harmful effects of food and beverage marketing media that influence children's diet-related outcomes.

4.2 | Implications for practice, policy and future research

Children are increasingly exposed to marketing for unhealthy foods and beverages via the Internet.[56,96–99] As screen media use and obesity rates are rising,[1,100] it is imperative to understand their interrelation and take proper measures to prevent illness arising therefrom. (Inter)national restrictions regarding HFSS marketing towards children could include the prohibition of celebrity endorsements or use of premiums, restrictions from advertising HFSS products in "children's media" or restricting food businesses' social media sited from carrying content designed to engage children until a certain age.[101] However, these regulations are only effective to a limited extent and each have implementation issues.[101]

Given the speed in which commercial food and beverage companies develop new marketing strategies,[102] future research could focus on the way in which these companies respond to planned or implemented regulatory policies, for example through a complex systems approach. Indeed, the food and beverage industry is part of the global food system that consists of a complex web of interactions between producers, retailers, customers, media, policy makers, etc. If public health interventionists plan to intervene in this system with the aim to reduce children's exposure to unhealthy food and beverage marketing, actors in this system that would perceive these interventions as adverse to their business will try to restore a balance in the system that is in their favor. That is, the way a complex system respond to an intervention may lead to unintended or unexpected responses and it is therefore of importance that public health interventionists understand the interplay between the food system and the proposed interventions.[103,104] If restrictions are implemented in certain regions, large-scale natural experiments can provide important insights into the longer-term effects of reduced exposure to marketing on changes in population levels of childhood obesity in a real-life setting.

It should be noted that the search in this systematic review yielded a substantially smaller amount of articles on social media than advergames. It is possible that there is so little literature about social media marketing effects because this data is not (or only limitedly) being released by social media companies. The data from the studies used in this review is sparse when compared to worldwide social media use. Large-scale studies using data from the biggest social media companies could give insights in the true extent of these effects. Also, it is notable that qualitative and observational studies are scarce when compared to experimental studies. However, these study designs bring valuable depth as they provide insight in aspects such as how marketing influences people in different stages in life, how marketing is perceived in different cultures and what makes certain groups of people more susceptible to marketing.

Finally, the outcomes considered in this review are more proximal to disease risks such as obesity, but other determinants such as product preference, recall and attitude are also an integral part of the hierarchy of effects of advertising.[34] Therefore, the determinants more distal to disease risk should also be taken into consideration in the process of policy-making.

5 | CONCLUSION

Although the number of available studies is limited and risk of bias is high, this review provides consistent evidence that the marketing of unhealthy food and beverages through social media and advergaming influences children's pester behaviors, food choices and food intake. Together with research on the effects of food and beverage marketing on children from the past decade, this review provides clear evidence of the need for change in (online) marketing restrictions. Given that the far majority of marketing is for unhealthy foods and beverages, policy makers should take these findings into consideration and extend and reinforce measures to protect children from these persuasive efforts to influence their eating habits.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTIBUTIONS

CMM and JDM conceived the review. RV had the primary responsibility of preparing and conducting the search. CMM and JDM contributed to the analysis of the results and to the writing of the manuscript. All co-authors were involved in revising the manuscript and reviewing the final version. All authors approved the final manuscript.

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