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REVIEW

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A systematic review and meta-analysis of the effect of digital game-based or influencer food and non-alcoholic beverage marketing on children and adolescents: Exploring hierarchy of effects outcomes

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Summary

Videogame livestreaming platforms are an emerging form of digital media, popular with young people, where users watch gaming influencers play videogames. Food and non-alcoholic beverage (hereafter: food) brands have a substantial presence on these platforms, yet no studies have examined the impact of this food marketing on young people. This systematic review and meta-analysis examined the evidence (quantitative or mixed-method) for a relationship between exposure to digital game-based or influencer food marketing, and food-related (brand awareness, attitudes, preferences, purchase, and consumption), and post-consumption (weight, body mass index [BMI], and dental caries) outcomes in young people (≤18 years). Twenty-three databases were searched in March 2021. Twenty-two studies met the inclusion criteria, of which 20 were included in the quantitative synthesis. Meta-analyses indicated food marketing was associated with more positive attitudes and greater preferences (OR = 1.74, $p < 0.001$ [95%CI: 1.355, 2.232]), and increased consumption (SMD = 0.37, $p < 0.001$ [95%CI: 0.219, 0.529]). Narrative synthesis indicated that food marketing may increase brand awareness but not pester intent, although data were limited. Evidence suggests that there is a relationship between exposure to food marketing via influencers and digital gaming media, and several food-related outcomes. This is the first quantitative synthesis to demonstrate these relationships; this work has implications for food marketing policy.

KEYWORDS
advergame, food marketing, influencer marketing, in-game advertising

1 | INTRODUCTION

Global rates of overweight and obesity among children and adolescents have more than quadrupled since 1975, rising from just 4% to over 18% in 2016.[1] In the UK specifically, by age 11, one in four children are living with obesity, and almost one in five with overweight, and these rates persist into late adolescence.[2,3] Typically, weight gain occurs because of excess energy intake,[4] which can be driven by a

myriad of disparate and associated factors, including behavior, genetics, culture, and environment.[5] One key environmental factor is the pervasive marketing of foods that are high in (saturated) fat, salt, or sugar (HFSS).[5] In recent years, food giants have shifted focus from more traditional media to digital media as an outlet for food marketing.[6,7] The marketing is predominantly for unhealthy foods and is increasing exponentially over time.[8] This shift in marketing outlet mirrors growth in child digital media usage. Globally, under 18 s account for an estimated 1 in 3 internet users, with 71% of youth worldwide able to access digital media.[9] Among UK 12–15 year olds, 87% use social media, 80% play games online, and 60% use livestreaming platforms (platforms where individuals or organizations can broadcast live video content to their audience online).[10] These usage habits are similar for teenagers in the United States,[11] and Australia.[12]

Marketing for HFSS foods is prevalent on social media. Specifically, content analyses have identified a strong presence of HFSS food marketing on Instagram,[13] YouTube,[14] Facebook,[8] and Twitter.[8] This marketing frequently occurs via social media influencers. Influencers are seen as familiar and trustworthy, and their opinions can affect those of their subscribers,[15,16] with many seeking them out for companionship,[17] and aspiring to be like them.[18] Children's imitation of food-related behavior is thought to occur via social learning,[19] which is more likely to happen if a para-social relationship (i.e., the relationship a child develops with a media character) exists.[20] A growing body of evidence suggests that this is indeed the case. A systematic review found that the use of celebrities and influencers in both traditional and digital marketing significantly increased children's consumption of marketed HFSS products by 56.4 kcal.[21]

Young people are also frequently exposed to HFSS food marketing within digital gaming media. Digital game-based marketing typically occurs via in-game advertising (IGA) and advergames.[22,23] More recently, brands have integrated themselves into the online game platform Roblox, which is popular with children.[24] For example, Chipotle launched a Chipotle Burrito Builder, which allows players to roll virtual burritos to earn "Burrito Bucks" that can be exchanged for codes on the chain's digital platforms.[25] Social cognitive theory posits that children may construct ideas about brand preference through continual play,[19] and these learned preferences can be reinforced by rewards (e.g., in-game currency for completing an in-game task).[26] Evidence suggests that food marketing via gaming media influences a variety of food-related behaviors in young people. A systematic review found that food marketing via advergames influences attitudes toward, and purchase and consumption of marketed brands and products in 6–14 year olds.[27] More broadly, a substantial body of research outlines the impact of IGA on brand-related cognitive, attitudinal, and behavioral responses of predominantly adults.[23] However, syntheses of research on the effects of IGA and more current digital gaming media on child food-related behavior are lacking.

Influencer and digital game-based marketing occur in tandem on a popular and emerging form of digital media: videogame livestreaming platforms. On these platforms, individuals can broadcast or watch streamed videogame footage and communicate synchronously with both streamers and other viewers on the platforms, which can be accessed via PC, tablets, mobile devices, and gaming consoles.[28] The current top three most popular videogame livestreaming platforms (in terms of market share by hours watched) are Twitch (~71%), YouTube Gaming (~14.5%), and Facebook Gaming (~14%).[29] On these platforms, there is a main video stream, which typically features the gameplay and streamer (or "gaming influencer"). This presents a marketing opportunity for food brands. For example, a gaming influencer may consume a product on screen (typical influencer marketing) or include a brand logo overlaid on the gameplay (typical digital game-based marketing) (see Figure 1 for an example of these marketing techniques). HFSS food marketing is known to be ubiquitous on these platforms, with energy drinks (e.g., GFUEL), restaurants and food delivery services (e.g., KFC, Uber Eats), sugary drinks (e.g., Mountain Dew), and processed snacks (e.g., Doritos) representing the most frequently advertised food categories.[30,31] Preliminary evidence suggests that food marketing via Twitch is associated with food purchasing and consumption behaviors in adults[32] and adolescents.[33] Yet, to date, no studies have explored this effect in children experimentally. However, with videogame livestreaming platforms representing a hybridisation of digital game-based and influencer marketing, it may be possible to infer the likely effects through investigation of the effects of these two marketing outputs.

A large majority of UK children use video-sharing platforms, play videogames online, and watch livestreams (99%, 80%, and 60% of 12–15 year olds respectively[10]). Young teens (13–16 year olds) also report viewing content on Twitch whilst playing videogames.[24] Moreover, available data (16 years and above) on Twitch users suggests that the viewer base is skewed toward a younger audience (41% of users are aged 16–24),[34] and an estimated 1 in 10 viewers is thought to be a teenager.[35] Streamed games also include those popular with children, such as Fortnite and Minecraft; both were in the top five most watched games across the three platforms during 2021[29] and have been nominated for Kid's Choice Awards multiple times in recent years.[34,36]

Children may be particularly vulnerable to influencer and digital-game based marketing techniques due to a range of factors. One key factor is their developmental stage (i.e., cognitive and emotional maturity[37,38]). The Reactivity to Embedded Food Cues in Advertising Model suggests that the level of processing of a food cue influences the effect of exposure.[39] When placements are embedded in the media content (as is typical for influencer and digital game-based marketing), children process cues with minimal cognitive elaboration,[39–41] and may not even be aware of them at all. This makes the advertising harder to recognize,[42,43] and also more difficult to resist. Another key factor is peer-group influence.[44,45] Children are in the process of identity formation and are therefore more susceptible to the influence of their peers and other external influences.[44,45] Sources such as influencers, videogames, and the communities that surround them can be hugely influential.[46] For example, a child may adopt specific eating behaviors to assimilate with a particular role model or community.[47] Moreover, when liked sources (e.g., a favorite videogame or influencer) are paired with advertising, the positive affective responses toward them can transfer onto advertised brands and products[48,49] via "meaning transfer",[50] perpetuating their consumption. There are also additional factors to consider as children reach adolescence. Teenagers are likely to have reduced parental protection and guidance,[51] and

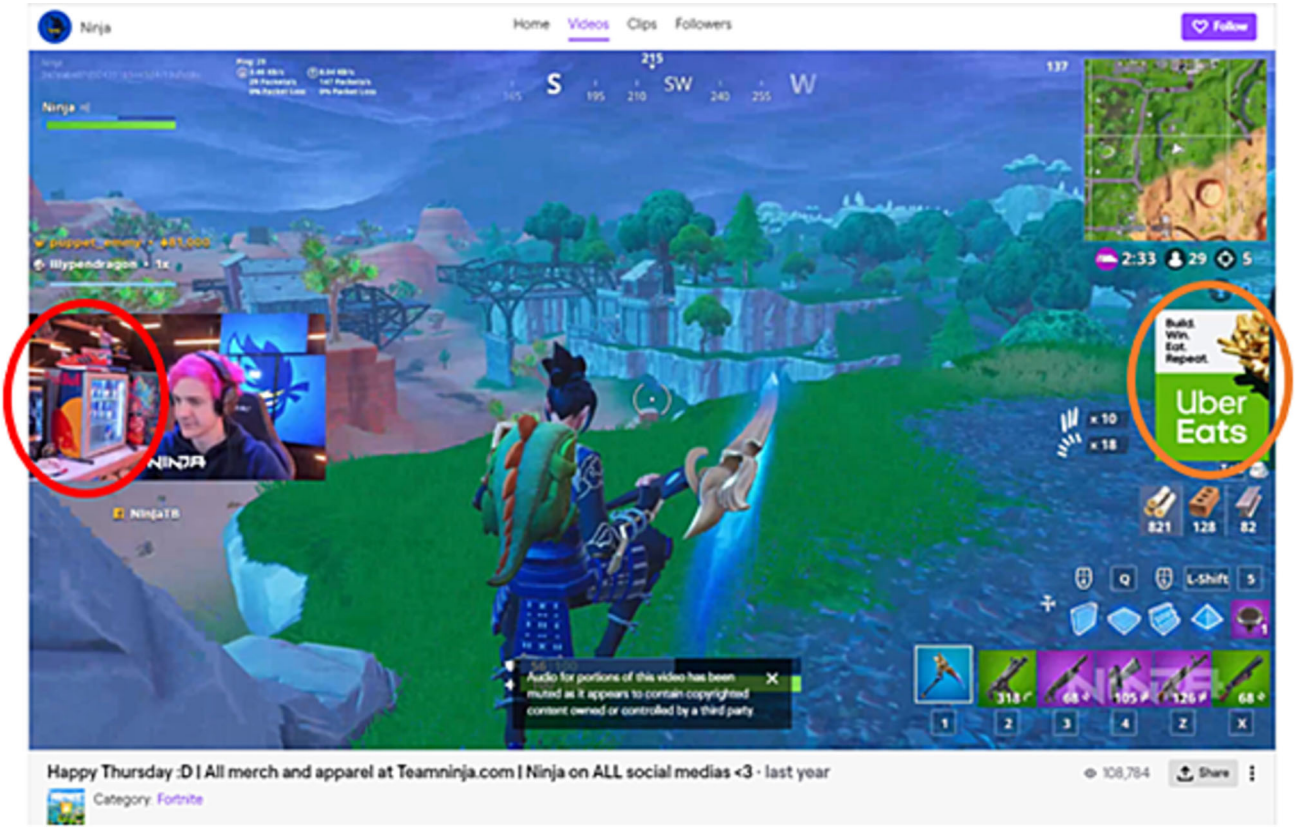

FIGURE 1 Examples of marketing techniques used by gaming influencers on twitch. In the red circle is an example of product placement (typical influencer marketing); in the orange circle is an example of a brand logo overlaid on the gameplay (typical digital game-based marketing).

access to their own money,[52] meaning that purchasing decisions are more within their control.

One way of describing the likely effects of food marketing via digital media on the food-related behavior of children is through the Hierarchy of Unhealthy Food Promotion Effects Model,[25] a conceptual pathway of the effects of promotions based on a narrative review of studies assessing the impact of television food promotions on children. It depicts a logical hierarchy of effects linking food promotions to post-consumption effects (weight gain and diet-related disease) via brand and product awareness (recall, recognition), attitudes and preferences, purchase (or intended purchase, product requests), and consumption (or intended consumption). There are also physiological and contextual influences that can mediate the outcomes at each step: epigenetic phenomena, food price, taste and availability, and peer and social influences.

Enhanced regulations of commercial marketing have become a priority on the global health and policy agenda.[53] Specifically, the WHO recommends policies to limit the effectiveness of HFSS food marketing to children by limiting its exposure (the frequency and reach of marketing messages) and power (the creative content, design, and execution of the marketing message).[6] One way in which power can be reduced is by restricting the use of impactful techniques that are of special appeal to children (e.g., influencers, digital games, or a combination of the two).[6] Yet, videogame livestreaming platforms currently remain out of the regulatory spotlight. Although tighter regulations on HFSS food marketing online have been announced in the United Kingdom,[54] these regulations have been pushed back to 2024, and it is unclear whether they would encompass videogame livestreaming platforms. Moreover, the top videogame livestreaming platforms are US-owned which makes HFSS food marketing on these platforms particularly difficult to regulate a national level, due to it being "cross-border."[55] Therefore, although evidence suggests that videogame livestreaming platforms have a prominent child audience,[10,34,35] employ powerful child-directed marketing techniques (influencer and digital-game based marketing),[31] and marketing on these platforms is associated with adult and adolescent food-related behavior,[32,33] they are yet to be effectively restricted by policies to protect children. To inform policy design and implementation processes, it is important to clarify the potential effects of these emerging platforms on child food-related behavior through synthesis of the available evidence.

The current systematic review and meta-analysis explores the effects of influencer and digital game-based marketing on Hierarchy of Unhealthy Promotion Effects[25]: awareness, attitudes and preferences, purchase, consumption, and post-consumption effects. The specific review question was: What is the effect of exposure to (a) digital game-based or (b) influencer marketing for food and non-alcoholic beverage brands/products on the outcomes of interest, compared to no, less, or less powerful marketing exposure?

2 | METHODS

2.1 | Protocol and registration

The current systematic review and meta-analysis was conducted and reported in accordance with the PRISMA statement checklist[56] and was registered with PROSPERO (CRD42020167360).

2.2 | Selection criteria and search strategy

We considered evidence from primary studies of quantitative or mixed-method design (randomized controlled trial [RCT] or nonrandomized study [NRS]) for inclusion if they assessed the effect(s) of either digital game-based marketing or influencer marketing with specified outcomes in children (aged 0–18 years) in relation to an appropriate comparison. See Appendix SB for a detailed summary of the PICOS inclusion and exclusion criteria.

We included both digital game-based and influencer marketing as both occur concurrently on videogame livestreaming platforms. We defined marketing as "any form of commercial communication or message that is designed to, or has the effect of, increasing the recognition, appeal and/or consumption of particular products or services. It comprises anything that acts to advertise or otherwise promote a product or service."[53] We defined *influencer* marketing as marketing via social media influencers; individuals who have built a sizeable social network of people following them. Social media influencer status can vary; they may have a "small but engaged" following (<1000 followers), micro-influencer status (1000–100,000 followers), or celebrity status (100,000–1 million+ followers).[57,58] Influencer marketing occurs when brands ask influencers to endorse their products on their social media profiles or channels in return for free promotional goods or payment.[16,59] We defined *digital game-based* marketing as marketing occurring via videogames (i.e., IGA, advergames, or videogame livestreaming platforms). IGA is the inclusion of products or brands within a digital game. Whereas an advergame is specifically designed and created to promote a brand or product.[60–62]

Outcomes of interest were derived from the Hierarchy of Unhealthy Food Promotion Effects Model[52] and included awareness (recall and recognition of brands and products), attitudes and preferences (preference for promoted brands and products [including choice over other brands and products], association of brands and products with positive attributes, normalization of promoted brands and products), purchase (purchase or intended purchase of marketed brand or product, and purchase requests), consumption (consumption or intended consumption of marketed brands or products [including desire to eat], no compensation of excess energy intake) and post-consumption effects (weight gain and diet-related disease, sustained energy imbalance through overconsumption of energy dense foods). See Appendix SB for a detailed breakdown of the outcomes.

We defined an appropriate comparison as exposure to no food marketing, less food marketing (e.g., fewer exposures), or less powerful food marketing (e.g., less prominent, frequent, and interactive).

Searches were devised in collaboration with an information specialist (M.M.) and conducted during March 2021 (see Appendix SA for the full search strategy). Twenty-three databases were searched: PsycINFO, MEDLINE, CINAHL, Web of Science (SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, and IC), ERIC, The Cochrane Library (CENTRAL, CSDR), Business Source Complete, EconLit, Emerald, HMIC, Google Scholar, Communication & Mass Media Complete and Academic Search Complete. Reference lists of retrieved systematic reviews and included articles were also scanned by hand. Searches were restricted to articles that were written in English or had an accessible English version.

One reviewer (R.E.) screened titles and abstracts of potential studies against the inclusion criteria. One reviewer (R.E.) independently screened the full texts of potential studies against the inclusion criteria; 10% of the full texts were screened by a second reviewer (A.F.). Agreement was almost perfect (96.6%, Cohen's $k = 0.87$). Disagreement was resolved through consensus and, if necessary, consulting a third reviewer (E.B.).

2.3 | Quality assessment

We used Risk of Bias 2[63] to assess bias in RCTs and the Newcastle-Ottawa Scale (adapted for cross-sectional studies)[64] to assess quality of NRS. Bias assessments were conducted independently by two reviewers (R.E. and A.F.). Disagreement was resolved through consensus and consultation of a third reviewer (E.B.) if necessary.

2.4 | Data extraction

Data extracted included study identification (authors, country, year of publication), participants, design, marketing intervention, comparison, outcomes, and relevant results. Participant data in relation to weight status and socioeconomic status was extracted to facilitate potential subgroup analyses, as these factors are known to moderate food marketing effects.[52,65] One reviewer (R.E.) extracted data using pre-piloted forms. Accuracy of data extraction was checked by a second reviewer (A.F.). Study authors were contacted, if necessary, to provide data.

For studies with multiple interventions, we extracted data from all relevant interventions and the control group or most relevant comparator intervention. For studies with interventions incorporating multiple levels of exposure, we selected the largest and smallest exposures for the exposure and comparator arms respectively, to maximize identification of effects where present. Where more than one eligible effect measure for the same outcome was available, priority was given to more comprehensive measures (e.g., overall consumption) and for unhealthy (non-core, HFSS, etc.) categories. Data was not extracted for healthy categories, and therefore studies **only** reporting these outcomes were excluded. Where effect measures included food items listed individually, the first unhealthy item in the list (based on study author descriptors and reviewer judgment) was

selected for extraction. Similarly, where effect measures included multiple adjectives relating to food attitudes (e.g., liking, fun, taste, healthiness) listed individually, the first adjective in the list was selected for extraction. Where phrasing was very similar for multiple effects relating to the same outcome in the same study (e.g., "favorite," "preferred," "chosen," brand/product), the first effect measure to be reported was selected for extraction.

2.5 | Data synthesis and analysis

Cochrane recommendations were followed for the data synthesis.[66] Meta-analyses were conducted for each outcome where studies were sufficiently homogenous (attitudes and preferences, and consumption). Where meta-analysis was not possible (awareness, purchase), we synthesized the data narratively.

For the meta-analysis on consumption, we computed the Standardised Mean Difference (SMD), using the "escalc" function in the "metafor" package[67] in R. Here the formula is [^{mean}Advertisement = ^{mean}Control/Pooled Standard Deviation], so positive SMDs are indicative of greater consumption after food marketing exposure(s). For the meta-analysis on attitudes, there was a mixture of continuous and dichotomous outcomes. For continuous outcomes we computed SMDs and for dichotomous outcomes we computed Odds Ratios. For analysis, we converted SMDs to Odds Ratios using the formula [SMD * 1.81],[68] to ensure a common effect size[69] for synthesis. As there were multiple effect sizes from individual studies, we first fit a multi-level meta-analysis and compared this to a single level

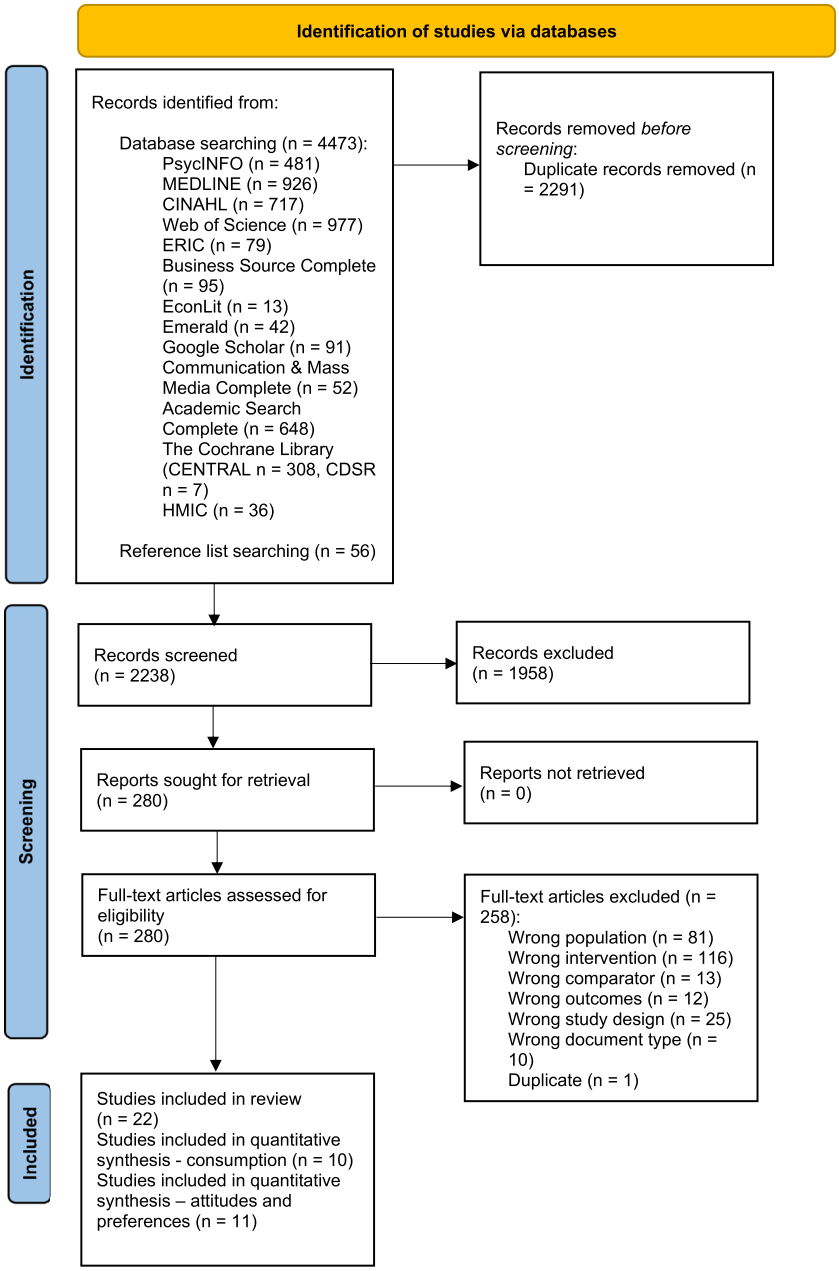

FIGURE 2 PRISMA 2020 flow diagram.

meta-analysis. Model fit indices (AIC and loglikelihood ratio) suggested that the multilevel meta-analysis was not a better fit for the data.

We conducted a number of sensitivity analyses. First, we conducted Graphical Displays of Study Heterogeneity (GOSH).[70] GOSH conducts a meta-analysis for all possible combinations of studies (2 + studies per meta-analysis). This allows us to examine the average effect size and heterogeneity across all possible combinations. Second, we conducted Trim and Fill analyses[71] to examine any potential asymmetry in funnel plots. Trim and Fill identifies any hypothetical studies which may lead to asymmetry (e.g., small studies with large effect sizes), imputes hypothetical studies to improve symmetry, and recalculates a pooled effect size based on the inclusion of these studies. We also conducted a robust Bayesian meta-analysis using the RoBMA package. The RoBMA package conducts several meta-analytic models,[72] before computing Bayes Factors for the likelihood of the true effect, presence of heterogeneity and presence of publication bias. We used an inclusion Bayes Factor of >3 as our "evidence threshold." Heterogeneity was assessed using I^2, with >50% indicative of moderate and >75% indicative of substantial heterogeneity.[73] We also report Tau values, which are the estimated standard deviation of the underlying effect sizes across the studies.

3 | RESULTS

3.1 | Identification and description of included studies

A total of 2238 titles and abstracts were assessed for eligibility and 1958 were ineligible (Figure 2). Of the 280 full-text articles assessed, 22 studies[74–95] were included in the systematic review, contributing 26 intervention arms in total. See Table 1 for summaries of the main characteristics of the included studies.

3.1.1 | Quality assessment

Quality assessments indicated that for the RCTs, the majority of studies ($n = 15$) had some concerns of bias, with four studies categorized as low risk of bias, and one study categorized as high risk of bias (see Figure 3), generated using *robvis*.[96] Concerns predominantly arose from bias in the randomization process and bias in the selection of the reported result. For NRSs, one study was of satisfactory quality, and one study was categorized as unsatisfactory (see Table 2). Concerns mainly arose from the quality of the selection process.

3.1.2 | Participants

Participant age range, where reported, was 4–18 years. The sex split was fairly even, ranging from 45% to 62.5% female across the studies. Just over half ($n = 13$) of studies reported weight status; prevalence of overweight and obesity ranged from 14.8% to 40%. Few ($n = 9$) studies reported socioeconomic status (SES), and measures varied, including SES of the recruitment area ($n = 2$), household income ($n = 4$), parental education (bachelor's degree or higher, $n = 1$), and school type (e.g., fee paying, $n = 2$). All studies were conducted in Western countries; Portugal ($n = 2$), United Kingdom ($n = 2$), Netherlands ($n = 5$), Spain ($n = 1$), United States ($n = 4$), Australia ($n = 4$), Ireland ($n = 1$), Belgium ($n = 2$), and one study had intervention arms in both the Netherlands and Spain.

3.1.3 | Design

The majority ($n = 19$) of studies used a between-subjects design. A minority ($n = 3$) of studies used a within-subjects design, but relevant comparisons were between-subjects. Nearly all ($n = 20$) studies adopted a randomized control trial design, the remaining ($n = 2$) were non-randomized studies. Most ($n = 14$) studies were conducted in schools. Other settings included research centers ($n = 1$), childcare facilities ($n = 1$), a combination of research centers and childcare facilities/holiday camps ($n = 3$), online—accessed remotely ($n = 1$), and the remaining ($n = 2$) studies did not report the specific setting.

3.1.4 | Marketing intervention

Three studies assessed marketing via social media influencers: Instagram ($n = 1$), Facebook ($n = 1$), and YouTube ($n = 1$). The majority ($n = 17$) used an advergame-based marketing intervention, with one study including an additional "watching advergame play" intervention arm,[92] and one study including two additional intervention arms, which explored banner advertising and rewarded video advertising within a digital game.[93] One study used an iPad app as a marketing medium.[91] Across all studies, marketing was predominantly ($n = 18$) for branded HFSS snacks (e.g., Pringles, McVitie's Chocolate Digestives, Pop Tarts, Lay's Potato Chips), although four studies featured marketing of unbranded HFSS snacks (e.g., cookies, ice cream, crisps, and sugary drinks). Studies from which multiple intervention arms were extracted marketed the same HFSS snacks across conditions. Where reported, duration of marketing exposure was between 1 and 12 min.

3.1.5 | Comparison

Half ($n = 11$) of comparisons were to no marketing exposure (e.g., no advergame, an "advergame" with no marketing), followed by non-food marketing exposure ($n = 6$) (e.g., branded trainers), less food marketing ($n = 2$) (e.g., via TV only), less powerful food marketing ($n = 2$) (e.g., less prominent), and healthy food (e.g., banana) marketing ($n = 1$). Studies from which multiple intervention arms were extracted adopted the same comparisons across conditions. Where reported, duration of the comparator exposure was between 0 and 12 min.

TABLE 1 Summary of included studies.

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
Agante & Pascoal (2019),[74] Portugal 10.1108/JPBM-08-2017-1554	$N = 104$ Age range = 6–9 years M_{age} = not stated 52.9% female Weight status = not stated SES = 55.2% of parents with bachelor's degree (or higher studies)	Experimental (school), between-subjects, NRS	$N = 70$ Advergame—Branded Pringles Flavor Grab. Duration: 5 min. One advergame exposure OR 5 days of one advergame exposure per day (groups combined).	$N = 34$ No advergame exposure	Preference (brand)—chose favorite chip brand (Ruffles/Pringles/Lay's) Preference (product category)—chose preferred product category (hamburger/unbranded Pringles/Jelly)	Intervention: 50% (35) selected Pringles; Comparison: 23.5% (8) selected Pringles $p < 0.001$ Intervention: 30% (21) selected chips; Comparison: 11.8% (4) selected chips, $p = 0.035$
Coates et al (2019a),[75] UK 10.1542/peds.2018-2554	$N = 178$ Age range = 9–11 years $M_{age} = 10.5$ (0.7) 59.66% female Weight status = 71% healthy, 18.2% with overweight, 10.8% with obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 58$ Mock Instagram profile (social media influencer). Images of influencer holding unhealthy snacks (e.g., cookies). Duration: 1 min.	$N = 59$ Mock Instagram profile. Images of influencer holding branded non-food items (e.g., trainers). Duration: 1 min.	Consumption—post-intervention ad-libitum intake of jelly candy and chocolate buttons (grams converted to kcal). Healthy snacks available. 10 min.	Intervention: 384.83 (141.21); Comparison: 292.24 (146.85), $p = 0.001$
Coates et al (2019b),[76] UK 10.1111/ijpo.12540	$N = 151$ Age range = 9–11 years $M_{age} = 10.32$ 52.98% female Weight status = 60% healthy, 32% with overweight, 8% with obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 51$ YouTube vlog. Influencer marketing of branded unhealthy snack (McVitie's chocolate digestives). Duration: 5 min with 1-min marketing segment.	$N = 50$ YouTube vlog. Influencer marketing of branded non-food item (Apple iPhone 8). Duration: 5 min with 1 min marketing segment.	Consumption—post intervention ad-libitum intake of McVitie's cookies (grams converted to kcal). Tesco's cookies available. 5 min.	Intervention: 181.36 (101.33); Comparison: 149.61 (67.42), $p = 0.521$
Dias & Agante (2011),[77] Portugal 10.1002/cb.359	$N = 231$ Age range = 7–8 years $M_{age} = 7.47$ (calculated) 49.4% female Weight status = not stated SES = not stated	Experimental (school), between-subjects, RCT	$N = 115$ Advergame featuring unhealthy snacks (ice cream, potato chips, cookies, etc.). Duration: ~5 min.	$N = 116$ Advergame featuring healthy snacks (banana, milk, strawberries, etc.). Duration: ~5 min.	Preference (intended consumption)—choice of 3+ unhealthy snacks to "eat" (12 pictures total, six healthy, six unhealthy, chose six snacks). Attitudes—mean unhealthy food liking (six foods, 4-point Likert scale)	Intervention: 63%; Comparison: 30.4%, $p < 0.001$, Cramer's $V = 0.34$ Intervention: 3.55 (0.42); Comparison: 3.28 (0.65), $p < 0.001$
Folkvord et al (2013),[78] Netherlands	$N = 270$ Age range = 8–10 years M_{age} = not stated	Experimental (school), between-subjects, RCT	$N = 67$ Advergame (online memory game) featuring	$N = 69$ No advergame exposure.	Consumption—post-intervention ad-libitum intake of marketed (jelly	Intervention: 156.3 (135.2); Comparison: 101.3 (74.1), $p < 0.01$

(Continues)

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
10.3945/ajcn.112.047126	48.5% female Weight status = 1.9% underweight, 80% healthy weight, 15.6% with overweight, 2.6% with obesity SES = not stated		a popular candy brand and eight different sweets from this candy brand. Duration: 5 min.		candy) and nonmarketed (milk chocolate candy shells) unhealthy snacks (grams converted to kcal). Healthy snacks available. 5 min.	
Folkvord et al (2014),[79] Netherlands 10.1542/peds.2013-3384	$N = 261$ Age range = 7–10 years M_{age} = not stated 49.8% female Weight status = 3.8% underweight, 71.3% healthy weight, 18.4% with overweight, 6.5% with obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 69$ Advergame (online memory game) featuring a popular candy brand and eight different sweets from this candy brand. Duration: 5 min.	$N = 62$ Advergame featuring a popular Dutch toy brand and eight toys from this brand. Duration: 5 min.	Consumption—during-intervention ad-libitum intake of marketed (jelly candy) and nonmarketed (milk chocolate candy shells) unhealthy snacks (grams converted to kcal). 5 min.	Intervention: 156.3 (135.2); Comparison: 101.3 (74.1), $p < 0.01$
Folkvord et al (2015),[80] Netherlands 10.1016/j.appet.2014.10.016	$N = 92$ Age range = 7–10 years (?) $M_{age} = 8.43$ (calculated) 56% female Weight status = 6.3% underweight, 75% healthy weight, 16.7% with overweight, 2.1% with obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 50$ Advergame (online memory game) featuring a popular candy brand and eight different sweets from this candy brand. Duration: 5 min.	$N = 42$ Advergame featuring a popular Dutch toy brand and eight toys from this brand. Duration: 5 min.	Consumption—post-intervention ad-libitum intake of marketed (jelly candy) and nonmarketed (milk chocolate candy shells) unhealthy snacks (grams converted to kcal). 5 min.	Intervention: 178 (99.5); Comparison: 132.9 (87), $p < 0.05$, Cohen's $d = 0.48$
Folkvord et al (2016), Netherlands[81] 10.1037/hea0000365	$N = 133$ Age range = 7–10 years $M_{age} = 8.9$ (1.0) 47% female Weight status = 3.8% underweight, 73.5% healthy weight, 18.9% with overweight, 3.8% with obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 33$ Advergame (online memory game) featuring a popular candy brand and eight different sweets from this candy brand. Duration: 3 min.	$N = 32$ Advergame featuring a popular Dutch toy brand and eight toys from this brand. Duration: 3 min.	Consumption—post-intervention ad-libitum intake of marketed (jelly candy) and nonmarketed (milk chocolate candy shells) unhealthy snacks (grams converted to kcal). 5 min.	Intervention: 223.4 (134.9); Comparison: 228.7 (151.5), $p = 0.75$
Folkvord et al (2017)[82] (1), Netherlands	$N = 211$ Age range = 6–11 years $M_{age} = 9.0$ (1.18) 49.3% female	Experimental (school), between-subjects, RCT	$N = 52$ Advergame (online memory game) featuring a popular candy brand	$N = 52$ Advergame featuring a popular Dutch toy brand	Consumption—during-intervention ad-libitum intake of marketed (jelly candy) and nonmarketed	Intervention: 182.43 (137); Comparison: 90.27 (129.1), $p = 0.001$, Cohen's $d = 0.69$

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
10.1016/j.appet.2017.01.026	Weight status = 7.1% underweight, 74.3% healthy weight, 13.3% had overweight, 5.2% had obesity SES = not stated		and eight different sweets from this candy brand. Duration: 5 min.	and eight toys from this brand. Duration: 5 min.	(milk chocolate candy) unhealthy snacks (grams converted to kcal). 5 min.	
Folkvord et al (2017)[82] (2), Spain	$N = 351$ Age range = 6–12 years $M_{age} = 8.9$ (1.68) 52.9% female Weight status = 18.5% underweight, 65.5% healthy weight, 11.1% had overweight, 3.7% had obesity SES = not stated	Experimental (school), between-subjects, RCT	$N = 83$ Advergame (online memory game) featuring a popular candy brand and eight different sweets from this candy brand. Duration: 5 min.	$N = 88$ Advergame featuring a popular Dutch toy brand and eight toys from this brand. Duration: 5 min.	Consumption—during-intervention ad-libitum intake of marketed (jelly candy) and nonmarketed (milk chocolate candy shells) unhealthy snacks (grams converted to kcal). 5 min.	Intervention: 149.5 (121.8); Comparison: 150.3 (124.2), $p = 0.417$
Harris et al (2012),[83] US 10.1080/17482798.2011.633405	$N = 152$ Age range = 7–12 years $M_{age} = 9.4$ 47.37% female Weight status = not stated SES = not stated	Experimental (research center), between-subjects, RCT	$N = 52$ Advergames—Pop-Tarts and Oreo cookies. Duration: 12 min.	$N = 50$ Advergames—JewelQuest and TumbleBugs (no food marketing exposure). Duration: 12 min.	Consumption—post-intervention ad-libitum intake of unhealthy snacks (potato chips and cookies) (grams converted to kcal by R.E.). Healthy and moderately healthy snacks available. 20 min.	Intervention: 246.15 (SE: 30.09); Comparison: 212.97 (SE: 37.04), $p = 0.65$
Mallinckrodt & Mizerski (2007),[84] Australia 10.2753/JOA0091-3367360206	$N = 294$ Age range = 5–8 years M_{age} = not stated 60% female Weight status = not stated SES = 41% attended a lower socioeconomic school, 62% attended public schools	Experimental (school), between-subjects, NRS	$N = 183$ Advergame—Fruit Loops Toss. Duration: ~5 min.	$N = 112$ No advergame exposure.	Preference (brand)—chose what cereal to "eat" (Froot Loops/ NutriGrain/Coco Pops). Preference (product category)—chose what food type to "eat" (hamburger/fruit/ salad/ sandwich/Froot Loops) Purchase (intended request)—"are you going to ask your family to buy Fruit Loops?" (yes/no)	Intervention: 65% (105) selected Froot Loops; Comparison: 35% (49), $p < 0.02$ Intervention: 54% (98) selected Fruit Loops; Comparison: 32% (35), $p < 0.001$ Intervention: 72% yes; Comparison: 72% yes, $p = 0.54$
Murphy et al (2020),[85] Ireland	$N = 72$ Age range = 13–14 years $M_{age} = 13.56$ (0.5)	Experimental (school), within-subjects, randomized	$N = 72$ Facebook news feeds of fictitious teen users.	$N = 72$ Facebook news feeds of fictitious teen users.	Awareness (brand recall)—Listed all brands they recalled seeing.	Intervention: 0.67 (0.71), 95% CIs 0.49 to 0.85; Comparison: 0.84 (0.84),

(Continues)

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
10.3390/ijerph17072181	62.5% female Weight status = not stated SES = fee-paying and non-fee-paying schools		Celebrity posts featuring 12 unhealthy food brands and an associated product (e.g., Ben & Jerry's Ice Cream—Cinnamon Buns Ice Cream)	Company posts featuring 12 unhealthy food brands and an associated product.	Awareness (brand recognition)—selected brands they recalled seeing from a list (36 target brands, 20 distractors).	95% CIs 0.63 to 1.05, $p = 0.239$ Intervention: 3.12 (1.15), 95% CIs 1.84 to 3.40; Comparison: 2.13 (1.17), 95% CIs 2.13 to 1.17, $p < 0.001$
Neyens et al (2017),[86] Belgium 10.1080/02650487.2017.1349029	$N = 940$ Age range = 6–14 years $M_{age} = 9.8$ (2.4) 53.5% female Weight status = not stated SES = not stated	Experimental (setting not stated), between-subjects, RCT	$N = 286$ Advergame—Coco-Pops. Duration: 10 min.	$N = 312$ No advergame exposure.	Attitudes—liking of Coco Pops on a 5-point Likert smiley-scale. Purchase (intended request)—"Will you ask your parents to buy Coco-Pops?" 4-point Likert scale. Preference (brand)—hypothetical choice of cereal box (Nestlés Crunch/Kellogg's Coco-Pops/Golden Bridges' Choco Chips/Crownfields' Choco Rice)	Intervention: 3.99 (0.96); Comparison: 3.81 (1.08), $p = 0.024$ Intervention: 2.90 (1.00); Comparison: 2.83 (0.97), $p = 0.363$ Intervention: 75% selected Coco-Pops; Comparison: 67%
Norman et al (2018),[87] Australia https://doi.org/10.1186/s12966-018-0672-6	$N = 154$ Age range = 7–12 years $M_{age} = 9.3$ (1.6) 50% female Weight status = 5% underweight, 80.5% healthy weight, 12.3% with overweight, 3.9% with obesity SES = median household weekly income $2000–$2499	Experimental (holiday camps and research center), within-subjects (but relevant comparisons are between-subjects), RCT	$N = 78$ Advergame and TV exposure (3 days of food adverts and 3 days of non-food adverts). Advergame—Food: Nestle Kokokrunch cereal; non-food: Lego. Played on iPad. Duration: 5 min. TV—10 × 30 s food (e.g., McVities Delichoc biscuit) and non-food (e.g., The North Face) embedded in a cartoon. Duration: 10 min.	$N = 76$ TV exposure only (3 days of food adverts and 3 days of non-food adverts). TV—10 × 30-s food (e.g., McVities Delichoc biscuit) and non-food (e.g., The North Face) embedded in a cartoon. Duration: 10 min.	Consumption—difference in post-intervention ad libitum mean snack intake between food and non-food advertising days. Mean difference = food—non-food (grams converted to KJ, then converted to kcal by R.E.). Snack foods provided: high fat savory (e.g., crinkle-cut crisps), low fat savory (e.g., pretzels), high fat sweet (e.g., milk chocolate), low fat sweet (jelly lollies), fruit (e.g., grapes) and vegetable (carrot sticks). 15 min.	Intervention: 48.04 (92.73); Comparison: 4.54 (109.94), $p < 0.01$

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
Norman et al (2020),[88] Australia *Secondary analysis of Norman* et al *(2018)* 10.1016/j.jand.2019.05.006	$N = 154$ Age range = 7–12 years $M_{age} = 9.3$ (1.6) 50% female Weight status = 5% underweight, 80.5% healthy weight, 12.3% with overweight, 3.9% with obesity SES = median household weekly income $2000–$2499	Experimental (holiday camps and research center), within-subjects (but relevant comparisons are between-subjects), RCT	$N = 78$ Advergame and TV exposure (3 days of food adverts and 3 days of non-food adverts). Advergame—Food: Nestle Kokokrunch cereal; non-food: Lego. Played on iPad. Duration: 5 min. TV—10 × 30 s food (e.g., Nestle Kokokrunch) and non-food (e.g., The North Face) embedded in a cartoon. Duration: 10 min.	$N = 76$ TV exposure only (3 days of food adverts and 3 days of non-food adverts). TV—10 × 30 s food (e.g., McVities Delichoc biscuit) and non-food (e.g., The North Face) embedded in a cartoon. Duration: 10 min.	Awareness (recognition)—asked if they recognized a photograph of advertised Nestle Kokokrunch brand and to describe the product to which the logo related Attitudes—5-point "cool," "exciting," and "fun" Likert scales for Nestle Kokokrunch (overall mean calculated, lower score = more positive attitude). Consumption (desire to eat)—would you like to eat Nestle Kokokrunch sometime soon (yes/no)	Intervention: 74% (56); Comparison: 60% (42) Intervention: 2.7 (0.96); Comparison: 2.8 (0.77) Intervention: 42% (24) yes; Comparison: 50% (21)
Pempek & Calvert (2009),[89] US doi:10.1001/archpediatrics.2009.71	$N = 30$ Age range = 9–10 years $M_{age} = 9.5$ (0.92) 50% female Weight status = not stated SES = Low-income area of Washington DC (37% of children in area impoverished)	Experimental (school), between-subjects, RCT	$N = 10$ Advergame—Pac-Man featuring unhealthy snacks (soda, chips, cookie, and candy bar). Duration: 9 min 32 s (2 min 22 s).	$N = 10$ No advergame exposure.	Preference (intended consumption of product category)—selected one food (chips/banana) and one beverage (soda/orange juice). 1 pt per unhealthy snack (calculated by R.E.).	Intervention: 1.80 (0.63); Comparison: 1.10 (0.88)
Putnam et al (2018),[90] US 10.1089/g4h.2017.0097	$N = 132$ Age range = 4–5 years $M_{age} = 4.80$ (0.48) 45% female Weight status = not stated SES = 51% low-income families.	Experimental (childcare facility), between-subjects, RCT	$N = 43$ iPad App—Action Bowl. Image of Dora the explorer holding an unhealthy snack (chips/soda) appeared in front of the pins. Duration: ∼5 min.	$N = 44$ iPad App—Action Bowl. Dora and the snacks did not appear (no food marketing exposure). Duration: ∼5 min.	Preference (intended consumption of product category)—selected one food (Lay's potato chips/banana) and one beverage (Coca-Cola/orange juice). 1 pt per unhealthy snack (calculated by R.E.).	Intervention: 1.26 (0.66); Comparison: 1.09 (0.56)
Redondo et al (2012),[91] Spain 10.1108/03090561211260031	$N = 405$ Age range = 11–17 (+) years $M_{age} = 13.13$ (2.00) 45.19% female	Experimental (online), between-subjects, RCT	$N = 115$ Advergame—M&M candies. M&M candies to be zapped. M&M logo and two personified	$N = 149$ Advergame—counters to be zapped (no food marketing exposure).	Attitudes—liking of M&Ms on a 9-point Likert smiley-scale. 1 = *sad face*, 9 = *happy face*.	Intervention: 7.98 (1.43); Comparison: 7.44 (1.64), $p < 0.005$, $\eta^2 = 0.021$

(Continues)

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
	Weight status = not stated SES = not stated		M&M candies featured. Duration: unlimited; 39.5% 2–3 min.	Duration: unlimited; 39.5% 2–3 min.		
Rifon et al (2015)[92] (1), US 10.2501/IJA-33-3-475-508	N = 276 Age range = 5–10 years M_{age} = 7.3 (1.6) 56.3% female Weight status = not stated SES = median household income $25,000–$49,999 (24.3%)	Experimental (setting not stated), between-subjects, RCT	N = not stated Advergame—City Glider. Cereal box (Honey O's) used as game token to be collected by glider. Duration: "limited," but not specified.	N = not stated Advergame—balloons used as game tokens (no food marketing exposure). Duration: "limited," but not specified.	Awareness (recognition)—selected cereal box seen in advergame (1 stimulus, 2 other, each with "Honey" in the brand name). Attitudes - liking of Honey O's on a 5-point smiley-face Likert scale. Purchase (intended requests)—"would you ask a grown-up to buy the Honey O's cereal for you?" 5-point "thumbs up/down" Likert scale.	Intervention: 79.80% identified Honey O's; Comparison: 8.20%, $p < 0.001$ Intervention: 3.93; Comparison: 3.59 Intervention: 3.57; Comparison: 3.30
Rifon et al (2015)[92] (2), US	N = 276 Age range = 5–10 years M_{age} = 7.3 (1.6) 56.3% female Weight status = not stated SES = median household income $25,000–$49,999 (24.3%)	Experimental (setting not stated), between-subjects, RCT	N = not stated **Watched** a digital recording of the game being played. Advergame—City Glider. Cereal box (Honey O's) used as game token to be collected by glider. Duration: "limited," but not specified.	N = not stated **Watched** a digital recording of the game being played. Advergame—balloons used as game tokens (no food marketing exposure). Duration: "limited," but not specified.	Attitudes—liking of Honey O's on a 5-point smiley-face Likert scale. Purchase (intended requests)—"would you ask a grown-up to buy the Honey O's cereal for you?" 5-point "thumbs up/down" Likert scale.	Intervention: 3.94; Comparison: 3.84 Intervention: 4.08; Comparison: 3.70
Smith et al. (2020)[93] (1), Australia 10.1016/j.jand.2019.07.017	N = 156 Age range = 7–12 years M_{age} = 8.7 (1.5) 45.51% female Weight status = 3% severely underweight, 6% underweight, 62% healthy weight, 15% with overweight, 13% with obesity SES = low (46%) and medium (55%) socioeconomic areas	Experimental (research institute and afterschool care centers), between-subjects, RCT	N = 38 Advergame—web-based side scroller game. Popular gummy confectionary brand logo and products used as game pieces. Duration: 4 min.	N = 41 Web-based side scroller game. Coins used as game pieces (no food marketing exposure). Duration: 4 min.	Preference (intended consumption of brand and product category)—chose a snack to eat (green grapes/ supermarket brand gummy lolly/marketed brand gummy lolly/ unfamiliar brand gummy lolly) Consumption—post-intervention ad-libitum intake of chosen snack	Intervention: 44.7% (17) chose marketed brand; Comparison: 19.5% (8), $p > 0.05$ Intervention: 153 (97.1); Comparison: 127 (108.2), $p > 0.05$ Intervention: 4 (median); Comparison: 4 (median)

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
					(grams converted to kcal). 10 min. Attitudes—5-point Likert scale from *boring* (1) to *fun* (5).	
Smith et al. (2020)[93] (2), Australia	$N = 156$ Age range = 7–12 years $M_{age} = 8.7$ (1.5) 45.51% female Weight status = 3% severely underweight, 6% underweight, 62% healthy weight, 15% with overweight, 13% with obesity SES = low (46%) and medium (55%) socioeconomic areas	Experimental (research institute and afterschool care centers), between-subjects, RCT	$N = 38$ **Banner advertising**—Web-based side scroller game. Coins used as game pieces. Banner advert for gummy lolly brand beneath the game. Duration: 4 min.	$N = 41$ Web-based side scroller game. Coins used as game pieces (no food marketing exposure). Duration: 4 min.	Preference (intended consumption of brand and product category)—chose a snack to eat (green grapes/ supermarket brand gummy lolly/marketed brand gummy lolly/ unfamiliar brand gummy lolly) Consumption - post-intervention ad-libitum intake of chosen snack (grams converted to kcal). 10 min. Attitudes—5-point Likert scale from *boring* (1) to *fun* (5).	Intervention: 44.7% (17) chose marketed brand; Comparison: 19.5% (8), $p > 0.05$ Intervention: 120 (101.8); Comparison: 127 (108.2) $p > 0.05$ Intervention: 4 (median); Comparison: 4 (median), $p > 0.05$
Smith et al. (2020)[93] (3), Australia	$N = 156$ Age range = 7–12 years $M_{age} = 8.7$ (1.5) 45.51% female Weight status = 3% severely underweight, 6% underweight, 62% healthy weight, 15% with overweight, 13% with obesity SES = low (46%) and medium (55%) socioeconomic areas	Experimental (research institute and afterschool care centers), between-subjects, RCT	$N = 39$ **Rewarded video advertising**—Web-based side scroller game. Coins used as game pieces. Between levels, game paused and advertisement for gummy lolly brand played for 30 s.	$N = 41$ Web-based side scroller game. Coins used as game pieces (no food marketing exposure). Duration: 4 min.	Preference (intended consumption of brand and product category)—chose a snack to eat (green grapes/ supermarket brand gummy lolly/marketed brand gummy lolly/ unfamiliar brand gummy lolly) Consumption—post-intervention ad-libitum intake of chosen snack (grams converted to kcal). 10 min. Attitudes—5-point Likert scale from *boring* (1) to *fun* (5).	Intervention: 64.1% (25) chose marketed brand; Comparison: 19.5% (8), $p < 0.002$ Intervention: 148 (109.7); Comparison: 127 (108.2), $p > 0.05$ Intervention: 4 (median); Comparison: 4 (median), $p > 0.05$

(Continues)

TABLE 1 (Continued)

Author(s), year of publication, country	Participants	Design	Marketing intervention	Comparison	Outcomes	Relevant results *Values are mean (SD) unless otherwise stated*
van Reijmersdal et al. (2012),[94] Netherlands https://doi.org/10.1016/j.intmar.2011.04.005	$N = 105$ Age range = 7–12 years $M_{age} = 9.49$ (1.65) % female = not stated Weight status = not stated SES = not stated	Experimental (schools), between-subjects, RCT	$N = 55$ Advergame—falling products were Lays crisps bags and Pepsi cans. Large logos of both brands were displayed centrally in the background. Duration: ~3 min.	$N = 49$ Advergame—crisp bags and soft drink cans contained no logos/brand identifiers. Small Lays and Pepsi logos were displayed outside the main field of visual focus. Duration: ~3 min.	Awareness (brand recall)—asked which brand they remembered from the game. Pepsi = 1, other = 0. Awareness (brand recognition)—indicated brand(s) they recalled from three logos (Pepsi, two other cola brands). 2 = only Pepsi, 1 = Pepsi and one other, 0 = all brands/no brands. Attitudes—liking and "greatness" of Pepsi on a 4-point Likert scale. Items averaged.	Intervention: 0.45 (0.5); Comparison: 0.02 (0.14), $\eta^2 = 0.28$ $p < 0.01$ Intervention: 1.47 (0.77); Comparison: 0.61 (0.84), $\eta = 0.24$, $p < 0.01$ Intervention: 2.53 (0.81); Comparison: 2.37 (0.80), $\eta^2 = 0.01$, $p > 0.05$
Verhellen et al (2014),[95] Belgium 10.1007/s10603-014-9257-1	$N = 125$ Age range = 11–14 years $M_{age} = 11.98$ (0.43) % female = not stated Weight status = not stated SES = not stated	Experimental (schools), between-subjects, RCT	$N = 25$ Advergame—Ola popsicles. Navigate character sitting on a popsicle and collect Ola popsicles. Duration: ~2 min.	$N = 25$ No advergame exposure.	Attitudes—liking, fun, and perceived taste of Ola popsicles on a 4-point smiley-scale. Items averaged. Preference (intended consumption of brand)—chose a popsicle from the freezer to eat (generic store brand—Carrefour/competitive brand—Ijsboerke/marketed brand—Ola).	Intervention: 3.39 (0.43); Comparison: 3.16 (0.44), $p > 0.05$ Intervention: 44% (11) chose Ola; Comparison: 64% (16), $p > 0.05$

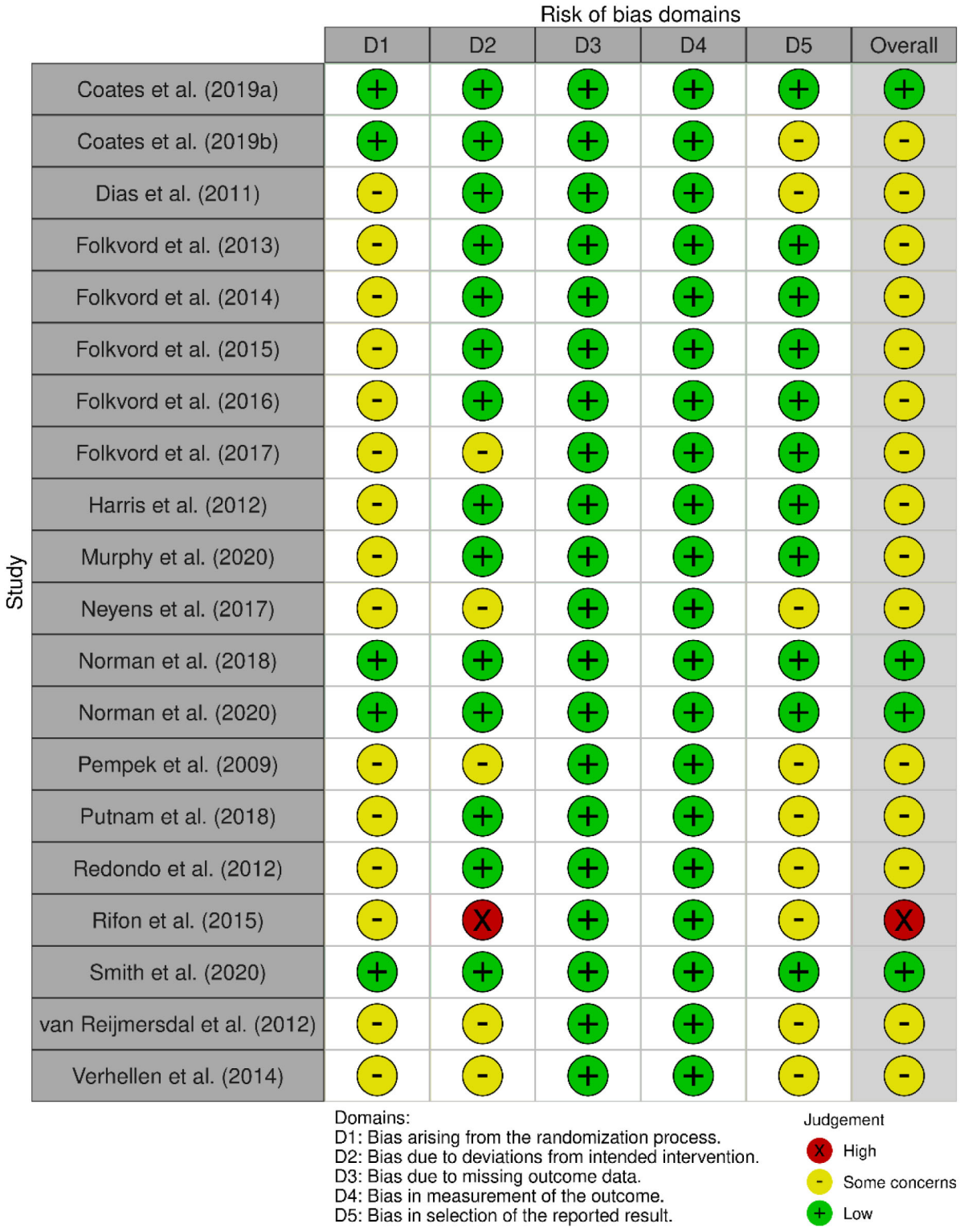

FIGURE 3 Quality assessment of randomized control trials (RCT) using the Cochrane risk of bias 2 tool.

Study	Selection	Comparability	Outcome	Total	Quality
Agante et al. (2019)			***	3	Unsatisfactory
Mallinckrodt et al. (2007)		**	***	5	Satisfactory

TABLE 2 Quality assessment of non-randomized studies (NRS) using the Newcastle-Ottawa quality assessment scale for cross-sectional studies.

Note: Selection—maximum five stars. Representativeness of the sample, sample size, non-respondents, and ascertainment of the exposure. Comparability—maximum two stars. Comparability of subjects in different outcome groups, confounding factors controlled. Outcome—maximum three stars. Assessment of outcome, statistical test. Overall: 9–10 = *very good*; 7–8 = *good*; 5–6 = *satisfactory*; 0–4 = unsatisfactory.

3.1.6 | Awareness

Four studies contributed data (6 effects) for awareness outcomes: brand recall ($n = 2$ effects), brand recognition ($n = 4$ effects). Recall was measured as the number of correctly recalled brands, or the %/*N* of participants correctly recalling the test brand (without prompts). Recognition was measured as the number of correctly selected brands (from a list of prompts) or the %/*N* correctly identifying the test brand (from prompt images).

3.1.7 | Attitudes and preferences

Twelve studies provided data (23 effects) for attitudes and preferences outcomes. For preference (12 effects), four effects related to brand preference, five to product category preference, and three to both. In terms of adjectives used in studies, children were asked to simply choose an item ($n = 1$ effect), choose their favorite item ($n = 1$ effect), preferred item ($n = 1$ effect), an item to hypothetically eat ($n = 3$ effects), or an item to actually eat ($n = 6$). Preference was measured as either the %/N of children choosing the test brand or product category ($n = 9$ effects), or the number of test brand or product items selected ($n = 3$ effects). For attitudes (11 effects), children were asked to rate the test brand using adjectives: liking ($n = 5$ effects), fun ($n = 3$ effects), or multiple adjectives to form a mean score (e.g., exciting, fun, great, tasty, $n = 3$ effects). Ratings were assessed using simple Likert scales and pictorial Likert scales (e.g., smiley-face and thumbs-up).

3.1.8 | Purchase

Three studies provided data (four effects) for purchasing outcomes, all measuring pester intent. Pester intent was measured on a Likert scale of how likely the child was to ask an adult/parent to purchase the test product for them ($n = 3$ effects), or the % of children indicating that they would ask an adult/parent to purchase the test product for them ($n = 1$ effect).

3.1.9 | Consumption

Eleven studies provided data (14 effects) for consumption outcomes: intake from unbranded HFSS snacks ($n = 2$ effects), intake from a branded HFSS snack (test brand) ($n = 1$ effect), chosen snack intake (healthy/unhealthy) ($n = 3$ effects), difference in mean intake from unbranded snacks (unhealthy and healthy) between experimental and comparison condition ($n = 1$ effect), intake from test brand and other nonmarketed HFSS snack combined ($n = 6$ effects), and desire to consume the brand (yes/no; $n = 1$ effect). For studies measuring actual consumption, change in vessel weight (*g*) was measured, and typically converted to kcal. One researcher (R.E.) converted from g or kJ to kcal where this had not been reported in the article ($n = 2$ effects). Where reported, the ad libitum eating opportunity was between 5 and 20 min. During the ad-libitum opportunity, a minority ($n = 2$) of studies included healthy snack options.

3.1.10 | Post-consumption effects

No studies provided data in relation to post-consumption effects.

3.2 | Meta-analyses

3.2.1 | Consumption

Thirteen effect sizes from nine studies were included in the model. The multilevel model (SMD = 0.345 [95% CI: 0.191 to 0.499], $Z = 4.39$, $p < 0.001$), was not a better fit than the single-level model (loglikelihood ratio = 0.00, $p = 1.00$). There was a significant small-to-moderate main effect of influencer and digital game-based food marketing exposure on consumption from 13 effect sizes (SMD = 0.344 [95% CI: .191, 499], $Z = 4.38$, $p < 0.001$, $I^2 = 51.9\%$, Tau = 0.203: see Figure 4). The effect was robust, with GOSH demonstrating the average effect size across 8191 models of SMD = 0.345 (mean $I^2 = 45\%$). Trim and Fill analyses imputed one hypothetical effect into the model which slightly increased the overall effect size (SMD) = 0.374 [95% CI: .219, .529]. If we assume a standard deviation of ~100 kcal, this is the equivalent of ~37 kcal. The funnel plot demonstrated reasonable symmetry (see Figure 5). Based on the pooled effect size, the median statistical power of the studies to detect this effect was 44%.

The inclusion Bayes factor for the effect was BF = 4.46 and heterogeneity was BF = 4.047, whereas the Bayes Factor for publication bias was BF = 0.76. This suggests that food marketing exposure had a small but robust effect on consumption.

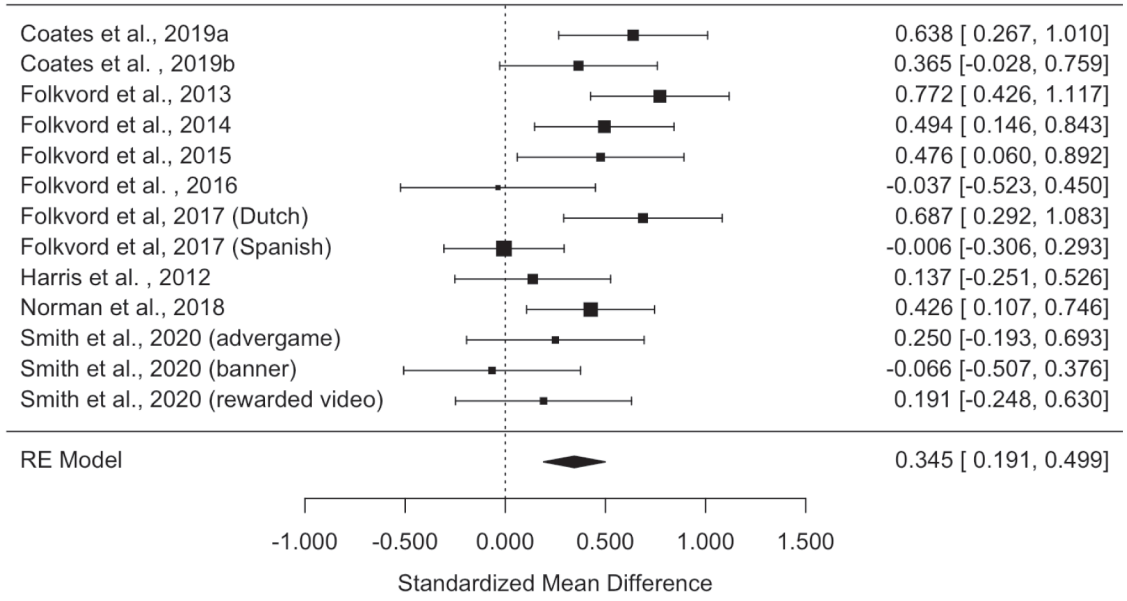

FIGURE 4 Forest plot showing mean difference (kcals) in consumption between marketing exposure and comparison conditions.

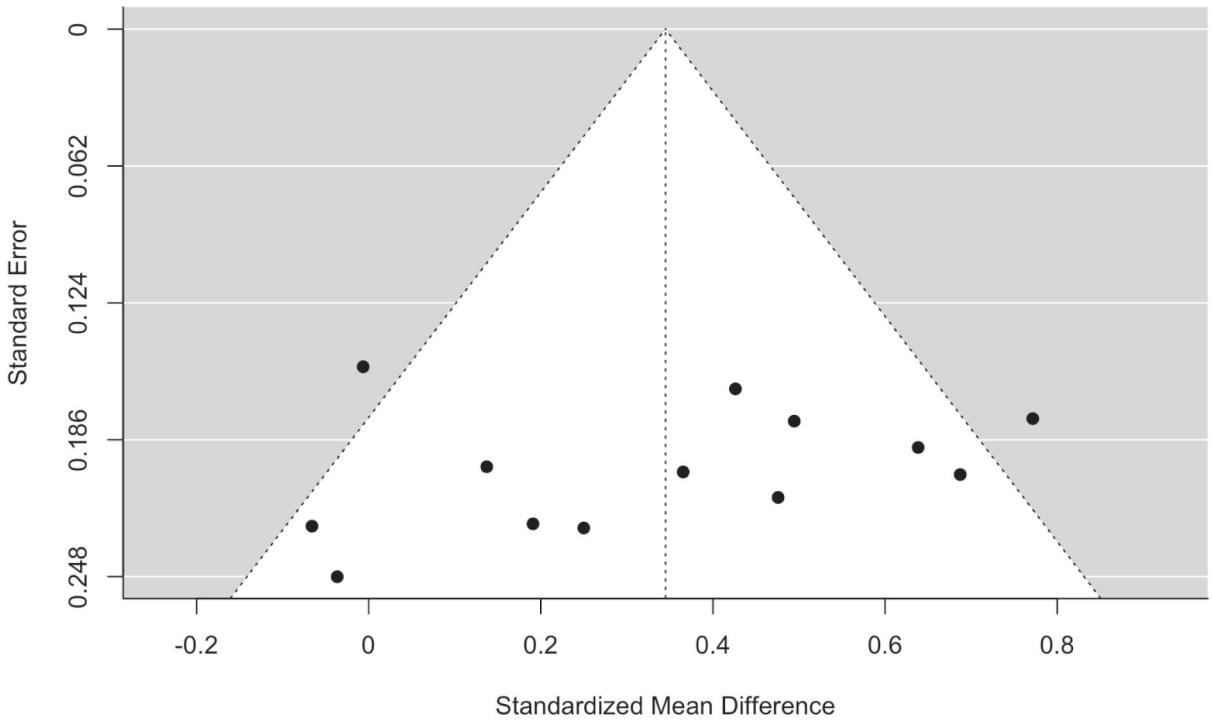

FIGURE 5 Funnel plot of the meta-analysis of consumption outcomes.

Analysis of digital game-based marketing studies only (11 effect sizes) found a pooled effect size of SMD = 0.314 ([95% CI: 0.140 to 0.488], $Z = 3.54$, $p < 0.001$), with similar heterogeneity to the full model ($I^2 = 55.3\%$). We did not statistically compare these studies to the social media influencer marketing studies due to the small subgroup size ($n = 2$).

3.2.2 | Attitudes and preferences

Eighteen effect sizes from 11 digital game-based marketing studies were included in the model. No influencer marketing studies provided relevant data. A multilevel model (OR = 1.982) ([95% CI: 1.562, 2.514], $Z = 5.69$, $p < 0.001$) was not a better fit of the data than a

single-level model (loglikelihood ratio = 2.77, $p = 0.095$), therefore we retained a single-level model for simplicity (AIC difference = 0.78). The main effect of digital game-based food marketing exposure was significant, with marketing exposure increasing the odds of choosing the brand or product type by OR = 2.049 ([95% CI: 1.651, 2.541], $Z = 6.525$, $p < 0.001$, $I^2 = 64.0\%$, Tau = 0.338: see Figure 6). The effect was robust, with GOSH demonstrating the average effect size across 262,059 completed models (OR = 2.061). The funnel plot demonstrated fairly poor symmetry (see Figure 7). Trim and fill analysis demonstrated five hypothetical studies imputed on the left-hand side of the distribution, slightly reducing the overall effect size to OR = 1.739 ([95% CI: 1.355, 2.232], $p < 0.001$). The inclusion Bayes factor for the effect was BF = 3.14, with the Bayes factor for heterogeneity BF = 10.98, and the BF for bias BF = 8.73.

Analysis of binary outcomes separately (N= 10) demonstrated a significant effect of food marketing exposure on choice (OR = 2.445 [95% CI: 1.672, 3.605], $p < 0.001$). Examination of continuous related outcomes (continuous measures, $N = 8$) also demonstrated a significant effect of advertisement exposure (SMD = 0.547 [95% CI: 0.331, 0.762], $p < 0.001$).

3.3 | Narrative synthesis

3.3.1 | Awareness

Four out of six awareness effects were supportive of an effect of the marketing intervention on brand awareness. One study[85] found that

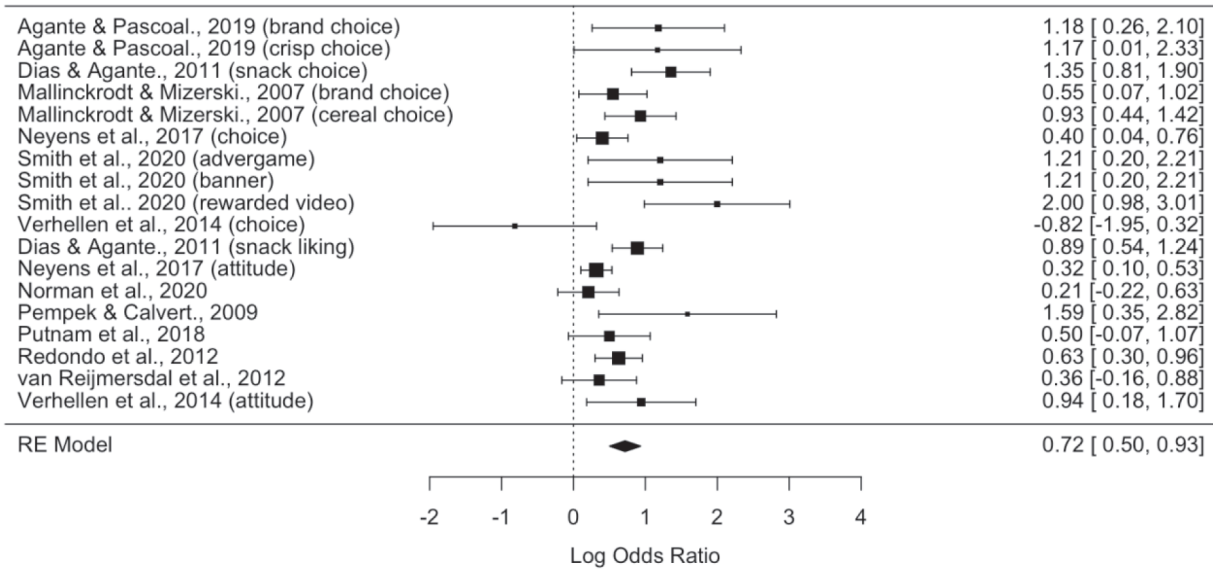

FIGURE 6 Forest plot showing log odds ratio for attitudes and preferences between marketing exposure and comparison conditions.

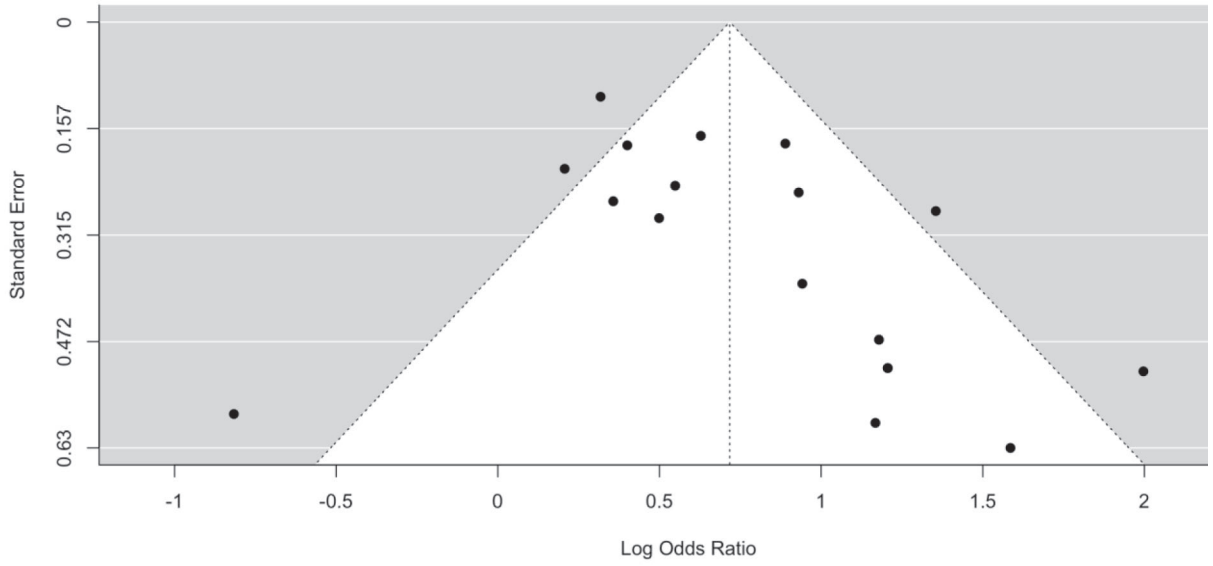

FIGURE 7 Funnel plot of the meta-analysis of attitudes and preferences outcomes.

13–14-year-olds recognized ($p < 0.001$), but did not recall ($p = 0.239$), significantly more test brands following celebrity influencer marketing in comparison to company marketing via Facebook. Another study[88] found that more 7–12 year-olds recognized the test brand following advergame and TV exposure (74%), compared to just TV exposure (60%), although this effect was not accompanied by a measure of statistical significance. A third study[92] found that recognition of the test brand was significantly ($p < 0.001$) greater following exposure to the brand in an advergame (79.80%), compared to exposure to an advergame with no food marketing (8.20%) in 5–10 year olds. Similarly, another study[94] found that both brand recall ($p < 0.01$) and recognition ($p < 0.01$) were greater in 7–12 year olds following exposure to more prominent food marketing in an advergame, compared to less prominent food marketing.

3.3.2 | Attitudes and preferences

Five effects relating to attitudes were not included in the meta-analysis. Three effects from one study[93] were not included due to reporting of *median* attitude score. No difference was found between perceived "fun" score of the test brand in 7–12 year olds following either exposure to an advergame, banner advertising within a digital game, or rewarded video advertising within a digital game, in comparison to an advergame with no food marketing exposure. However, these effects were not accompanied by a measure of significance. Two effects from another study[92] were not included in the meta-analysis due to the missing data regarding the number of participants in each condition, and measures of dispersion. Study authors were contacted regarding the missing data, but no response was received. Liking of the test brand was higher in 5–10 year olds after exposure to playing an advergame, and exposure to watching an advergame be played, in comparison to an advergame with no food marketing exposure. However, these effects were not accompanied by a measure of significance.

3.3.3 | Purchase

No purchasing effects were supportive of an effect of the marketing intervention on brand purchasing. One study[84] found no difference ($p = 0.54$) in pester intent to purchase the test brand following advergame exposure (72%), compared to no advergame exposure (72%). Similarly, another study[86] found that 6–14-year-olds were no more likely to ask their parents to buy the test brand following advergame exposure, compared to no advergame exposure ($p = 0.363$). A final study[92] found that 5–10 year olds were more likely to ask a grown-up to buy the test brand after (1) playing an advergame, and (2) watching an advergame be played, in comparison to playing or watching an advergame with no food marketing exposure. However, these effects were not accompanied by a measure of significance. There was no available data on the effects of social media influencer food marketing on purchasing behavior.

3.3.4 | Consumption

Only one effect[88] relating to consumption was not included in the meta-analysis, due to heterogeneity in the measurement of the outcome. The effect measured desire to eat the test brand (yes/no) after advergame and TV exposure, compared to just TV exposure, whereas all other consumption effects were measured continuously (i.e., caloric intake). Forty-two percent of 7–12 year olds in the intervention condition desired to eat the test brand, relative to 50% in the comparison condition. The effect was not accompanied by a measure of significance.

4 | DISCUSSION

The current review and meta-analysis found that digital game-based food marketing significantly influences attitudes and preferences, and both digital game-based and influencer marketing influence consumption behaviors. Children are significantly more likely to prefer and have more positive attitudes toward a brand or product that has been marketed to them via digital games, and immediately consume more of a brand or product that has been marketed to them via digital games or influencers, compared with lesser or no food marketing exposure. Assuming the small-to-moderate effect of SMD = 0.374 on calorie consumption, and a standard deviation of ~100 kcal, we might expect that a single exposure to food marketing would lead to an increase in consumption by ~37 kcals. Consumption behaviors also extended to other HFSS snacks (not just the specific ones advertised), and greater overall ad-libitum food consumption. Findings in relation to awareness tentatively suggest that children are more likely to recognize, and perhaps also recall, brands and products that are marketed to them via influencers and advergames, although more data is needed to draw reliable conclusions. Findings on purchasing behaviors suggest that children do not intend to pester adults to purchase brands and products more after seeing them marketed in advergames. Notably, findings in relation to influencer marketing were far fewer across all outcomes, and no data was found in relation to attitudes and preferences or purchasing behaviors. No data was found in relation to post-consumption effects.

Findings are largely in line with the Hierarchy of Unhealthy Food Promotion Effects Model.[25] Although the strength of the evidence varied for the different outcomes it would appear that digital game-based and social media influencer marketing impacted awareness and consumption behaviors, and digital game-based marketing impacted attitudes and preferences in children. Evidence was less convincing for purchasing behaviors, and no data was available for post-consumption effects. Limited data was available on contextual (e.g., socioeconomic status), and biological (e.g., current weight status) factors, despite them being known to moderate food marketing effects,[25,65] which meant that subgroup analyses could not be performed. This highlights the need to investigate and consistently report these variables in future studies. Overall, findings from the current

review suggest that effects of food promotions via television on children are likely to also extend to digital-game based and social media influencer marketing.

Findings are also in line with established theories in relation to food marketing effects. The Reactivity to Embedded Food Cues in Advertising Model suggests that when placements are embedded in the media content (as is typical for influencer and digital-game based marketing), they are more difficult to resist.[39] Findings from the current review indicate that, in line with this model, children were influenced to choose and consume more of food products embedded in digital games or influencer marketing. Results also support the notion of "meaning transfer," whereby positive affective responses toward liked sources (e.g., a favorite digital game or influencer) can transfer onto brands and products.[50] Children in the current review were found to foster more positive attitudes toward foods that were marketed to them via a digital game. In relation to digital-game based marketing specifically, social cognitive theory posits that children construct ideas about brand preference through continual play,[19] and these learned preferences can be reinforced by rewards.[26] Current findings support this, indicating that advergame play (which encompasses "reward" elements, such as additional points for selecting unhealthy food items), and rewarded video advertising within a digital game increased preference toward the test brand. In relation to influencer marketing, social learning theory[19] surmises that children are likely to mimic the behavior of role models (e.g., influencers). In the current review, children were found to consume more of foods that were marketed to them via influencers, assimilating this promoted behavior. Finally, both brand-specific and "beyond brand" effects were observed in the current review. In response to digital game-based and influencer food marketing exposure, children not only consumed more of the marketed brand but also more of other HFSS snacks and food in general, suggesting that food marketing has a priming effect on eating more broadly. These effects have been observed previously in response to TV food marketing exposure.[97,98]

This review supports and builds upon other reviews in the area. Those exploring advergames[27] and celebrities and influencers[21] have also found that this marketing influences a variety of food-related behaviors. In line with the current review, these include attitudes toward and consumption of marketed brands on products. Existing reviews on the effects of IGA have tended to focus on adults,[23] finding impacts on brand-related cognitive, attitudinal, and behavioral responses. The current review extends these findings to children by evidencing an effect of IGA (e.g., via iPad apps, banner advertising, and rewarded video advertising) on child food-related behaviors. However, the review also highlighted that research exploring digital-game based marketing was dominated by advergames. This is outdated, with new and emerging gaming platforms (e.g., Roblox, videogame livestreaming platforms) being overlooked. Some techniques used on these emerging platforms (e.g., banner advertising, rewarded video advertising) were assessed, although research directly exploring the impacts of these platforms is needed.

The review highlighted numerous gaps in the research area that warrant attention. No studies explored *actual* purchase. Investigation of actual purchase is particularly pertinent for adolescents, who are more likely to have reduced parental protection and guidance,[51] and access to their own money,[52] meaning that they have greater autonomy over purchasing decisions. Moreover, no studies explored post-consumption effects such as weight gain, BMI, and dental caries. This is a perennial issue which has been highlighted in relation to television food marketing exposure effects also.[99] Research on post-consumption effects is needed in order to ascertain health impacts of food marketing exposure via digital games and influencers. Emerging technology that can reliably track exposure to digital food marketing (e.g., screen-recording software) could facilitate this line of research.[100] Level of exposure over time could be tracked in association with post-consumption effects such as weight gain and diet-related disease.[25] Further, research on teenagers, particularly in relation to digital-game based marketing, was limited. This is despite teenagers being avid consumers of videogames, with 80% of UK 12–15 year olds reporting playing videogames online.[10] Moreover, teenagers are uniquely vulnerable to marketing effects due to their cognitive and emotional maturity,[37,38] and peer-group influence.[44,45] There was no research on the effects of influencer marketing on attitudes and preferences. Relevant theory[19,50] and questionnaire evidence in relation to adolescent users of videogame livestreaming platforms[32,33] suggests that attitudes toward unhealthy foods would be impacted. Therefore, experimental research is warranted. There was also limited research on the effects of influencer food marketing on younger children. This research is needed, particularly with the emergence of "Kid influencers" (i.e., child social media influencers) who are known to market unhealthy branded food items and may be particularly persuasive to children their own age.[101]

The review also highlighted the need for consistent terminology and practice in this research domain. For example, there was overlap in the definition of preference and consumption outcomes, with preference and choice used interchangeably in reference to a favorite product and choosing a product to eat. Standardization of definitions would facilitate better comparison for future reviews in this area. Although many elements of the studies were consistent (e.g., setting), consistency was lacking in other areas. For example, there was wide variation in the duration of the marketing intervention. Also, in relation to consumption outcomes, the duration of the ad libitum eating opportunity widely varied, and the range of foods offered for consumption (i.e., unhealthy or a mix of unhealthy and healthy) and measurement of food consumption (e.g., unhealthy and healthy consumption combined, unhealthy consumption, test brand consumption) was inconsistent. This again makes cross-study comparison more difficult. This heterogeneity was reflected in the I^2 scores for the attitudes and preferences, and consumption meta-analyses. This is an issue that has been consistently raised regarding food marketing and eating behavior research.[99,102] Quality assessments also highlighted the need to pre-specify outcomes to be reported. The absence of this may be contributing to the wide variation in consumption outcomes reported, due to potential post-hoc reporting of significant outcomes.

This review has a few limitations. Firstly, an insufficient number of studies exploring influencer marketing effects meant that we were

unable to directly compare the effects of influencer and digital game-based food marketing on food-related behaviors. Second, the titles and abstracts of the studies retrieved in database searches were screened by one reviewer. Some research suggests that this may lead to missed eligible studies.[103] Finally, this review assesses experimental studies of one-point exposure. However, children are frequently exposed to influencer and digital game-based food marketing in their daily lives, suggesting that the overall effect may be stronger than what was found in this review.

Despite the leading videogame livestreaming platform, Twitch, being well-established for over a decade, having launched in 2011 and been acquired by Amazon in 2014,[104] no experimental data was available on the effects of food marketing via videogame livestreaming platforms on children's food-related behaviors. While watching others play has long been a part of gaming culture,[105] and is integral to the videogame livestreaming platform appeal, only one study explored the impact of *watching* gameplay featuring food brands.[92] The study found that watching a branded food advergame being played appeared to influence test brand attitude and pester intent, although the study was marked as having a high risk of bias. However, overall, the current review findings suggest that videogame livestreaming platforms may be powerful mediums for influencing the food-related behaviors of children. These platforms represent a hybridization of digital-game-based and influencer marketing, with the interaction on Twitch through playing games being described as a "facilitator" of influencing.[106] Both influencer and digital-game based marketing were found to be impactful in the current review. This mirrors preliminary questionnaire evidence which suggests that food marketing via Twitch is as impactful as other digital media in terms of influencing food craving, purchasing, and consumption behaviors.[32,33] Studies are needed to ascertain the direct impacts of videogame livestreaming platforms on child eating behavior, with a focus on the most popular gaming influencers among children.

The current review findings have implications for food marketing policy. Findings support the introduction of policies proposed by the WHO to limit the power of food marketing by restricting the use of techniques that are of special appeal to children (e.g., influencers, digital games, or a combination of the two),[6,55] which are shown to impact a variety of food-related behaviors in the current review. In conjunction with emerging cross-sectional evidence on the effects of food marketing via videogame livestreaming platforms on food-related behaviors in adolescents and adults,[32,33] findings also support the widening of policy scope (e.g., the proposed ban of online HFSS food marketing in the United Kingdom[54]) to include videogame livestreaming platforms. However, additional experimental data on the direct effects of videogame livestreaming platforms on children's food-related behaviors are needed. It is important that videogame livestreaming platforms are not overlooked, as the current review suggests that individually, digital games and influencers represent powerful marketing mediums, and thus a combination of the two on videogame livestreaming platforms may be even more impactful.

5 | CONCLUSION

This is the first systematic review and quantitative synthesis to demonstrate that digital game-based and food marketing influences attitudes and preferences, and both digital game-based and influencer marketing influence consumption behaviors in children. Evidence in relation to awareness and purchasing behaviors is more tentative, and there is currently no evidence in relation to post-consumption effects. Findings build on theoretical models and existing reviews in the area. Recommendations are made for future research, with a focus on purchasing behaviors, post-consumption effects, digital-game based marketing effects on older children, and influencer marketing effects on younger children. The review also highlighted the need for consistent terminology, practice and reporting to facilitate cross-study comparison. Findings have implications for food marketing policy aiming to limit the power and scope of food marketing targeting children.

AUTHOR CONTRIBUTIONS

Rebecca K. Evans was responsible for the systematic review, wrote the manuscript, and was involved in the interpretation of results. Andrew Jones was responsible for the statistical analyses and was involved in interpretation of results. Emma Boyland, Michelle Maden, and Paul Christiansen were involved with the systematic review and the interpretation of results. Rebecca K. Evans and Amy Finlay accessed and verified the data. All authors were involved in devising and agreeing the final protocol for this work, had full access to all the data in the study, had final responsibility for the decision to submit for publication, reviewed and commented on the draft manuscript, and approved the submission of the final manuscript.

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CONFLICT OF INTEREST STATEMENT

We declare no competing interests.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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