 doi: 10.1111/obr.12445

Review

Influence of unhealthy food and beverage marketing on children's dietary intake and preference: a systematic review and meta-analysis of randomized trials

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Received 24 January 2016; revised 27 May 2016; accepted 31 May 2016

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Summary

Marketing of foods and beverages high in fat, sugar and salt are suggested to contribute to poor dietary behaviours in children and diet-related diseases later in life. This systematic review and meta-analysis of randomized trials aimed to assess the effects of unhealthy food and beverage marketing on dietary intake (grams or kilocalories) and dietary preference (preference score or percentage of participants who selected specific foods/beverages) among children 2 to 18 years of age.

We searched MEDLINE, EMBASE and PsycINFO up to January 2015 for terms related to advertising, unhealthy foods or beverages among children. Randomized trials that assessed the effects of unhealthy food and beverage marketing compared with non-dietary advertisement or no advertisement in children were considered eligible. Two authors independently extracted information on study characteristics and outcomes of interest and assessed risk of bias and the overall quality of evidence using GRADE methodology. Meta-analysis was conducted separately for dietary intake and preference using a random-effects model.

We identified 29 eligible studies, of which 17 studies were included for meta-analysis of dietary preference and nine for meta-analysis of dietary intake. Almost half of the studies were at high risk of bias. Our meta-analysis showed that in children exposed to unhealthy dietary marketing, dietary intake significantly increased (mean difference [MD] = 30.4 kcal, 95% confidence interval [CI] 2.9 to 57.9, and MD = 4.8 g, 95%CI 0.8 to 8.8) during or shortly after exposure to advertisements. Similarly, children exposed to the unhealthy dietary marketing had a higher risk of selecting the advertised foods or beverages (relative risk = 1.1, 95% CI 1.0 to 1.2; $P = 0.052$). The evidence indicates that unhealthy food and beverage marketing increases dietary intake (moderate quality evidence) and preference (moderate to low quality evidence) for energy-dense, low-nutrition food and beverage. Unhealthy food and beverage marketing increased dietary intake and influenced dietary preference in children during or shortly after exposure to advertisements. © 2016 World Obesity

Keywords: Dietary intake, dietary preference, meta-analysis, randomized trial, unhealthy, food and beverage marketing.

obesity reviews (2016)

Introduction

The rates of overweight and obesity among children are rising worldwide (1,2). Obesity is one of the major predisposing factors of most non-communicable diseases, and it is associated with a lower life expectancy (3,4). Unhealthy diet and the food and beverage environment that perpetuates poor dietary behaviours are suggested to play major roles in the global obesity epidemic (5,6). In 2010, unhealthy diet was the leading risk factor for death and disability globally (7,8).

There is increasing evidence that unhealthy food and beverage marketing directed at children negatively impacts their eating behaviours (9). The increasing prevalence of obesity seems to further coincide with marked increases in the food and beverage industry's budget for marketing aimed at children and youth (10), with data showing that energy-dense, low-nutrient foods and beverages make up the majority of commercially marketed products (9,10).

Regulating bodies and international health organizations have concluded that the advertising of unhealthy foods/beverages impacts children's eating habits and may be associated with the concurrent rise in childhood obesity (11,12); nevertheless, governments in North America remain committed to industry self-regulation as the primary approach to reduce child-directed marketing of energy-dense, low-nutrient products, which, to date, has not been effective (13,14).

Several systematic and narrative reviews on the effects of child-oriented food and beverage promotion on diet, dietary determinants and health have been published (11,15–17). However, these reviews have mostly reviewed observational or non-randomized experimental studies, and none have focused specifically on randomized controlled trials (RCTs). We aimed to systematically review all RCTs involving children aged 2 to 18 years that evaluated the impact of unhealthy food and beverage marketing compared with non-active control (e.g. TV programs or movies with toys or non-food advertising) on dietary intake and preference.

Methods

Search strategy

In January 2015, we searched MEDLINE, EMBASE and PsycINFO to identify studies published in English with the criteria (i) the population (children and adolescents 2–18 years of age); (ii) the intervention (unhealthy food or non-alcoholic beverages advertising delivered through TV/movie commercials, advergames [electronic games to advertise a product and might be played online or offline] or use of branded logos, packaging with licenced characters or booklet/magazine advertisements); (iii) comparison (TV programs or movies with toys or non-dietary advertising, unbranded logos, plain packaging, watching regular TV programs or a movies without advertising); (iv) the outcomes (dietary intake or preference) and (v) methodology (randomized trials, according to Cochrane definition and criteria (18)). An *a priori* protocol for this study was not published. No substantive changes were made to the study design after inception. The search terms and strategies are available in the Supporting Information (e-supp 1). We also reviewed reference lists and bibliographies of all included studies and related reviews for additional studies of relevance.

Study selection

Two reviewers independently screened the titles and/or abstracts of all identified studies and excluded those that were clearly not relevant. Subsequently, the full text of the identified articles were collected and independently read to determine whether they met our eligibility criteria. Discrepancies were resolved by consensus, or, if needed, by arbitration from a senior author. We used the eligibility criteria listed previously. We excluded studies or study arm(s) that exclusively focused on healthy foods and beverages (fruits and vegetables) marketing. If in the article marketed foods/beverages were only named but not categorized as healthy or unhealthy, we used the WHO definition of 'unhealthy foods/beverages' as products high in energy, added fat, added sugar or sodium (19).

Data abstraction and risk of bias assessment

Data were extracted independently and in duplicate. We extracted the data (i) general study information (author's name, publication year and study location); (ii) study population details (sample size, age and ratio of male vs. female); (iii) details on the intervention and comparison (e.g. marketing method including TV/movie advertisement, advergames and branded foods/beverages), duration of exposure to the marketed foods/beverages (eating opportunity and duration of advertising), test foods/beverages and type of foods/beverages provided for children to consume during or after the intervention (e.g. potato chips, candy and soda pop) and (iv) dietary intake in grammes or kilocalories (kcal) and foods/beverages preference score or percentage of participants who selected specific foods/beverages.

Risk of bias was assessed using the Cochrane risk of bias instrument (20). Among eligible studies, two reviewers independently assessed the following risk of bias issues: random sequence generation, allocation concealment, blinding of study participants, blinding of outcome assessors, incomplete outcome data and other potential sources of bias. Studies were considered at high risk of bias when at least three items were assessed as high risk of bias.

The GRADE principles were applied to independently assess the certainty (quality) of our pooled estimates using the following criteria: risk of bias, consistency, directness, imprecision and publication bias (21). The GRADE profiler software (version 3.6) was used to prepare the summary of finding table and to evaluate the quality of the evidence. Any discrepancies in data extraction, risk of bias or quality of evidence were resolved by consensus, and a third researcher was consulted for advice when necessary.

Data synthesis and statistical methods

To compare the effects of unhealthy dietary marketing on dietary intake and dietary preference, three measures of effect were used: mean difference, standardized mean difference (SMD) and relative risk (RR). We calculated the mean difference and its corresponding 95% confidence intervals (CIs) for dietary intake, reported as grammes or kcal of foods/beverages consumed during or after the experiments. To assess the dietary preferences, we calculated the SMD and its corresponding 95%CIs. Dietary preference was reported as the percentage of children who preferred the experimental foods/beverages under study (all those included in the dietary preference measure). We treated this as a dichotomous variable (yes/no) and pooled eligible trials using the RR and the corresponding 95%CIs.

Heterogeneity was determined using the Q statistic and I^2. A significance level of $P < 0.10$ for Cochran's Q test or $I^2 > 40\%$ were considered as clinically important heterogeneity (18,22). We used the DerSimonian–Laird random-effects model for meta-analysis. Regardless of the observed statistical heterogeneity, we conducted the following subgroup analyses to explain any observed heterogeneity: age (8 years or less vs. > 8 years of age), assuming a larger dietary intake in older children; sex (boys vs. girls), assuming a larger intake in boys; type of foods/beverages provided for children (healthy vs. less healthy/unhealthy –foods/beverages high in fat, sugar or salt), assuming a larger intake of less healthy/unhealthy foods/beverages; and type of advertisement (TV advertisement vs. advergames vs. branded logos/packaging

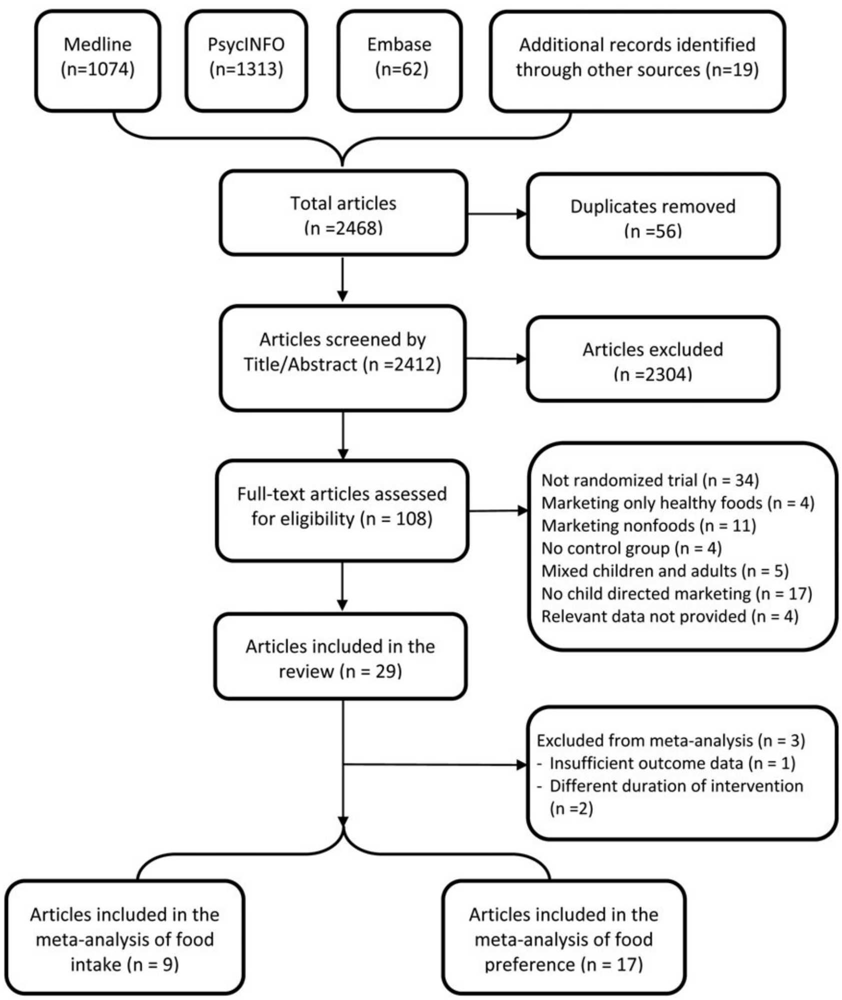

Figure 1 Flow diagram of database searches and articles included in the systematic review and meta-analysis.

with licenced characters), assuming a larger intake of foods/beverages using TV advertisements. For any observed or theoretical heterogeneity in pooled estimates of dietary intake, we also considered two more probable explanations: duration of exposure to advertisements (5 min or less vs. >5 min), assuming a larger intake in children with >5 min exposure to advertisements, and duration of exposure to experimental foods/beverages for consumption (eating opportunity) during and/or after advertisement (15 min or less vs. >15 min), assuming an increased intake in children with >15 min to consume the provided foods/beverages.

For subgroup analysis, we tested for interaction using a chi-square significance test (23). For subgroups with more than two variables and seven observations, we performed meta-regression. If 10 or more studies were included in the meta-analysis, publication bias was examined by funnel plots and Begg's and Mazumdar's adjusted rank correlation test (24). Data were analysed in STATA software version 11.0, Texas, USA.

Results

Description of included studies

Our literature search identified 2,468 titles and/or abstracts, 108 full texts were retrieved and screened. Of these, 79 studies were excluded after applying our eligibility criteria. The main reasons for exclusion included (i) not being a randomized trial ($n = 34$); (ii) no child-directed marketing ($n = 17$) and (iii) non-food/beverage marketing such as advertising toys or cosmetics ($n = 11$). The stages of evaluation and exclusion of the identified studies are presented in Fig. 1.

We identified 29 eligible RCTs enrolling a total of 5,814 children. Of these, three studies were excluded from our meta-analyses because of insufficient outcome data (no data provided on number of children randomized, or no data on measures of variability) and different duration of intervention (repeated exposure to advertisements for more than a week) (25–27). The majority of studies were performed in North America ($n = 20$). Studies most frequently examined the impact of TV advertising (12 studies), followed by licenced characters/logos (nine studies) and advergames (six studies). Two studies looked at the effects of advertising in magazines/booklets. The median for the mean age of participants in the included studies was 8.2 years (interquartile range (IQR) = 5.6 to 9.5). The median sample size among included studies was 105 participants (IQR = 65 to 261). A detailed description of included studies is presented in Table 1.

We identified 17 studies eligible for meta-analysis on dietary preference and nine for meta-analysis on dietary intake. The quality of reporting among the included studies was poor, with half of the included studies assessed as high risk of bias. Based on the full text of included studies, the main reasons for assessing studies as high risk of bias included poor reporting with respect to allocation concealment and blinding of participants and data assessors. Four of the nine studies on dietary intake were rated as high risk of bias, while 9 of 17 studies reporting dietary preference were rated at high risk of bias (Table 1).

Effects of unhealthy food/beverage marketing on dietary intake

Dietary intake (kilocalories)

Of the nine studies included in our meta-analysis on dietary intake, four studies reported dietary intake in grammes (28,29,40,41) while five studies reported intake data in kcal (36–38,42,44). We were able to convert food intake in grammes to kcal of food intake in only one study (28). Among the six studies (665 participants) providing data on dietary intake in kcal, the average time children were exposed to marketing was 3.8 min (median: 3.8 min) and the average time they were given to consume the food was 17.3 min (median: 17.5 min). Among the six included studies, the pooled estimate showed a significant increase of 30.4 kcal (95%CI 2.9 to 57.9) favouring exposure to unhealthy dietary advertising vs. non-dietary advertising ($I^2 = 72.0\%$; Fig. 2).

The results for our seven subgroups are as follows. Among the six identified studies evaluating dietary caloric intake, in one study the intervention was TV advertisements, three used advergames and in the remaining two studies, familiar licenced-characters or logos were used as the intervention. The pooled estimate of dietary intake reported as kcal was not significantly different among the three categories (Table 2). Our subgroup analysis for risk of bias revealed that the difference between the studies at high risk of bias ($n = 3$) vs. low risk ($n = 3$) was significant ($z = 2.4$, $P = 0.016$; MD = 46.4 kcal, 95%CI 11.0 to 81.7 and MD = −7.9 kcal, 95%CI −34.6 to 18.8, respectively), indicating that more methodologically sound studies found a stronger effect of advertising on caloric intake.

Children exposed to unhealthy dietary advertisements for more than 5 min ($n = 222$) had less caloric intake than those who were exposed ≤ 5 min ($n = 265$) (MD = 6.5 kcal, 95%CI −25.8 to 38.8; $I^2 = 77.0\%$; and MD = 64.4 kcal, 95%CI 39.8 to 89.0; $I^2 = 0.0\%$). The test of interaction showed that the difference between two estimates was significant ($z = 2.8$, $P = 0.005$). Our subgroup analysis for duration of exposure (eating opportunity) to unhealthy foods/beverages showed that participants given <15 min (two studies) for eating/drinking had more caloric intake than those given ≥15 min to eat/drink (four studies; Table 2), and the difference between two estimates was significant ($z = 3.2$, $P = 0.001$).

In our subgroup analysis on type of foods/beverages provided, we found that when children were exposed to

Table 1 Characteristics of studies included in the systematic review

Author (date) country	$N^{\dagger}$	Mean age [range]	% male	Intervention	Comparison(s)	Test food/ beverage	Outcome and results	Risk of bias
Anschutz (2009)[28] Netherlands	120	9.8 [NR]	46.7	20 min movie with three food and two neutral commercials for 5 min	Same movie as intervention with five neutral commercials	Freely eat from a pre-weighed bowl containing M&M chocolate-coated peanuts during the movie	Significant interaction between commercial type and sex of the child	Low
Anschutz (2010)[29] Netherlands	120	9.6 [8–12]	—	20 min movie with four food and one neutral commercials for 5 min	Same movie as intervention with five neutral commercials	Freely eat from a pre-weighed bowl containing M&M chocolate-coated peanuts during the movie	No significant effect on food intake	Low
Borzekowski (2001)[30] USA	39	4.0 [2–6]	52.0	26 min videotape of two animated children programs with seven food commercials mixed with one neutral commercial for about 4 min	The same animated videotape as intervention with no commercial	Choose foods similar to the advertised item	Significant preference toward advertised items	High
Chernin (2008)[25 ‡] USA	133	8.2 [5–11]	39.8	13 min segment of an animated children program with 1 food commercial	Same program with one food commercial (different from intervention item)	Choose advertised food product among three alternatives in the same product category	Significant preference toward advertised items	Low
Dawson (1988)[31] USA	80	6.2 [NR]	—	Two 30-s low-nutritional TV commercials with one repetition	Two 30-s toy commercials played for two times	Self-report desire to transgress using VAS[§]	No significant effect on temptation to transgress toward low-nutrient foods	High
de Droog (2010)[32] Netherlands	210	NR [4–6]	50.0	Food with a familiar (cartoon) character on the package	Food with a unfamiliar character/no character on the package	Purchase request intent for banana candy using VAS[§]	No significant effect on purchase request intent	Low
Dixon (2007)[33] Australia	919	10.8 [NR]	—	Four 30-s junk food commercials mixed with four 30-s neutral commercials played twice during a video program	Same video as intervention with eight 30-s neutral commercials	Intention to eat four junk foods using a 5-point Likert scale	No significant effect on intention to eat	Low
Dixon (2014)[34] Australia	1,302	11.0 [10–12]	48.7	Foods with sports celebrity endorsements on packages	Foods with nutrient content claims or no promotion on packages	Percentage of children choosing EDNP products and rating the likelihood of asking to buy	Significant lower rating in likelihood of asking to buy (all) and selecting control products (only boys)	Low
Elliot (2013)[35] Canada	65	3.8 [3–5]	44.6	Food with the logo of a popular fast food restaurant packaging	Food in plain, colourful, or Starbucks wrapping	Taste preference score range from −1 to +1	Significant taste preference of branded over plain packaging	Low
Folkvord (2013)[36] Netherlands	270	8.9 [8–10]	51.5	5 min of memory game promoting energy-dense snacks on cards	Same game as intervention promoting toys or no game	Freely eat from two pre-weighed bowls of energy-dense snacks and two bowls of fruits	Children who played advergame promoting food ate significantly more than control and toy advergame	Low
Folkvord (2014)[37] Netherlands	261	7.7 [7–10]	50.2	5 min of online memory game promoting energy-dense snacks on cards	Same game as intervention promoting toys	Freely eat from pre-weighed bowls of snacks	Significant effect of advergame promoting food on caloric intake	Low

(*Continues*)

Table 1 (Continued)

Author (date) country	$N^{\dagger}$	Mean age [range]	% male	Intervention	Comparison(s)	Test food/ beverage	Outcome and results	Risk of bias
Forman (2009)[38] USA	43	5.9 [4–6]	39.8	In two visits children were exposed to branded foods (McDonalds, Coca Cola, Trix)	In two visits children were exposed to unbranded foods	Eat *ad libitum* for 30 min from their respective dinner	No difference in intake of the branded vs. unbranded food conditions	High
Galst (1980)[26‡] USA	65	NR [3–6]	55.4	Groups of children watched two different short cartoons each day for 4 weeks with nine 30-s commercials for food products	Same cartoons as intervention without commercials	Children were allowed to select a daily snack containing added sugar or no added sugar	Significant lower request for sugared snack in control. No difference in request for no added sugar snacks between groups	High
Goldberg (1978)[39] USA	80	NR [4–6]	—	Groups of children were exposed to a minimum of 4.5 min of sugared snack commercials embedded in a 24-min cartoon program	Children not exposed to any program	Preference was assessed based on selection of the snack foods on a series of boards	Significant more sugared food were selected by children in intervention group than controls	High
Gorn (1980)[40] Canada	77	NR [8–10]	100	Five 30-s ice cream commercials embedded in a 30-min cartoon	Same cartoons as intervention without commercials	Eat *ad libitum* for 15 min from his choice of ice cream	No significant difference in the consumption of ice cream between groups	High
Gorn (1982)[27‡] Canada	288	NR [5–8]	—	14 different 30-min shows with 4.5-min candy commercials were played for 2 weeks during a summer camp	Same procedure as intervention with 4.5-min public announcements or no commercial	Children were allowed to choose one of two beverages and two of four food choices (fruits and candy bars) each afternoon	Those in candy commercial condition picked significantly less healthy foods and beverages	Low
Harris (2009)[41] USA	118	8.8 [7–11]	52.5	14 min of an animated children program with four 30-s food commercials	Same program as intervention with four 30 s non-food commercials	Freely eat from a pre-weighed bowl containing goldfish crackers during the program	Significant more crackers were eaten by those who watched food commercials	Low
Harris (2012)[42] USA	149	9.4 [7–12]	52.6	12 min playing with an online game featuring foods	12 min playing with a non-food online game	Freely eat from a pre-weighed snack bowls for 20 min	Significant effect of advergame promoting healthy/unhealthy food on food consumption	High
Jones (2011)[43] Australia	47	8.7 [5–12]	—	15 min to read the magazine with food advertisements	Magazine with no food advertisements	Given two vouchers for their choice of snack foods from items advertised/ not advertised brands	Participants were equally likely to select a healthy but not an unhealthy food item	Low
Keller (2012)[44] USA	41	8.4 [7–9]	51.2	A multi-item test-meal that was branded with the logo of a popular fast food restaurant	Same test-meal as intervention served in plain white packaging	Eat *ad libitum* for 30 min from the test foods	Non-significant increase in branded food intake	High
King (2008)[45] UK	309	9.7 [9–10]	51.1	Children received a booklet with food adverts as a media literacy exercise	Same booklet as intervention with non-food adverts	After the intervention children exchanged food choice coupons for raisins or confectionery	No significant effect of advert group on food choice	Low
	343	4.1 [2–6]	—					High

(*Continues*)

Table 1 (Continued)

Author (date) country	N†	Mean age [range]	% male	Intervention	Comparison(s)	Test food/ beverage	Outcome and results	Risk of bias
Kotler (2012a)[46] USA				Children were given food pairs with a familiar and an unknown character on the first and the second of each of the nine pairs	Children were given food pairs with no character stickers associated with the foods	They were asked to pick one food from each of nine pictured pairs they would like to eat	Significant effect of character on food preference	
Kotler (2012b)[46] USA	207	NR [3–6]	—	A familiar and an unknown character were placed in front of bowls with small pieces of food	No character stickers was associated with the food bowls	Choice of foods children ate were recorded	Significant more foods associated with a familiar character were eaten	High
Lappier (2011)[47] USA	80	5.6 [4–6]	45.0	Children were given a small cup dry serving of a cereal with a familiar character on the box	Cereal box with no character on the box	Five-point rating scale was used for taste preference	Significant effect for character presence on children taste	Low
Mallinckrodt (2007)[48] Australia	294	NR [5–8]	40.0	5 min playing with an advergame featuring foods	Not exposed to the advergame	Preference for advertised cereal over other cereal options	Significant effect of advertisement on children's preference	High
Pempek (2009)[49] USA	30	9.5 [9–10]	46.7	5 min playing an advergame before selection of a snack and beverage	5 min playing an advergame after snack and beverage selection	A summary score ranged from 0 to 2 for selection of a snack and beverages same advertised items	Significant effect of advertisement on preference score	High
Rifon (2014)[50] USA	92	7.3 [5–10]	43.8	Playing an advergame with a branded cereal box as the game token	Same advergame as intervention with unbranded cereal box	Attitude towards the brand was measured using two items on a 5-point scale	No significant effect of playing branded advergame on brand attitude	Low
Roberto (2010)[51] USA	40	5.0 [4–6]	65.0	Three pairs of identical foods presented in packages with a popular cartoon character	Same pairs of foods as intervention in packages with no character	Children selected which food items they prefer to eat for a snack and which taste better	Significant effect of licensed-character on both preference measures	High
Robinson (2007)[52] USA	63	4.6 [3–6]	47.6	Pairs of identical foods presented in packages with the logo of a popular fast food restaurant	Same pairs of foods as intervention in plain packaging	Taste preference score range from −1 to +1	Significant taste preference of branded over plain packaging	High
Toomey (2013)[53] USA	69	9.8 [8–12]	—	Product placement was implemented using a soft drink brand within a 4-min video	Same video as intervention with an unbranded soft drink	Preference and choice were assessed 2 weeks after the experiment	No significant effect on preference of branded foods	High

†Trial sample size (number randomized).
‡Excluded from meta-analysis.
§Visual analogue scale.

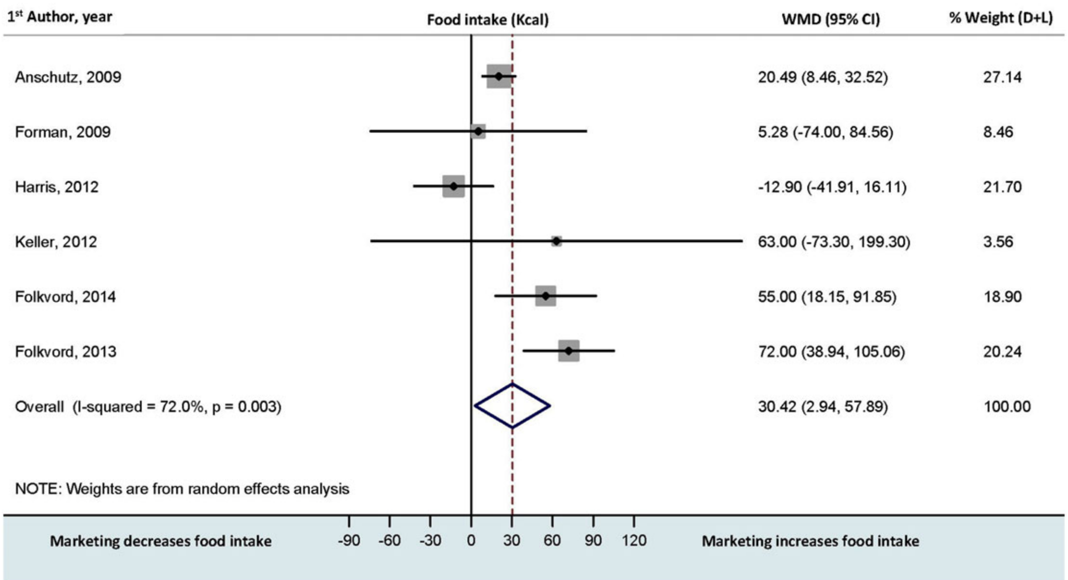

Figure 2 Forest plot showing the weighted mean difference in food intake (kcal) between unhealthy food and non-food marketing groups. Horizontal bars denote 95% CIs. Studies are represented as squares centred on the point estimate of the result of each study. The area of the square represents the weight given to the study in the meta-analysis by STATA software. The pooled mean difference was calculated by a random-effects model. The diamond represents the overall estimated effect and its 95% CIs in total (centre line of diamond, dashed line). The solid vertical line is the line of no effect.

Table 2 Results of the meta-analysis and subgroup analysis of randomized trials investigating the effect of unhealthy food/beverage marketing on dietary intake

		No. of trials	Mean difference	95% CI		No. of participants		*P*-value for difference	I^2	*P*-value for interaction
				Lower	Upper	Control	Intervention			
Dietary intake (kcal)	TV advertisement	1	20.5	8.5	32.5	57	63	0.001	—	—
	Advergame	3	37.4	−16.8	91.6	177	199	0.176	87.7	
	Logo/brand	2	19.9	−48.7	88.4	89	89	0.570	0.0	
	Low risk of bias	3	46.4	11.0	81.7	184	201	0.010	80.6	0.016
	High risk of bias	3	−7.9	−34.6	18.8	139	141	0.561	0.0	
	Advertisement time ≤ 5 min§	2	64.4	39.8	89.0	127	138	<0.001	0.0	0.005
	Advertisement time > 5 min§	2	6.5	−25.8	38.8	107	115	0.693	77.0	
	Consumption time < 15 min¥	2	64.4	39.8	89.0	127	138	<0.001	0.0	0.001
	Consumption time ≥ 15 min¥	4	9.6	−13.4	32.6	196	204	0.413	38.4	
	Healthy	2	−2.7	−27.9	22.6	115	121	0.837	75.7	0.051
	Unhealthy/less healthy	4	30.3	7.8	52.9	234	253	0.008	82.1	
	Boys	3	94.8	77.0	112.5	64	64	<0.001	0.0	0.004
	Girls	3	−8.8	−77.6	60.1	77	83	0.803	60.1	
	≤8 years of age†	2	43.0	1.38	84.7	110	117	0.043	79.7	0.578
	>8 years of age†	4	27.5	−7.8	62.7	213	225	0.127	19.5	
	Total	6	30.4	2.9	57.9	323	342	0.030	72.0	—
Dietary intake (g)‡	Low risk of bias	3	4.9	0.3	9.5	156	162	0.036	50.7	0.552
	High risk of bias	1	−4.1	−33.4	25.3	40	37	0.785	—	
	Advertisement time ≤ 5 min	3	3.6	−6.5	13.6	139	136	0.485	42.0	0.936
	Advertisement time > 5 min	1	4.0	1.7	6.4	57	63	0.001	—	
	Consumption time < 15 min	1	8.8	3.4	14.3	59	59	0.002	—	0.099
	Consumption time ≥ 15 min	3	3.8	1.4	6.1	137	140	0.002	0.0	
	Total	4	4.8	0.8	8.8	196	199	0.018	31.6	—

†Based on the mean age reported in the trial.

‡All trials in this category used TV advertisements as intervention, mean age in all of them was more than 8 years and none reported the intake of healthy vs. unhealthy products.

§Time participants were exposed to unhealthy food/beverage marketing.

¥The time given to the participants for eating the food/beverage provided by researchers during or after the intervention.

unhealthy advertisements they consumed more unhealthy calories ($n = 487$; MD = 30.3 kcal, 95%CI 7.8 to 52.9, $I^2 = 82.1\%$) than healthy calories ($n = 236$; MD = −2.7 kcal, 95%CI −27.9 to 22.6; $I^2 = 75.7\%$) and that the difference between the two estimates was statistically significant ($z = 1.9$, $P = 0.051$). With respect to baseline characteristics, the mean difference of dietary intake as reported in kcal among boys ($n = 128$) was 94.8 kcal (95%CI 77.0 to 112.5; $I^2 = 0.0\%$), while in girls ($n = 160$) it was −8.8 kcal (95%CI −77.6 to 60.1; $I^2 = 60.1\%$) (Table 2), and the difference was significant ($z = 2.9$, $P = 0.004$). Results for our subgroup analysis on age were not significantly different (≤8 years MD = 43.0 kcal; 95%CI 1.4 to 84.7; >8 years MD = 27.5 kcal; 95%CI −7.8 to 62.7, P for test of interaction = 0.58).

Dietary intake (grammes)

Among the four studies (395 participants) assessing dietary intake in grammes, the average time children were exposed to the marketing was 6.9 min (median: 5.25 min) and average time they were given for eating was 19.3 min (median: 22.5 min). Our meta-analysis showed a significant increase of 4.8 g (95%CI 0.8–8.8) among those exposed to unhealthy dietary advertising ($I^2 = 31.6\%$; Fig. S1).

All four studies included in our pooled estimate for dietary intake as grammes employed TV advertisements as the intervention. Results of subgroup analysis were similar based on risk of bias, duration of exposure to advertisements and duration of exposure (eating opportunity) to unhealthy foods (Table 2). We had insufficient data to assess subgroups based on quality of calories (healthy vs. less healthy/unhealthy), sex or age.

For dietary intake reported as either kcal or grammes, there were too few studies to assess the risk of publication bias. The overall quality of evidence for dietary intake for both estimates was moderate. We rated the quality of evidence down from high to moderate because of indirect evidence (dietary intake is a surrogate for more patient-important outcomes such as weight gain and obesity). Details of the overall quality of evidence are summarized in the GRADE summary of findings in Table 5.

Effects of unhealthy dietary marketing on dietary preference

Dietary preference scores

Of the 17 included studies on dietary preference, 12 trials reported a food or taste preference score. Our meta-analysis showed a small non-significant increased effect favouring preference for unhealthy foods/beverages when accompanied by advertising (SMD = 0.23, 95%CI −0.04 to 0.5; $I^2 = 87.6\%$; Fig. S2). Results of the subgroup analysis showed that dietary preference was not influenced by type of advertisement, risk of bias and type of foods/beverages provided to children (Table 3). The mean age of participants in the eight RCTs (879 children) was ≤8 years, and their preference for unhealthy foods/beverages showed a small to moderate effect size (SMD = 0.46; 95%CI 0.21 to 0.72; $I^2 = 72.7\%$), whereas in the four RCTs ($n = 1{,}174$) including participants >8 years, their dietary preference for unhealthy foods/beverages showed a small non-significant effect size (SMD = −0.28; 95%CI −0.72 to 0.16; $I^2 = 19.5\%$). The test for interaction was significant ($z = 2.85$, $P = 0.004$).

Food preference percentage

Of the 17 included studies on foods/beverages preference, eight trials reported the percentage of children who preferred specific foods/beverages. Children exposed to unhealthy foods/beverages marketing had a higher risk of selecting the advertised products that were associated with a familiar licenced-character/logo (RR = 1.1, 95%CI 1.0 to

Table 3 Results of the meta-analysis and subgroup analysis of studies investigating the effect of unhealthy food/beverage marketing on dietary preference (preference score)

	Food/beverage preference								
	No. of trials	SMD	95% CI		No. of participants		*P*-value	*P*-value for interaction	I^2
			Lower	Upper	Control	Intervention			
TV advertisement	3	0.29	−0.28	0.86	262	268	0.313	0.772	72.1
Advergame	2	−1.20	−4.44	2.04	56	56	0.467		95.6
Logo/brand	7	0.34	0.01	0.67	706	705	0.050		89.6
Low risk of bias	7	0.11	−0.10	0.32	904	898	0.315	0.743	77.5
High risk of bias	5	0.23	−0.46	0.91	120	131	0.518		86.8
Healthy	4	−0.01	−0.57	0.56	498	493	0.982	0.071	92.3
Unhealthy/less healthy	6	0.74	0.16	1.33	551	559	0.013		95.1
≤8 years of age	8	0.46	0.21	0.72	433	446	0.001	0.004	72.7
>8 years of age	4	−0.28	−0.72	0.16	591	583	0.212		87.7
Total	12	0.23	−0.04	0.50	1,024	1,029	0.094	—	87.6

1.2; $P = 0.052$, $I^2 = 27.6\%$; Fig. S3). Subgroup analysis based on types of advertising demonstrated no significant difference, whereas studies with higher risk of bias and studies performed on children less than 8 years of age showed significantly increased risk of selecting the advertised products. However, the test of interaction for all three subgroups was non-significant (Table 4). We had insufficient data to assess subgroups based on advertisement time, type of food (unhealthy vs. healthy) and sex.

The funnel plot and the Begg's and Mazumdar's adjusted rank correlation test for 12 studies reporting dietary preference scores did not indicate evidence of publication bias (Fig. S4). We did not test for publication bias among studies that reported dietary preference as a percentage as only eight studies were included. The overall quality of evidence for dietary preference scores was low. We rated the quality of evidence down because of risk of bias and unexplained heterogeneity. The overall quality of evidence for dietary preference reported as a percentage was moderate. We rated down from high to moderate based on risk of bias issues (Table 5)

Discussion

We identified 29 randomized trials evaluating the effects of unhealthy food and beverage marketing involving almost 6,000 children aged 2–18 years. We found that exposure to unhealthy food and beverage marketing increased children's dietary intake and influenced children's dietary behaviours during or shortly after exposure to advertisements. Our findings were consistent across studies. That is, in 18 of 26 studies amenable for meta-analysis, the mean dietary intake or preference was greater for the marketed dietary products than non-marketed products.

Using GRADE methodology, the overall quality of evidence for food intake in kcal (665 children) and food intake in grammes (395 children) was moderate, meaning the true effect is likely to be close to the estimate of the effect but there is a possibility that it is different. Considering the short average time children were exposed to the adverts (approximately 5 min) and the nearly 30 kcal (4.5 g) increase in dietary intake over an average of 15 min, an association between exposure to energy-dense, low-nutrition food and beverage advertising and weight gain, obesity and other dietary related non-communicable diseases is plausible. Although results were non-significant with respect to food and beverage preferences, among 1,648 children exposed to energy-dense, low-nutrient products marketing, we found an increased risk of selecting advertised foods or beverages that were associated with a familiar licenced-character or logos (moderate quality evidence). Similarly, the food and beverage preference score among 2,053 children showed a non-significant increased risk (low quality evidence).

Our findings suggest that younger children (≤8 years of age) might be more susceptible to the impact of food and beverage marketing in terms of quantity and quality of calories consumed. Looking at subgroup analyses, the most consistent finding suggested that younger children have increased caloric intake, preference scores and often selected unhealthy foods and beverages as compared with older children. However, only preference scores were significant, demonstrating that those ≤8 years of age had higher preference scores than those >8 years. While children at the age of 2 or 3 are able to recognize familiar characters and identify food and beverage products, they are less able to understand the intention behind advertising and differentiate between program content and advertisements until the age of 7 or 8 (10,54). Thus, younger children might be more vulnerable to the influence of advertisements and associate the marketed products with positive features of commercials and subsequently try to imitate the behaviours they see.

Although we were only able to conduct a subgroup analysis based on sex for one of our four outcomes, our findings

Table 4 Results of the meta-analysis and subgroup analysis of studies investigating the effect of unhealthy food/beverage marketing on dietary preference

	Food/beverage preference (percentage)								
	No. of trials	RR	95% CI		No. of participants		*P*-value	*P*-value for interaction	I^2
			Lower	Upper	Control	Intervention			
TV advertisement	2	1.1	0.74	1.58	54	54	0.688	0.303	0.0
Advergame	2	1.5	0.95	2.37	122	193	0.082		39.4
Logo/brand	4	1.1	0.96	1.13	612	613	0.282		0.0
Low risk of bias	2	1.0	0.93	1.12	429	430	0.641	0.061	0.0
High risk of bias	6	1.2	1.05	1.36	359	430	0.007		0.0
Healthy	—	—	—	—	—	—	—	—	—
Unhealthy/less healthy	—	—	—	—	—	—	—		—
≤8 years of age	4	1.2	1.04	1.37	314	386	0.012	0.223	0.0
>8 years of age	4	1.1	0.91	1.22	474	474	0.491		34.1
Total	8	1.1	1.0	1.23	788	860	0.052	—	27.6

Table 5 Summary of findings

Patient or population: Children 2 to 18 years of age
Intervention: Unhealthy foods/beverages marketing
Comparison: Non-foods/beverages marketing and/or no marketing

Outcomes	Anticipated absolute effects* (95% CI): Risk with non-food/beverage marketing	Anticipated absolute effects* (95% CI): Risk with unhealthy food/beverage marketing	Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)	Comments
Dietary intake (kilocalories) for 2 to 30 min during or after exposure to advertisements	The median food intake was **140.6** kcal	The mean food intake in the intervention group was 30.4 kcal higher (2.9 higher to 57.9 higher)	—	665 (6 RCTs)	⊕⊕⊕○ MODERATE[1]	
Dietary intake (g) for 2 to 12 min during or after exposure to advertisements	The median food intake was **33.1** g	The mean food intake in the intervention group was 4.8 g higher (0.8 higher to 8.8 higher)	—	395 (4 RCTs)	⊕⊕⊕○ MODERATE[3]	
Dietary preference score after exposure to advertisements	The mean preference score was **0**	Although non-significant, the mean preference score in the intervention group was 0.23 standard deviation units higher (−0.04 lower to 0.5 higher)	—	2,053 (12 RCTs)	⊕⊕○○ LOW[5]	
Dietary preference as a percentage after exposure to advertisements	**Risk with non-food marketing** 504 per 1,000	**554 per 1,000** (504 to 605)	**RR 1.1** (1.0 to 1.2) $P = 0.052$	1,648 (8 RCTs)	⊕⊕⊕○ MODERATE[7]	

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

GRADE Working Group grades of evidence:

High quality: We are very confident that the true effect lies close to that of the estimate of the effect.

Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.

Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

[1]Five of six trials had an unclear risk of bias because of lack of allocation concealment, and three of six trials had a high risk of bias because of lack of blinding of participants and/or assessors. However, given that dietary intake is an objective outcome, we did not rate down for risk of bias.

[2]Substantial heterogeneity (I^2 72.0%) in the pooled estimate was observed. Results of our subgroup analyses on risk of bias, quality of calories and sex were significant, helping to explain the inconsistency.

[3]Considering that the dietary intake is a surrogate outcome for weight gain and other patient-important outcomes, we rated down for indirectness.

[4]Two of four trials had unclear risk of bias because of lack of allocation concealment and blinding of participants and/or assessors. However, given that dietary intake is an objective outcome, we did not rate down for risk of bias.

[5]Six of 12 trials had an unclear risk of bias because of lack of allocation concealment, and eight of 12 trial had a high risk of bias because of lack of blindness of participants and/or assessors. Dietary preference is a subjective, and many of the instruments used were unvalidated so we rated down for risk of bias.

[6]Given the substantial heterogeneity (I^2 87.6%) in the pooled estimate that was generally unexplained (three of four subgroups were non-significant; the subgroup on age was significant but both subgroups had I^2 values > 72%), we rated down for inconsistency.

[7]The majority of trials (six of eight) had an unclear or high risk of bias because of lack allocation concealment and blinding of participants and/or assessors, and given that this is a subjective measure, we rated down for risk of bias

CI, confidence interval; RR, risk ratio; OR, odds ratio.

further suggest that boys might be more susceptible to the impact of food and beverage marketing in terms of caloric intake. Girls may have a higher tendency towards dieting practices possibly as a result of maternal encouragements to be thin (42,44) that may have suppressed their natural response (55). It has also been suggested that boys may be more vulnerable when exposed to external cues for food and beverage advertisements and therefore may consume more than girls (55,56). Another explanation for the observed difference between boys and girls might be that child-targeted and adolescent-targeted food and beverage advertisements tend to focus on boys perhaps because they are more susceptible to external cues of food advertisements (57,58).

It is important to note that advergames differ from TV advertising in several key ways (active vs. passive reception, low vs. high interactivity while exposed to the brand, exposure time) (55,56). In comparing the subgroups (TV advertisement, advergames and using familiar characters/logo), our analysis showed no significant difference in children's dietary intake or preference among different types of marketing. This might be due to the small number of included studies. In addition, none of the identified trials directly compared the effects of advergames with TV advertising in terms of dietary intake or preference.

Subgroup analysis of included studies according to the time children were exposed to the advertisements (≤5 min vs. >5 min) and the time they were given to eat (<15 min vs. ≥ 15 min) showed that those exposed to less marketing and those who had less time to consume had higher intakes. These findings were counter-intuitive; however, studies that exposed children >5 min of advertisements or provided ≥15 min to consume tended to have higher risk of bias and were more likely to provide more energy-dense foods (28,38,42,44). These findings may also be due to chance given the sparse number of studies included in the analysis or the fact that children may have gorged the energy-dense snacks at the beginning of each study given that they had limited time.

Four systematic reviews have investigated the effects of food and beverage marketing to children, three of these being technical reports from authoritative bodies such as the World Health Organization (WHO) (14–16,28). While largely based on evidence from observational studies, each review concluded that the marketing and promotion of foods and beverages high in fat, sugar and/or salt have a negative impact on children's nutrition preferences, purchase behaviour, consumption patterns and diet-related health. A recent meta-analysis showed that acute exposure to food and beverage advertising is associated with greater food intake in children (57); however, they combined randomized and non-randomized trials and did not assess risk of bias or the quality in evidence using the GRADE approach. Further, Boyland *et al*. (57) included only 13 studies in their meta-analysis, while we included 26 RCTs. While not conclusive, the findings from this review contribute to the growing body of research suggesting that the marketing of energy-dense, low-nutrition foods and beverages to children contribute to unhealthy dietary choices, which puts children at risk for diet-related diseases later in life.

This paper has a number of noted limitations. First, using the GRADE approach the overall quality of evidence for the effects of food and beverage advertising on dietary intake and preference was low to moderate quality. The quality of evidence was impacted primarily because of lack of reporting of allocation concealment, blinding of outcome assessors and participants and the unavailability of study protocols that were substantial among included articles, limiting the overall certainty in evidence. Second, the included studies examined responses to acute advertising exposure only. The collective effects of continued exposure to food and beverage marketing that occurs in real life and over a lifetime may differ. Third, the designs of these interventions (being conducted in laboratory setting rather than in real-life situations) may be different from the typical daily exposure to advertising children are subjected to.

Implications for public health policy

A recent global study spanning 13 countries revealed that children are exposed to an average of five food advertisements per hour with unhealthy 'non-core' foods accounting for greater than 80% of all televised food advertisements in Canada, the United States and Germany (58). Collectively, the evidence linking children's exposure to unhealthy food and beverage marketing to poor dietary behaviours and increased risk of overweight and obesity has sparked global debate. Results of a recent modelling study suggested that a ban on television advertising of foods high in fat, sugar and/or salt could reduce overweight and obesity in childhood by 18% and 2.5%, respectively (54,59). Given the potential impact on children's health, in 2010 the WHO released a set of recommendations urging member states to restrict the marketing of foods and beverages high in saturated fats, trans-fats, added sugar and salt to children (12). Voluntary self-monitoring by industry and inadequate nutritional standards for defining healthy/unhealthy dietary products and the lack of government monitoring and oversight remain key flaws to recent initiatives and likely account for the lack of reduction in child-targeted marketing for unhealthy foods and beverages (13,60–62).

Conclusions

The evidence indicates that unhealthy food and beverage marketing increases dietary intake and preference for energy-dense, low-nutrition products in children during or shortly after exposure to advertisements. Further research is needed to evaluate the impact of unhealthy food and beverage advertising on daily and weekly dietary intake and choices. Overall, our analyses support the need for a review of public policy on child-targeted unhealthy food and beverage marketing.

Acknowledgements

We would like to thank Gordon Guyatt, MD, Distinguished University Professor in the Departments of Clinical Epidemiology and Biostatistics and Medicine at McMaster University, for his methodological advice.

Conflict of interest

Authors declare no conflicts of interest.

Funding and support

The research was funded in part by the Heart and Stroke Foundation, Canadian Institute for Health Research Chair in Hypertension Prevention and Control (NRCC). The funder had no role in design and conduct of the study, collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript and decision to submit the manuscript for publication.

Authors' contributions

Dr Sadeghirad and Dr Johnston had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: N. R. C. C. and B. C. J.

Acquisition, analysis or interpretation of data: T. D., B. S., S. M., and B. C. J.

Statistical analysis: B. S. and B. C. J.

Drafting of the manuscript: B. S. and T. D.

Critical revision of the manuscript for important intellectual content: All authors.

Study supervision: B. C. J. and N. R. C. C.

Supporting Information

Additional Supporting Information may be found in the online version of this article, http://dx.doi.org/10.1111/obr.12445

Figure S1. Forest plot showing the weighted mean difference in food intake (grammes) between unhealthy food and non-food marketing groups. Horizontal bars denote 95% CIs. Studies are represented as squares centred on the point estimate of the result of each study. The area of the square represents the weight given to the study in the meta-analysis by STATA software. The pooled mean difference was calculated by DerSimonian–Laird (D + L) random-effects model inverse variance (I-V) fixed-effects model. The diamond represents the overall estimated effect and its 95% CIs (centre line of diamond, dashed line). The solid vertical line is the line of no effect.

Figure S2. Forest plot showing the standardized mean difference (SMD) in food/taste preference between unhealthy food marketing and control groups. Horizontal bars denote 95% CIs. Studies are represented as squares centred on the point estimate of the result of each study. The area of the square represents the weight given to the study in the meta-analysis by STATA software. The pooled standardized mean difference was calculated by a random-effects model. The diamond represents the overall estimated effect and its 95% CIs in each subgroup and in total (centre line of diamond, dashed line). The solid vertical line is the line of no effect.

Figure S3. Forest plot showing relative risk (RR) for unhealthy food marketing vs. control groups. Horizontal bars denote 95% CIs. Studies are represented as squares centred on the point estimate of the result of each study. The area of the square represents the weight given to the study in the meta-analysis by STATA software. The pooled RR was calculated by DerSimonian–Laird (D + L) random-effects model Mantel–Hansel (M-H) fixed-effects model. The diamond represents the overall estimated effect and its 95% CIs in total (centre line of diamond, dashed line). The solid vertical line is the line of no effect.

Figure S4, Funnel plot of studies included in the meta-analysis food preference. The standardized mean difference (SMD) is plotted on the x-axis, and the standard error (SE) of the SMD is plotted on the y-axis. Each point in the plot represents a study and its effect estimate; the shape of a symmetrical funnel suggests the absence of publication bias.

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