# SCIENTIFIC OPINION

## ON THE VALIDITY OF SELECTED STUDIES ON THE RELATIONSHIP BETWEEN ADVERTISING EXPOSURE AND CHILDREN'S DIETS

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# Scientific Opinion
# on the validity of selected studies on the relationship between advertising exposure and children's diets

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# List of abbreviations

***A***

AGF ......... *AGF Videoforschung GmbH (formerly Arbeitsgemeinschaft Fernsehforschung (working group TV research))*

***B***

BMEL ........ *Federal Ministry of Food and Agriculture*
BMI ........ *Body-Mass-Index*

***C***

CITS ........ *Controlled Interrupted Time Series Analysis*

***D***

DANK ........ *German Alliance Noncommunicable Diseases*
DGE ........ *German Society for Nutrition*

***G***

GfK ........ *GfK SE (formerly GfK-Nürnberg Gesellschaft für Konsumforschung e. V. (institute for consumption research))*

***H***

HFSS ........ *high in fat, salt or sugar*

***I***

IOM ........ *Institute of Medicine*

***K***

kcal ........ *Kilocalories*
kj ........ *Kilojoule*

***M***

mpfs ........ *Media Education Research Association Southwest*

***R***

RCT ........ *Randomized Controlled Trial*

***S***

SMD ........ *Standardized mean difference*

***T***

TfL ........ *Transport for London*

***W***

WHO ........ *World Health Organization*

# 1. Summary

This report examines the scientific and statistical basis behind a frequently called-for ban on the advertising of foods which do not meet the requirements of the WHO nutrient profile model for Europe in terms of their sugar, salt, or fat content (WHO, 2015, 2023) (*high in fat, salt, or sugar*, HFSS).[3] The motivation for this expert opinion is, among other things, the following statement by Professor Berthold Koletzko, metabolic specialist at the University Children's Hospital in Munich and chairman of the Stiftung Kindergesundheit (Children's Health Foundation). He claims that "the findings of relevant studies are crystal clear" and support the relevant (media) opinion: "Exposure to advertising is directly associated with increased obesity" (Roggenkamp, 2023).

However, an unbiased assessment of the relevant studies leads to the conclusion that this opinion is not factually supported. There is no evidence of a direct, causal relationship between children's exposure to advertising and increased weight gain or even obesity. Furthermore, there is no clear scientific evidence of a sustained effect of advertising on increased consumption of HFSS foods by children, nor does any study establish a causal link to overweight. On the contrary, this relationship is hardly studied at all. The object of investigation of current research is merely the temporary consumption of HFSS foods by children directly following their exposure to HFSS food advertising.

However, an evidence-based policy intervention for population-based prevention – which is all that an advertising ban would amount to – requires "the identification of preventive potential based on representative national exposure data and evidence-based risk estimators" (Knorpp, 2013, p. 262). Thus, in addition to (1) evidence of a causal relationship between exposure to advertisements and arising health problems, there is a need for (2) a valid estimate of the preventive potential of the intervention and (3) ongoing evaluation, including a criterion for terminating the intervention, should the expected level of prevention could not be achieved by the method of intervention. This third requirement is based on the ethical principles for health promotion and public health, "Do not harm" (principle #2) and "Accountability" (principle #10) (Tannahill, 2008, p. 386).

A scientific basis, from which an evidence-based ban on advertising for health promotion could be derived, is not sufficiently given. Rather, the following applies: All examined studies cited in the context of the proposed ban, either

- make no such claims whatsoever,

[3] According to the German Federal Ministry of Food and Agriculture (BMEL), there are to be certain exceptions to the advertising ban. These include fruit juices (without added sugar or sweeteners) and milk (with regard to the possibly excessive fat content) (BMEL, 2023b).

- are not methodologically appropriately constructed to demonstrate a causal relationship to health outcomes (overweight, obesity), or
- are so flawed in terms of content and methodology that the conclusion of the study is baseless.

The first point of criticism relates to the fact that study results are misinterpreted by third parties. The second point of criticism alludes to the problem that possible risk factors, which are responsible for the occurrence of the observed effect, are not considered or that the observation period is simply too short. For example, the German Nutrition Society (DGE) states, in order "to evaluate primary preventive effects with respect to diet-related diseases, a study duration of at least 1 year, preferably several years, is necessary" (Deutsche Gesellschaft für Ernährung e.V., 2014, p. 10).

The third point of criticism, methodological deficiencies, is exhibited as "alpha error inflation" (*Type I error inflation*). In the event that more than one primary study endpoint is present, for instance in the comparison of multiple subject groups or the testing of multiple hypotheses on the same data, the level of significance must be adjusted, in order to prevent a rising probability of false positive results (Victor et al., 2010).

In addition to the criticisms of the studies individually, there is also the issue of publication bias. Publication bias occurs when studies with statistically significant effects are published more frequently in peer-reviewed journals (Sterling, 1959; Thornton & Lee, 2000) This undermines the quality criteria of statistical tests, i.e., random effects are disproportionately reported (Schüller, 2015, p. 111). The statistical significance reported in the relevant studies, in the sense of probabilities of spurious positive effects, are in fact far greater than the 5% or 1% typically used as the cutoff value for hypothesis testing.

Overall, it is extremely difficult to prove a causal relationship without a long-term randomized controlled trial (RCT) or complex statistical methods (e.g., instrumental variables). Thus, it remains doubtful whether children would not have an equally strong preference for yogurts, sweets, soft drinks, breakfast cereals, etc. even without advertising, and whether childhood overweight is promoted by advertising exposure per se or rather by the (excessive) media consumption that advertising exposure necessarily presupposes, as well as the associated low level of physical activity. For this reason, a scientifically based study at the end of this review which investigates the advertising effects of HFSS products on children's health and address the criticisms of current literature, while avoiding common limitation is briefly outlined at the end of this review.

## 2. Introduction

A current demand in nearly all debates regarding German social and health regulations is that of "evidence-based policies". Recommendations for policy implementations in any context and of any form should not be based solely on abstract theories, and certainly not on wishful thinking; a conditio sine qua non is factual evidence of effectiveness. "The AWMF [Association of the Scientific Medical Societies] welcomes the fact that the new Federal Minister of Health, Professor Dr. Karl Lauterbach, wants to anchor future health policy in science and make evidence-based decisions"[4], as he emphasized during his inauguration (Diabetologie online, 2021). However, not every arbitrary measure can be empirically justified. For example, in the early stages of the Covid 19 pandemic, anyone aiming to back up their actions using data was faced with an insurmountable task. After all, without any precedent or long-term experience in the form of scientific studies, it is incredibly challenging to support the fight against a previously unknown virus with empirical data. Instead, the term "evidence-based" was used in an inflationary way to add scientific merit to one's own argumentation, at least seemingly, or to conceal one's own uncertainty by referencing numerical data. Meanwhile, "the term 'evidence-based' is slowly becoming synonymous for 'scientific', which is as false as it is harmful, since it undermines any reasonable doubt," writes the *Frankfurter Allgemeine Zeitung* (Igel, 2023).

Therefore, a closer look is required, given the fact that the proponents of an advertising ban for foods which do not comply with the WHO Nutrient Profile Model for Europe (WHO, 2015, 2023) describe their recommendations as "evidence-based": "The study findings are crystal clear" (Roggenkamp, 2023). "Exposure to advertising is directly associated with increased obesity." As in the early days of the corona pandemic, however, it is advisable to ask: "Is there evidence in certain claims labelled as such?" After all, sufficiently proving the existence of causal relationships is one of the most challenging tasks of all regarding empirical statistics. It is not without reason that various such attempts have earned their authors several Nobel Prizes: James Heckman in 2000 or David Card, Joshua Angrist and Guido Imbens in 2021 (Nobel Prize Outreach AB, 2023a, 2023b).

The gold standard for proving a causal relationship consists of a planned experiment. Such experiments are relatively simple in the fields of natural science, however, in the areas of medicine, epidemiology, or economics and social sciences they are usually far too complex to conduct and, therefore, quite rare. In such "Randomized Controlled Trials (RCT)" also called randomized experiments, one divides the test subjects into two groups at random; one group – in the context of the topic at hand – is exposed to an advertisement for HFSS foods, while the other views an

[4] German quotations are translated to English in this report.

advertisement for an unrelated product. Subsequently, the dietary behaviours of both groups are observed. Random assignment of participants guarantees that, given a large enough sample, these groups differ – on average – only in the characteristic of interest. Some of the studies we examined in this report attempt to take this approach, at least to some extent.

In the absence of planned experiments, applied statistics often resorts to so-called observational studies, especially cohort studies, which consist of comparing two groups of people: one is exposed to the respective risk of interest (here: advertising for HFSS foods) over a certain period, while the other is not. An example of an observational study in the context of this review, to some extent, can be found in a study by Yau et al. (2022), which examines sales of HFSS products during a London transit advertising ban compared to a cohort from the North of England.

In addition to the characteristic of interest, the two groups are investigated for additional distinguishing characteristics with the aim of identifying possible explanatory factors: Do unemployed people have depression more often? Are regular discotheque visitors more likely to have impaired hearing? Do chain smokers have a higher risk of lung cancer? etc. In fact, it is found that chain smokers have a much higher risk of lung cancer than their non-smoking peers. Ergo: smoking is the cause of cancer.

In the case of smoking, this assumption is indeed true. However, the potential pitfalls of this way of reasoning are quite plain to see, even for a non-statistician. Perhaps individuals suffering from depression have a harder time gaining employment? Or (admittedly, a bit of a stretch): Only individuals with impaired hearing can stand the loud noise of a disco. Even the indisputable causal relationship between smoking and increased cancer risk is by no means as clear-cut as often assumed. For example, it has been proven by numerous studies that smokers are also murdered or run over by a bus much more often than non-smokers for the same reason they like to smoke: Because they are more risk averse people (Karlsson Linnér et al., 2019). These so-called "smoking personalities" would allegedly die one to two years earlier than their non-smoking peers, even if they never touched a cigarette in their lives. In other words, the life expectancy of heavy smokers, which is around ten years less than average, is not entirely attributable to smoking.

This is the great Achilles' heel of epidemiology: one can never be completely certain that the two comparison groups do not differ in some other aspect besides the supposed explanatory factor. Omitting one of these control variables potentially leads to 'omitted variable bias'. The scientific journal Science (see Taubes, 1995) has revealed the following and numerous other carcinogens identified by epidemiological studies – actual or alleged – as false alarms. None of the findings could be replicated by independent follow-up studies:

- High cholesterol diet: + 65% risk of rectal cancer (men)
- Consumption of yogurt at least once a month: + 100% risk of ovarian cancer (women)
- High-fat diet: + 100% risk of breast cancer (women)
- Severe exposure to dioxins over a long period of time: + 50% risk of all cancer types
- Drinking more than 3.3 litres of fluid in a day (especially chlorinated tap water): + 100% risk of bladder cancer
- Diet high in saturated fats: + 600% risk of lung cancer (non-smoking women)
- Consumption of more than 20 grams of processed meat per day: + 70% increased risk of colon cancer
- Consumption of red meat 5 times or more per week: + 150% risk of colon cancer
- Consumption of red meat 2 times per day: + 100% risk of breast cancer (women)
- Obesity (adiposity) in men (the most severe 25% of the study): + 200% risk of oesophageal cancer
- Consumption of olive oil no more than once a day: + 25% risk of breast cancer (women)

According to *Science,* all these results are fraught with doubt and most likely false. Corresponding doubts are also indicated for observational studies on the relationship between food advertising and calorie intake, as well as overweight in children. This will be discussed further in the detailed critique of these studies subsequently in the report.

Technically, most of the aforementioned fallacies result from a confusion of correlation and causality. Two metric variables are correlated (more precisely: positively correlated) if they systematically move together in the same direction. If one rises, so does the other; if one falls, so does the other. This is not true in every individual case, but it is valid for the statistical average. A simple example of positive correlation is the relationship between height and weight: the taller a person is, the more they tend to weigh. Of course, this is not true for every individual case, but in general the assumption applies.

Two variables, on the other hand, are called negatively correlated, if they systematically move in opposite directions. An example of this type of correlation is the relationship between the age of a used car and its current market price: the older the car, the lower its resale value (for a given make and model). Once again, this does not apply in every individual case – a well-maintained older car with low mileage is often more expensive than a newer model in less optimal condition. In this example, there is in fact a causal relationship present: increasing age is the reason for decreasing price – the older the car, generally, the shorter its remaining lifespan.

However, by no means is every correlation also based on a causal relationship. This is due to two factors: a third variable, on which both correlated variables are dependent, and the so-called "two-sided causality". In many cases, this third variable is simply time – both variables contain a trend. For example, in April 2021, a variety of media reported on a study by French biomedical scientists Serge Morand and Claire Lajaunie which found a high negative correlation between global rainforest abundance and the incidence of animal-based infectious diseases. From 1990 to 2016, they had noted a steady decline in the Earth's surface covered by rainforest along with an equally steady increase in infectious waves of various animal-based diseases. Thus, the two variables were automatically negatively correlated. This correlation drove some media platforms to publish lurid headlines, such as the following: "Clear finding: Deforestation promotes spread of infectious diseases" (derstandard.de), "Deforestation promotes animal diseases" (blick.ch) and "Study shows: If we keep deforesting, there will be more infectious diseases" (tag24.de).

Correlations without causal background are also called "spurious correlations" or "nonsense correlations". The most prevalent cause for spurious correlations is, as previously mentioned, a common trend: two variables over the course of time either systematically move in the same direction or in the opposite direction. In the former, the variables are positively correlated and in the latter case, they are negatively correlated. The positive nonsense correlation between shoe size and intelligence in adolescents often cited in textbooks, for example, is due to age: the older an individual, the larger their feet tend to be and the better they tend to perform on conventional intelligence test tasks.

Returning to the subject at hand, children's health is also determined by a variety of factors, including the parents' environment and lifestyle, level of activity, genetics, and diet. The relationships between these various factors, however, are completely unclear; ergo, how much of children’s health and wellbeing can reasonably be attributed to the influence of advertising, when considering these other factors? In the subsequent sections of this report, we will further elaborate on some criteria used to infer causality and demonstrate how none of the examined studies adequately met these criteria.

A further point of critique is the insouciant use of statistical significance. The long-lasting and widespread adherence to statistical significance as a deciding factor is now being rejected by leading statisticians, as it can lead to notable false conclusions (Amrhein & Greenland, 2018; Gigerenzer, 2018; Hirschauer et al., 2020; Ioannidis, 2005; Krämer, 2011; McCloskey, 2002; McCloskey & Ziliak, 2008). Meanwhile, leading journals discourage reporting such findings altogether without an account of the effect. In particular, it is crucial that a p-value be embedded in the context of the study and interpreted, and not merely reported as "evidence" of the alleged relationship without further reflection.

Statistically significant means: If the investigated effect were not present, then the observed result would be extremely improbable within a random process with certain assumptions. If an effect is nevertheless observed – based on a random sample – a false positive result occurs. In statistics, this is also called a "type I error", in distinction to another possible error, which would consist of not recognizing an existing effect ("type II error").

"Extremely unlikely" generally refers to a probability less than 5% (often symbolized by the sign *) or 1% (symbolized by the sign **). However, this statement is purely hypothetical, based on assumptions which do not necessarily correspond to the substantive facts, which is why this assumption is increasingly criticized in mathematical statistics: "The progress of economic science has been seriously damaged [by the common practice of significance testing]. You can't believe anything that comes out of [it]. Not a word. It is all nonsense, which future generations of economists are going to have to do all over again. Most of what appears in the best journals of economics is unscientific rubbish. I find this unspeakably sad. All my friends, my dear, dear friends in economics, have been wasting their time... They are vigorous, difficult, demanding activities, like hard chess problems. But they are worthless as science" (McCloskey, 2002, p. 40).

In particular, the (hypothetical) improbability of the observed data deemed statistically significant has attracted particularly strong criticism. On the one hand, this improbability is, as previously explained, a purely hypothetical fact, and therefore limited in its informative value. On the other hand, it is exacerbated by the fact that even the alleged hypothetical minimal probability does not apply: "Despite the nominal endorsement of a maximum false-positive rate of 5% (...) current standards for disclosing details of data collection and analyses make false positives vastly more likely. In fact, it is unacceptably easy to publish 'statistically significant' evidence consistent with *any* hypothesis" (Simmons et al., 2011, p. 1359). Ioannidis (2005), Krämer (2011, 2012) or Ziliak and McCloskey (2008), among uncounted other authors, compile numerous examples of this occurrence.

Another explanation for the much higher probability of a type I error is referred to as publication bias in the relevant literature and has been the subject of intense scrutiny for several decades. "There is some evidence that in fields where statistical tests of significance are commonly used, research which yields nonsignificant results is not published. Such research, being unknown to other investigators may be repeated independently until eventually by chance a significant result occurs" (Sterling, 1959, p. 30). In other words, it may be rather probable to find a "significant" effect even if no such effect exists. Dubben and Beck-Bornholdt (2004) provide an extensive account of such spurious effects in the field of medicine.

In accordance, the studies considered in this report regarding the relationship between advertising directed at children and caloric intake of children, as well as childhood overweight also present mostly irrelevant or spurious effects, however, no conclusive evidence of a causal effect. This is further elaborated on in the following chapters. The scientific studies examined in this review were required to meet two specific criteria regarding their relevance to the debate on an advertising ban: They are either cited by relevant parties, such as lobby organizations or policy makers, or serve as a reference in said cited papers, and thus lay the foundation for the results of these studies.

## 3. Frequent methodological weaknesses within the studies[5]

Before addressing the methodological weaknesses common in all studies published on the topic of advertising effects on children, the general design of these studies will be briefly presented first.

All of the (experimental) studies examined (i.e., apart from literature reviews or meta-reviews) follow a very similar study design. It entirely ignores the health effects of advertisement consumption, which are, however, ultimately used in the public debate regarding an advertising ban as the central justification for such a ban. As described in the chapter Causality the studies do not examine the influence of advertisement consumption on overweight – only the immediate (and time-limited) HFSS consumption following the exposure to advertising is examined. Most of the papers examined conduct a randomized controlled trial (RCT). This implies the presence of a control group, as well as random assignment of participants to experimental and control groups. The randomization ensures that the groups do not differ in their composition, i.e., they have the same variance in factors, such as age, gender, and social status, although these are not controlled.

The exact procedure of the studies is generally as follows:

Subjects are usually between seven and twelve years old, however, there are also studies which examine participants from two to 18 years old (e.g., Sadeghirad et al., 2016). The study period is usually a few minutes to a few hours. At the beginning, participants are usually asked about their hunger level, allergies, as well as food preferences. Subsequently, subjects are instructed to watch a movie or cartoon series which explicitly makes no references to food. The clip is usually less than 15 minutes in length and watched in a group setting, sometimes in isolation. The intervention group then views a series of commercials for HFSS foods, such as salty and fatty foods, or advertisements for fast food restaurants. The control group watches a series of non-food-related advertisements, such as for toys, clothing, or travel. Participants are then given a selection of snacks, usually a mix of high-fat, sweet and salty (chocolate, gummy bears, cookies, crisps), as well as unprocessed snacks (e.g., carrots, grapes). Participants are told they can eat as many of the snacks as they want. Snacks were usually replenished when fully consumed. In some studies, the eating period is limited (e.g., to 15 min), however, most of the time there is no time constraint. Finally, the uneaten food is weighed, from which the consumed calories are calculated to compare the consumption of the control group with that of the experimental group. Occasionally, the weight of the subjects is also considered and consumption is compared within weight classes (Halford et al., 2008; Norman et al., 2018). An exception to this classic procedure is the study by Norman et al. (2018): In this particular study,

[5] Under 7. tabular study overview, the mentioned criteria for the experimental studies included in the report are clearly presented.

children are observed for the duration of an entire morning at several summer camps in Australia, where they are served breakfast and lunch, in addition to snacks during the course of the experiment. Certain studies also or exclusively examine other advertising formats besides TV commercials, such as advergames[6] (Norman et al., 2018) or Instagram profiles (Coates et al., 2019b). Nevertheless, this does not alter the study process significantly different from the description above. These other media formats are underrepresented within the literature, have been less frequently addressed in public debate, and thus were not studied to the same extent as TV advertising in this review.

Almost all of the studies examined in this report are subject to the methodological weaknesses discussed in more detail in the subsequent sections. They are representative of all available literature on advertising effects regarding the consumption of HFSS foods among children.

Another widespread problem lies in the small sample size of these studies. If the study subjects are subdivided into smaller groups for evaluation, for example by weight or BMI, basic assumptions for the applicability of statistical methods, such as t-tests or linear regression, are violated. Additional tests for normal distribution of the underlying data are required once the sample is smaller than 30, however, these tests are never performed. Furthermore, in such cases, the data is highly sensitive to individual subjects. Therefore, in studies with a small sample size, even a few subjects can affect whether the outcome is statistically significant. A sufficient sample size is also mandatory for the generalization of study results to ensure that the sample is as similar to its studied population's composition as possible. For example, if an experiment is conducted with schoolchildren from districts with higher socioeconomic status, the results cannot be generalized to the rest of the population.

Another point of critique is that children are not observed extensively and over several days within all studies. Therefore, when higher food consumption is observed, possible compensation for this additional consumption at later meals or through exercise cannot be taken into account. Hence, it is fair to assume that children are tempted to temporarily consume more food, through advertising, however, eat less during subsequent meals or exercise more throughout the day instead. As a result, children would not be consuming more calories overall. In the study by Norman et al. (2018), children are further observed during lunch following the experiment, however, compensation of prior food consumption could equally occur at dinnertime, which is why this method is equally insufficient. This study also has other shortcomings which affect its results (see Chapter 6.2). Additionally, the short observation period of children within the experimental setting leads to a situation, whereby non-

[6] Advergames are computer games or cell phone games in which the manufacturer links brand logos, the product itself or design aspects or characters associated with the product or brand. The child then "learns" through play how to deal with the product or brand.

measurable psychological effects may play a role. Most of these experiments also take place within the school context or at a summer camp, where the choice and provision of snacks is completely out of the parents' control. This does not reflect the reality of most children's lives. The examined studies thus have only little external validity, i.e., the results cannot be applied to the everyday lives of these children.

Beyond these methodological weaknesses, the misinterpretation and analysis of a strikingly large number of studies, such as a non-scientific and incomplete presentation of the results (p-values and effect sizes in particular), as well as violated assumptions of statistical analyses (test for normal distribution) are also important factors.

Finally, none of the studies examined considered additional factors influencing children’s health, such as physical activity and lifestyle. This design flaw is inherent in all current study designs and will be addressed separately in the next chapter.

# 4. Causality

Causality describes the relationship between cause and effect, i.e., a change in one variable (A) results in a change in another variable (B). Correlation, on the contrary, means there is a statistical relationship between the variables, while a change in A does not necessarily result in a change in B, i.e., correlation does not necessarily lead to causality. There are two reasons why the relationship between two variables (A) and (B) may be correlated, but not entail causality.

First, additional influencing factors, so-called *confounding factors*, may condition the relationship between the two variables. For example, the variables "ice cream sales" and "sunburn" are strongly correlated, but not causally linked. Instead, both variables are influenced by a third variable – warm temperatures. Sunburn in this example is arbitrarily interchangeable with other sun-related factors (sales of sunscreen, visitors to outdoor swimming pools, etc.).

And second, a correlation and even a causal relationship may exist between two factors, but it is not possible to identify which variable causes the change in the other. This can be exemplified by the relationship between lack of exercise or television advertising and obesity. The longer a person watches television, the more frequently he or she consumes television advertising. However, they also sit longer and thus have a lower level of physical activity. Whether it is the unhealthy lifestyle or television advertising causing obesity is therefore unclear without further investigation.

The valid proof of causal relationships is one of the most challenging tasks of empirical statistics. The current literature on the effects of advertising HFSS products on consumption among children fails to provide such evidence.

To demonstrate a causal relationship, time series data at the individual level is needed first and foremost. However, a fundamental problem throughout all studies examined in the context of advertising effects is the focus on short-term consumption of food as the dependent variable. From a supposedly advertising-induced one-time increase in consumption by children, the authors generally conclude that there is an influence on health, including overweight and obesity. However, necessary health data such as BMI is never collected in these studies (for the necessary duration), which is why causality cannot be proven from a scientific point of view.

Other factors stand in the way of a causal conclusion, including the previously mentioned study period which is often too short. It is also essential to consider additional factors influencing children's health aside from nutrition, since overall health is determined by variety of factors: environment, parental lifestyle, level of activity, genetics, nutrition, and many more. Accordingly, obesity is indisputably a multicausal event caused by several factors. For example, the WHO writes in its European Regional

Obesity Report (2022), with regards to obesity, about "two compounding mechanisms" over the course of an individual's life: "(i) developmental programming based on preconception and gestational exposure to obesity and (ii) unhealthy diet and physical inactivity driven by exposure to obesogenic environmental factors" (p. 26). More specifically, the report cites the following risk factors, among others: Maternal weight before and during pregnancy, breastfeeding, socioeconomic status, parental lifestyle, and physical activity. The exact interaction of the various factors has not been conclusively clarified scientifically. Therefore, especially in the context of the discussed advertising ban, it is indispensable to prove how much influence advertising has on children's health when controlling for the other factors mentioned.

From the above explanations, two prerequisites for a causal relationship can be derived for the present topic. In order to be able to prove beyond doubt that advertising for products that do not meet the requirements of the nutritional profile of the World Health Organization for Europe (WHO, 2015, 2023) has an effect on children's health, two things must be shown:

1. Advertising has a long-term positive effect on body weight and does not just have a short-term effect on HFSS food consumption.
2. This effect exists under the control of all other relevant influencing factors.

In all relevant studies that purport to investigate the effect of advertising on HFSS food consumption and children's health, without exception, there is a problematic lack of evidence of a long-term effect. Without this long-term causal evidence while controlling for all other relevant factors influencing children's health, there is no scientific basis for banning advertisement of foods that do not meet the requirements of the WHO Nutritional Profile Model for Europe for the purpose of preventing obesity.

A scientific basis should not be attempted to be established through a comprehensive long-term field study of the population in the form of an advertising ban, but rather it must be available a priori for the enforcement of a ban in the context of evidence-based policy. Compelling characteristics of a scientifically based study are therefore discussed in Chapter 8 (pp. 61-70).**Fehler! Verweisquelle konnte nicht gefunden werden.**

# 5. Publication bias

In addition to the criticisms that apply to individual studies, there is the issue of *publication bias,* which has been the subject of critical scrutiny for several decades. "There is some evidence that in fields where statistical tests of significance are commonly used, research which yields nonsignificant results is not published. Such research, unknown to other investigators, may be repeated independently until a significant result eventually occurs by chance" (Sterling, 1959, p. 30). Hence, publication bias occurs, since studies with statistically significant or positive effects are published far more frequently in professional journals. In addition, selective reporting of results, manipulation of data or methods of analysis, and pressure to confirm pre-existing hypotheses can also contribute to publication bias (Thornton & Lee, 2000). This undermines the goodness-of-fit criteria of statistical tests, i.e., random effects are disproportionately reported (Schüller, 2015, p. 111). Publication bias results in studies with invalid or negative results being underrepresented, which can distort the available evidence base and in turn lead to inaccurate or biased conclusions. The statistical significances reported in the relevant studies, in terms of probabilities of falsely positive effects (false *positives*), are much larger than the 5% or 1% threshold set as the basis of hypothesis testing. For example, a meta-review on lung cancer found that up to 45% of the discovered effect could be attributed to publication bias (Tweedie et al., 1996). Dubben and Beck-Bornholdt (2004) provide a collection of unbalanced reporting in medicine in this regard.

Especially in studies with small samples – which are quite common in the investigated research on food advertising – significance is less likely and is mostly due to random outliers regarding compositional differences between groups in the sample. Results of small studies are less likely to be published unless they are significant which leads to publication bias (Thornton & Lee, 2000).

In the context of the effects of food in media on children's consumption, Villegas-Navas et al. (2020) find evidence of publication bias. A corresponding diagram, as well as further details can be found in Chapter 6.7. Accordingly, it is fair to assume that several studies with non-significant or negative effects of advertising on food consumption have been conducted, but not published. This means that the currently available studies do not cover the true state of research and may systematically overestimate the actual impact of food marketing on children. If there is evidence of publication bias, results of literature reviews and meta-reviews should be interpreted with caution. In particular, when deriving regulatory actions with high implications, it should be taken into account that there may be a substantial number of studies which provide a different evidence base, which however, due to the aforementioned reasons, have not been published.

Smith et al. (2019) also cannot exclude publication bias in their literature review (see Chapter 6.13), "There is a possibility of publication bias that studies which did not find any signification associations may not have been published" (2019, p. 7). The same is true for the study by Sadeghirad et al. (2016) (Chapter 6.6) and Boyland et al. (2016) (Chapter 6.12). The latter study finds evidence of publication bias based on one test, while no risk of bias is found using another test.

# 6. Selected studies in detail

In the following, the most prominent studies referenced in the discussion within the Federal Republic of Germany are examined regarding the quality characteristics described in the previous chapters.

## 1. Effertz (2021): Children's marketing for unhealthy foods on the Internet and TV

*Effertz, T. (2021). Kindermarketing für ungesunde Lebensmittel in Internet und TV [Projektbericht]. Universität Hamburg. https://www.bwl.uni-hamburg.de/irdw/dokumente/kindermarketing2021effertzunihh.pdf*

**Executive Summary**

This project report on the extent of advertising targeted at children is of particular public interest; in a press conference, the Federal Minister for Food and Agriculture, Cem Özdemir, quotes the report’s core finding that children in Germany watch an average of 15 commercials per day. However, this figure is incorrect and presumably too high, due to questionable assumptions and scientific errors made in the report. Moreover, this number of per capita commercials results from exclusively considering media-using children, while the underlying number of media users is presumably too low inflating the per capita advertising consumption. Other notable limitations of the project include the scientifically incomprehensible decision to not consider the public broadcast TV station KIKA, which has the widest reach among children in the study year of 2019 and is entirely free of advertising.

However, due to a systematic lack of transparency in the calculations, as well as the lack of publication of the data, the results of the report are impossible to reproduce. Finally, the recommendation for advertising restrictions to protect against childhood obesity, which is derived in the report, is not supported by the results. Neither health nor children’s consumption of food is investigated at all.

**Content and results**

The present study by Effertz (2021) differs from the work discussed below in both its nature and focus. It is an unpublished project report which has neither undergone scientific peer review nor has been published in a peer-reviewed journal. Thematically, it’s primary focus is not the effect of children's marketing, but rather its extent. The report’s core finding, which is frequently quoted in public debate, is that children aged three to 13 who watch television and browse the internet are exposed to an average of 15.48 commercials per day, portraying food that is high in fat, salt or sugar, according to the WHO European Nutrient Profile Model (WHO, 2015). However, considering the total number of children in this age group, the result shrinks to 7.68 advertisements on TV, as well as the internet per day. According to the author, children's marketing has increased by 29% since 2007. In addition, the report portrays and analyses individual internet advertisements and YouTube videos related to HFSS products. Data regarding internet behaviour was collected from Nielsen Media Research, while data regarding TV usage was collected by the University of Hamburg (both 2019) and is not provided for peer review in either case. According to the author, the report covers 69% of all TV shows watched by children and refers exclusively to the following channels: Disney Channel, Nickelodeon, ProSieben, RTL and Super RTL.

**Evaluation**

The author uses quite extensive amounts of data to confirm his initial thesis: "One of the problematic results of direct advertising by the food industry is the high prevalence of increased weight gain and obesity among children in almost all high-income countries, where children's marketing has so far been possible without major restrictions" (p. 9). However, such a relationship is not examined by the seven research questions formulated on pages 9 and 10 of this project, and evidence is not provided in the remainder of the report. "What statistical relationships can be shown between children's marketing and unhealthy foods?" (p. 9). The author assumes that this causal relationship exists, and solely credits the extent of advertising, which is simply assumed to be the cause of obesity. "For the two types of media mainly used by children, television and the internet, a high extent of advertising for food in general, and specifically for unhealthy food, by means of children's marketing could be demonstrated" (p. 7). Despite this deficiency, far-reaching political interventions are then called for.

A possibility to further prove the existence of a causal link could have been in section 5.1 of the report "The Regulation of Children's Marketing in EU and International Context", where the author discusses international differences in children's marketing. According to this report, "there are basically four types of 'regulatory regimes' of children's marketing with distinctly different outcomes. Group 1 relies exclusively on voluntary commitments by the food industry, which either have not brought about any change so far or are not expected to result in noticeable reductions in children's marketing [...]. A second group has attempted to regulate children's marketing but has fallen short of significant measurable effectiveness with the implemented methods [...] A third group of countries has provided regulation of children's marketing with strong rules, mostly affecting other areas of advertising as well, however, not very imprecise in terms of achieving goals [....] Finally, a fourth group of countries, which have not yet regulated children's marketing of unhealthy products completely, but at least substantially and with intended expansion, can also be used as a desirable comparison group for German health policy. This group includes, for example, Ireland, the UK, Sweden, Norway, Chile, and Brazil" (p. 42). It would have been interesting to know whether childhood obesity is less prevalent in Chile and Brazil than in group 1, which includes Germany. However, such a comparison is omitted.

From a statistical perspective, the extensive data collection on the impact of HFSS food advertising addressed to children also raises several unresolved questions**:**

Data regarding TV usage from AGF/GfK-TV research is available for children aged three to 13. This data is used by TV broadcasters, advertisers, and researchers alike and is regarded as currency in the advertising industry. It can be used to determine the exact reach of TV commercials (based on the commercial break). Net ratings over different broadcasts and longer periods can thus also be evaluated. However, this exact data is not used in the study; instead, aggregated values from published sources are used. The performed offsets are not transparent and difficult to understand.

| Nr. | Site | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 | Age 11 | Age 12 | Age 13 | Durchschnitt | Hochrechnung Anteil_kons |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Facebook | 21,65% | 15,21% | 15,79% | 20,54% | 15,86% | 17,66% | 14,13% | 13,35% | 16,77% | 2,59% |
| 2 | Instagram | 10,26% | 7,27% | 4,51% | 4,04% | 4,53% | 5,12% | 5,40% | 7,45% | 6,07% | 2,89% |
| 3 | YouTube | 41,03% | 35,15% | 54,14% | 35,69% | 32,36% | 30,16% | 42,11% | 28,88% | 37,44% | 5,10% |
| 4 | GMX | 15,38% | 14,55% | 9,02% | 9,09% | 9,53% | 5,87% | 6,65% | 7,14% | 9,65% | 3,67% |
| 5 | Web.de | 12,54% | 7,27% | 11,07% | 8,89% | 9,71% | 10,05% | 5,74% | 8,13% | 9,18% | 2,97% |
| 6 | T-Online | 13,19% | 7,27% | 6,32% | 8,66% | 5,05% | 6,79% | 11,08% | 7,76% | 8,26% | 2,87% |
| 7 | n-tv.de | 10,26% | 0,00% | 4,51% | 0,00% | 0,00% | 3,26% | 3,32% | 3,73% | 3,13% | 4,52% |
| 8 | RTL.de | 0,00% | 7,27% | 0,00% | 4,04% | 0,00% | 3,26% | 3,32% | 3,73% | 2,70% | 4,03% |
| 9 | SPIEGEL ONLINE | 10,26% | 7,27% | 5,26% | 4,04% | 3,88% | 3,26% | 3,74% | 3,73% | 5,18% | 3,17% |
| 10 | Wetter.com | 10,26% | 0,00% | 4,51% | 0,00% | 0,00% | 3,80% | 3,32% | 5,59% | 3,44% | 4,17% |
| 11 | Gala | 10,26% | 7,27% | 0,00% | 4,04% | 0,00% | 0,00% | 3,74% | 0,00% | 3,16% | 13,19% |
| 12 | Chefkoch | 0,00% | 7,27% | 4,51% | 4,04% | 3,88% | 4,89% | 3,99% | 3,73% | 4,04% | 2,95% |
| 13 | Wetter.de | 10,26% | 0,00% | 4,51% | 4,04% | 0,00% | 0,00% | 0,00% | 3,73% | 2,82% | 7,70% |
| 14 | Stern.de | 10,26% | 7,27% | 4,51% | 4,04% | 0,00% | 3,26% | 3,32% | 3,73% | 4,55% | 4,20% |
| 15 | eBay | 13,19% | 17,78% | 12,78% | 8,89% | 8,09% | 10,08% | 10,25% | 7,76% | 11,10% | 2,29% |

***Figure 1:*** *Average reach of children by age group and the extrapolated share of ad-impressions attributable to children on the respective websites. Source: Effertz (2021, p.16)*

The extrapolated number of children's ad-impressions on the internet in Table 1 on page 16 of the report (**Figure 1**) is just that: an extrapolation based on several questionable assumptions, the validity of which is difficult to judge without a closer look at calculations. In any case, no reliable measurement exists here. For example, the views of YouTube videos also included in the analysis, "together with the time elapsed since going online for each video [...] are normalized to the metric 'views per year'" (p. 16) and then aggregated across all products and brands that utilize children's marketing. This does not seem to consider that the number of new views on YouTube decreases over time. Especially regarding new videos which receive a high number of views within the first few days, extrapolating an estimated views per year based on this number leads to a massive overestimation of views. Another questionable assumption relates to the subjects under consideration. For example, young children under the age of six are excluded from the analysis because "their internet behaviours do not yet exhibit any real systematics" (p. 28) and it is assumed that the "determined per capita results do not deviate greatly from one another" (p. 16) because this is a very small group of 300,000 children nationwide. However, this statement is based on a study by mpfs from 2014 - thus five years before the study period. In an age of rapid digital progress and increasing digital penetration of everyday life, this is a thoughtless assumption exemplified by data from the same institute from 2020 (one year after the project). This data attests that 29% of all children aged 2-5 in Germany utilize media libraries, websites or apps, and 46% watch paid (mostly ad-free) streaming services (mpfs, 2020), representing at least a tripling of the usage shares. Since the usage shares are still significantly lower than those of older children, the inclusion of young children would presumably reduce the average number of commercials per capita. However, an explicit assessment is not possible without insight into the calculations. It is also unclear how the author estimates which other websites children visit: "Product websites without children's marketing elements were not visited by children during the observation period" (p. 19).

Since the underlying data was not made available and calculations, as well as methodological procedures were – for the most part – insufficiently documented (e.g., weightings), it is not possible to understand and verify all the statements made in the project report. This clearly represents a lack of scientific diligence and hinders the objective discussion of the results in a standard scientific discourse.

| | | Alle Kinder 3-13 | Alle das Medium nutzenden Kinder 3-13 | Alle Kinder 6-13 | Alle das Medium nutzenden Kinder 6-13 |
|---|---|---|---|---|---|
| Anzahl Kinder | Internet | 8.279.336 | 4.319.493 | 5.917.898 | 4.004.642 |
| | Fernsehen | 8.279.336 | 4.001.403 | 5.917.898 | 2.848.963 |
| | | | | | |
| Anzahl ungesunder ?Werbespots pro Tag und Kind | Internet_kons | 1,30 | 2,50 | 1,83 | 2,70 |
| | Internet_KM | 4,06 | 7,78 | 5,68 | 8,39 |
| | Fernsehen | 5,00 | 10,34 | 5,17 | 10,78 |
| | Summe_kons | 6,30 | 12,85 | 7,00 | 13,47 |
| | Summe_KM | 9,06 | 18,12 | 10,85 | 19,16 |
| | Gem. Summe | 7,68 | 15,48 | 8,92 | 16,32 |

***Figure 2:*** *Number of commercials per day and child (all children and only children using the specific medium) for food that does not comply with WHO guidelines. Source: Effertz (2021, p. 42)*

In the project report, the average number of ad viewings for HFSS foods (television and internet commercials) is provided (cf. **Figure 2**). As already mentioned, a distinction is made between the entire child-age population and media-using children. The number of commercials per capita is about twice as high when considering only media-using children, as compared to the inclusion of all children. In public debate, however, this higher figure that is quoted almost exclusively, giving the impression that this represents the average for all children in Germany.

It is striking that, according to the report's assumptions, only about half of all children aged three to 13 use the internet or television (4,319,493 and 4,001,403, respectively) (overlap possible). This is most likely an underestimation of the true situation. For example, in the UK during the 2019 study period, 75% of all children aged five to 15 watched TV and 80% used video on demand services (UK Office of Communications, 2019), which is significantly more than the 50% estimated in this study. Similarly, in Germany, three-quarters of all children in the six to 13 age group consumed television almost daily and two-thirds used the internet in 2018 (mpfs, 2019). An underestimation of the media-usage share leads to an overestimation of the number of HFSS food commercials consumed daily per child. Therefore, by the calculation in the project report, if the total number of ads viewed and the average time of media use per capita remain constant, the number of commercials per child decreases as the number of users increases. It can therefore be assumed that the true value of the frequently quoted figure (15.48) is in fact significantly lower.

Furthermore, a central limitation of this report is the exclusion of the public broadcaster KIKA, including its online offering (as well as all other public offerings) on the incomprehensible grounds that it does not contain any advertising at all. Although it was the most popular TV channel for children during the survey period of the study in 2019 with 17.1% total market share (see: AGF Videoforschung in collaboration with GfK, VideoSCOPE 1.3, Market Standard TV: base 06-21 hrs, children three to 13 years, 2019, as of 23.12.2019), the study does not take into account TV viewers who thus consume media without any advertising. This also clearly leads to a positive bias in the number of HFSS ads seen per child.

It is also worth noting that Effertz states that the data from Nielsen Media Research does not include any advertising from the fast-food chains McDonald's and Burger King, but that they are "included [nevertheless] through their websites and other internet advertising as content from the social media platforms Facebook and Instagram [in the analysis]" (p. 12). The restaurants' internet presences, specifically Instagram and Facebook presences, count as marketing, however, not as advertisements which would be covered by the proposed advertising ban. Thus, this data should not be used to justify such a ban, even if, as Effertz states, it plays a "quantitatively rather subordinate role" (p. 20).

It is also questionable that an advertising campaign for organic products from the discounters ALDI or LIDL is disregarded, as it is classified as "chain store advertising" (p. 38), which is likely to influence the non-significant correlation between children's marketing and HFSS foods. This is due to the fact that a statistical correlation test shows no significance, primarily due to the small number of cases of commercials for foods classified as healthy (28).

The use of statistical methods in the report is basically limited to a few Chi$^2$ tests, which in no way provide a sufficient basis for causal conclusions. Overall, the prominence of advertisements for HFSS foods can presumably be explained by the fact that products which are considered healthy do not have brand names and their advertisements are not explicitly addressed to children.

The paper ends with the conclusion, "Because this level of marketing to children causally promotes unhealthy diets in children, marketing to children should be prohibited by law" (p. 46). This recommendation is surprising because the report does neither examine children's consumption nor their health. According to basic scientific standards, no causality can be established (see chap. 4. Causality). Therefore, the report does not provide any empirical evidence for the abovementioned recommendation. Rather, Effertz seems to suffer from a lack of scientific neutrality. For example, in 2014 he previously authored a legislative proposal to restrict advertising directed at children (Effertz & Adams, 2015), without presenting sufficient evidence in his paper at the time. The present paper also makes detailed recommendations for a ban on advertising and presents an international comparison of the legal framework status quo with voluntary commitments and assesses their effectiveness. However, there is no indication of suitable data or sufficient references.

**Reception**

The work was funded by the following associations:

- AOK-Bundesverband (AOK Federal Association)
- Deutsche Diabetes Stiftung (German Diabetes Foundation)
- Deutsche Adipositas Gesellschaft (German Obesity Society)
- Deutsche Diabetes Gesellschaft (German Diabetes Society)
- Berufsverband der Kinder- und Jugendärzte (Professional association of paediatricians and adolescents)
- Deutsche Gesellschaft für Kinder- und Jugendmedizin (German Society for Paediatrics and Adolescent Medicine)
- diabetesDE – Deutsche Diabetes Hilfe (German Diabetes Aid)
- DANK – Deutsche Allianz Nichtübertragbare Krankheiten (German Alliance Noncommunicable Diseases).

The report has a strong presence in the public discourse and has been quoted by numerous media. The German Minister of Food and Agriculture, Cem Özdemir, referenced the study when presenting his proposed legislation on Feb. 27, 2023 (Klasen, 2023) to substantiate the supposed need for a ban on advertising. Accordingly, media-using children see an average of 15 commercials for foods with high sugar, fat or salt content (BMEL, 2023a). This is – although correctly referenced according to Effertz' work – highly misleading and, due to the limitations of the study described above, a highly overestimated value that does not reflect reality. Moreover, by mentioning this biased value in the context of a proposed advertising ban, it is suggested that obesity is directly related to the increase in advertising of foods which do not meet the requirements of the WHO nutrient profile model for Europe (WHO, 2015, 2023). However, the present study neither investigates this relationship, nor does it suitably demonstrate causality, due to its purely descriptive nature and scarce use of statistical methods. Accordingly, from a scientific point of view, the study is not suitable as a basis for the factual discussion of an advertising ban.

## 2. Norman et al. (2018): Sustained impact of energy-dense TV and online food advertising on children's dietary intake: A within-subject, randomised, crossover, counter-balanced trial.

*Norman, J., Kelly, B., McMahon, A.-T., Boyland, E., Baur, L. A., Chapman, K., King, L., Hughes, C., & Bauman, A. (2018). Sustained impact of energy-dense TV and online food advertising on children's dietary intake: A within-subject, randomised, crossover, counter-balanced trial. International Journal of Behavioural Nutrition and Physical Activity, 15(1), 37. https://doi.org/10.1186/s12966-018-0672-6*

**Executive Summary**

This comparatively extensive and complex experimental study is characterized by the documentation of subjects' lunch consumption following the experiment (albeit estimated). Despite this unique feature in the study design, the study exhibits some methodological shortcomings which prevent a meaningful interpretation of its results. For example, the children's food intake should be monitored throughout the day, and ideally for weeks, which has not been implemented in the literature to date. In addition, there are weaknesses in the reporting, e.g., effect sizes and p-values are only selectively reported; usually only if they are significant or approximately significant. The setting of the study – several summer camps – is also questionable in terms of external validity.

In terms of content, the authors do not clearly argue why there is no difference in snack consumption between viewers of TV advertising for HFSS products and other non-food products. Only the combination of playing an advergame and watching TV advertising leads to a significant increase in low-level consumption. The study is referenced by Koletzko (2021), but, as will be argued, is hardly suitable for examining the relationship between advertising and consumption among children.

**Content and results**

This is a relatively elaborate randomized controlled crossover study by Norman et al. (2018). Children (n=160) were shown advertisements for HFSS foods in the context of a commercial break within a cartoon series at several summer camps in Australia, and subsequently given a choice of various high fat, as well as sweet and unprocessed snacks (including crisps, cookies, chocolate, gummy bears, carrots, grapes). Subjects were given 15 minutes to consume any snacks they wanted, and the amount left over was weighed afterwards. The study also had a control group which viewed non-food advertisements. The study also measured participants' consumption during the following lunch period after the morning experiment. Due to the crossover design of the study, all children saw both food marketing and non-food advertising on different days. In addition to the consumption of TV advertising, the study also tested the additional five minutes of playing a so-called advergame. According to the authors, a significant increase in snack consumption for the intervention group exists only in cases when advertising exposure was combined with an HFSS advergame, however, not in cases of HFSS TV advertising alone. The weight of the participants, which was also investigated, was found to be of no significant influence to increased consumption – regardless of the type of advertising.

**Evaluation**

It is worth highlighting positively that, in addition to the children's consumption during the experiment, consumption during the subsequent lunch was also documented. At the time of the expert opinion, no other relevant study was known which controls for possible compensation of excess/reduced consumption caused by advertising. However, this measurement was only done as a visual estimate and, thus, might not be accurate.

The study abstract states that "the lack of compensation at lunch for children's increased snack intake after food advertising exposure suggests that unhealthy food advertising exposure contributes to a positive energy gap, which could cumulatively lead to the development of overweight." However, according to the study, this is only true to a limited extent and not true for TV advertising in particular. This is due to the fact that no significant difference in snack consumption is found between children who watch ads for HFSS snacks on TV and those who watch non-food ads (p = 0.058). This is shown in **Figure 3,** denoted by "#".

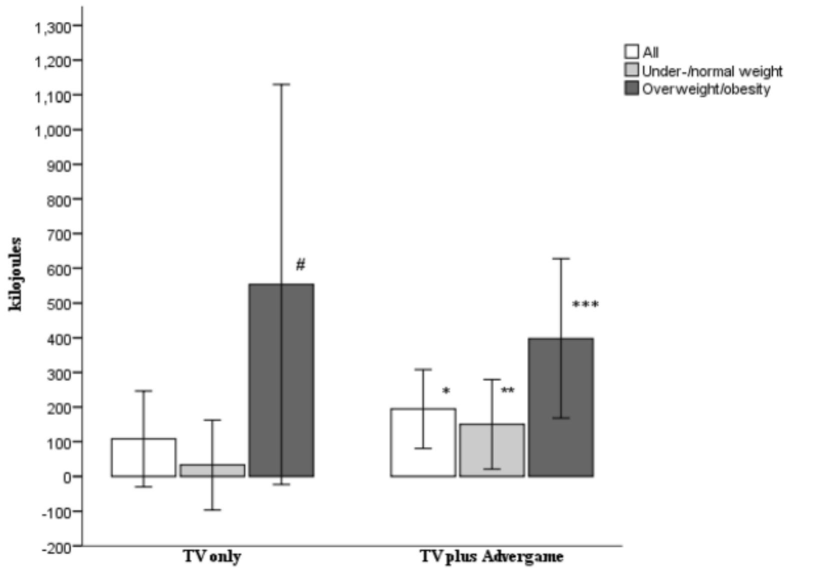


**Fig. 2** Mean daily additional kJ (95% CI) consumed at the camp after exposure to food advertising by children with under–/normal weight and overweight or obesity within the two media conditions. * Significant increase in total kJ consumed after food advertising compared with non-food advertising (*p* = 0.001). ** Significant increase in total kJ consumed after food advertising compared with non-food advertising (*p* = 0.024). *** Significant increase in total kJ consumed after food advertising compared with non-food advertising (*p* = 0.002). # Non-significant increase in total kJ consumed after food advertising compared with non-food advertising (*p* = 0.058)

***Figure 3:*** *Mean daily excess consumption of children by weight and type of advertising consumption. Source: Norman et al. (2018)*

The only statistically significant result of the study across all children refers to an increase in snack consumption compared to the control group immediately after watching a TV commercial and playing a so-called advergame. Whether this can be representative of the effect of other types of advertising is doubtful because playing an advergame is a conscious action and cannot be compared to the reception of TV advertising on TV. In addition, gaming is numerically disproportionate to TV advertising and is, therefore, not part of the public debate regarding a possible advertising ban. See Federal Ministry of Food and Agriculture (2023a): "To be covered are radio, press or other printed publications, information society services (esp. websites), audiovisual media services (TV and on-demand services) and video sharing platform services (social networks such as Instagram, TikTok, YouTube etc.). Influencer marketing and outdoor advertising will also be considered. In addition, sponsorship directed at children for foods with high sugar, fat or salt content will no longer be permitted in the future." According to this release, advergames will not be affected by the ban.

Methodologically, the present study is criticized for only measuring food intake of the participating children in the period from 8:00 a.m. to 1:30 p.m. A possible compensation of the increased intake during the morning by a later lower food intake could also take place during the evening and would, therefore, not be covered by the study. This deficiency is particularly critical because the study is brought up in later papers to justify that compensation does not need to be considered in study designs (see for example Coates et al., 2019b).

In addition, the study has poor external validity because the children are not in their usual environment, rather in a summer camp where they are exposed to increased physical activity and increased energy demand. Thus, these circumstances are not comparable to a normal daily routine.

The analysis refers to a linear mixed regression model, but the study lacks appropriate documentation; only a table showing the differences in the means of the control and treatment groups is shown. No explanation is given of the Cohen's d-statistic used or the p-values calculated. There are p-values given that (probably) refer to a t-test between reference groups, which is not exactly evident. In addition, placing this statement directly after announcing a regression seems misleading.

Moreover, there is no p-value correction for multiple testing (Bonferroni-corrected post-hoc test). This overestimates the statistical significance. For example, with $n = 3$, $\alpha^* = \alpha/3 = 0.0167$ must be used instead of $\alpha = 0.05$. It is also notable that only "convenient" (significant and near-significant (.058)) p-values are reported in the study while all others are neither reported nor discussed. This practice creates a biased impression and does not adhere to the standards of scientific work.

In terms of content, even in the significant category of TV commercials and advergames, there is only a calorie increase of about 46 kcal (194 kj) per day. This represents 2.4% of the German Society for Nutrition's (DGE) daily intake guideline value for girls aged 10 - 13 with low physical activity (1900 kcal) (Deutsche Gesellschaft für Ernährung e.V., 2015). For more physically active children and boys, this share is correspondingly lower. According to van den Berg et al. (2011), who quantified the positive energy balance responsible for excessive weight gain (energy gap) in young overweight children, an additional consumption of at least 69 to 77 kcal was required in purely mathematical terms for children aged five to seven years to become obese. For older children, the value is correspondingly higher. The significant additional consumption found in the present study for playing advergames and TV consumption is significantly lower and should thus not be considered as obesogenic according to van den Berg et al. (2011). However, this calculation does not consider other factors such as compensation or exercise and, therefore, possesses only limited generalizability.

Overall, there is a lack of explanation of the underlying statistical methods, preventing comprehension of which quantitative statements can actually be derived from the data. The results cannot be verified or reproduced either, as the data collected in the experiment was not published.

**Reception**

The study is referenced by Koletzko (2021, p. 9) in the context of a press conference of the lobby organization Foodwatch e.V. on August 25, 2021 to substantiate some results of an IOM study (cf. 6.3 IOM (2006)). Since the graph (**Figure 3**) is not explained in the presentation and was adapted without a legend, the impression of a relevant result is created. Both the slide title "Advertising to children makes children sick", as well as the title added to the graph by Koletzko, "Advertising increases energy intake", do not entirely apply in relation to the study and are highly misleading. This is because the graphic contradicts its own headline: it shows that TV advertising itself has no significant effect on energy intake.

The error bars forming a 95% confidence interval around the average overconsumption of each weight group and around the overall average overlap the entire bars for the "TV only" category, including the value zero (left). Therefore, it cannot be ruled out that the overconsumption of children who watch food advertising versus children exposed to other advertising is zero, because the interval contains the true value of overconsumption with 95% probability. In general, the longer the bars of the confidence interval, the greater the dispersion around the sample average. And in the present example, a high dispersion exists. Therefore, as mentioned above, the relationship between the reception of TV advertising and the consumption of HFSS foods is not significant in this study, so – contrary to what Koletzko suggests – no influence of TV advertising on energy intake is found. In the context of the discussed advertising ban on the part of the federal government, the rest of the diagram, the "TV plus advergame" category (right) and the distinction in weight classes, is irrelevant according to the current situation. Accordingly, the Norman et al. study provides no evidence for banning advertising to children. Furthermore, the numerous limitations listed above disqualify the study for any causal interpretation.

## 3. Institute of Medicine (2006): Food marketing to children and youth: threat or opportunity?

*Institute of Medicine. (2006). Food Marketing to Children and Youth: Threat or Opportunity? National Academies Press. https://doi.org/10.17226/11514*

**Executive Summary**

This literature review from the American Institute of Medicine (IOM) finds strong evidence for a correlation between TV advertising for HFSS products and obesity in children and adolescents aged two to 18 years. In addition, the authors find strong evidence for a positive influence of these ads on food consumption in two- to 11-year-olds, while not in 12- to 18-year-olds. However, the study also notes that alternative explanations for these associations cannot be ruled out. Thus, like all studies in this report, causal influences on the long-term effects of advertising on children's consumption or health cannot be inferred from the studies of only short-term consumption. The study on hand, which is already somewhat outdated due to its publication in 2006, is therefore, at best, a collection of initial indications.

**Content and results**

This study from 2006, commissioned by the U.S. Institute of Medicine (IOM), is a very detailed systematic review of the literature on the advertising effects of HFSS foods. All studies examined were peer-reviewed and published between 1970 and 2005. A large proportion of the studies examined only television advertising.

Results: The authors find strong evidence of a (positive) correlation between television advertising and short-term consumption in children aged two to 11 years. Insufficient evidence is found for a correlation between advertising and consumption regarding children aged 12 to 18 years. Moderate to weak evidence is found by the authors for advertising effects on everyday consumption in these age groups. Additionally, the study concludes that strong evidence exists for a correlation between TV advertising consumption and obesity in children ages two to 18. However, the authors put the findings into perspective: "The association between adiposity and exposure to television advertising remains after taking alternative explanations into account, but the research does not convincingly rule out other possible explanations for the association; therefore, current evidence is not sufficient to arrive at any finding about a causal relationship from television advertising to adiposity" (p. 308).

The authors also conclude that "most children ages eight years and under do not effectively comprehend the persuasive intent of marketing messages" (p. 309), and that most children ages four and under could not consistently distinguish between television commercials and programming. Nevertheless, they also put this into perspective: "The evidence is currently insufficient to determine whether or not this meaningfully alters the ways in which food and beverage marketing messages influence children" (p. 309). Thus, they do not find a particular influence on these children's food consumption due to the lack of adequate data.

**Evaluation**

It should be noted that the present study does not represent the current state of research on advertising effects of HFSS products due to its past publication date. Since 2006, advertising and its effects have presumably changed. This is because the spread of the Internet and social networks has changed forms of advertising; advertising has become significantly more multimedia-based, and the literature review focuses almost exclusively on TV advertising. At the same time, changes in the diet of children and adolescents, which can also influence study results, cannot be estimated. The authors also recommend further scientific research, particularly that of "fairly large scale" and using newer marketing methods (p. 309). In this review, however, we find that this large-scale aspect has not been implemented in the literature to a noteworthy extent yet.

The authors of the present study themselves state that despite the extensive literature reviewed, drawing causal conclusions in the relationship between advertising and children's consumer behaviours is not feasible.

In addition to this methodological criticism, all studies included in this scientific opinion suffer from the fact that the effects on consumption behaviours found or supposedly found in these studies only measure short- to at best medium-term consumption effects and at best allow indirect and by no means reliable conclusions to be drawn about long-term consequences for children's health and body weight.

**Reception**

Koletzko (2021) references this study at a press conference held by Foodwatch e.V. on Aug. 25, 2021. On slide eight, the most important results are reproduced under the heading "Advertising promotes childhood obesity." However, it is disregarded that the results of the study neither suggest causality nor even investigate long-term consumption. That being said, it is merely a correlation of advertising and short-term consumption by children. That advertising "promotes" childhood obesity is therefore statistically incorrect, it should read "advertising is associated or correlated with obesity".

Likewise, the Stiftung Kindergesundheit, founded by Prof. Koletzko, addresses the study in a press release (Roggenkamp, 2023). There, in addition to a correct reproduction of the results, it speaks of a "longstanding, well-documented effectiveness of advertising directed at children" (p. 2). This rather unspecific statement is referencing causal effect on obesity and is not justified from a statistical point of view. It represents a misinterpretation of the IOM report at hand.

## 4. Coates et al. (2019a): Social media influencer marketing and children's food intake: a randomized trial.

*Coates, A. E., Hardman, C. A., Halford, J. C. G., Christiansen, P., & Boyland, E. J. (2019). Social Media Influencer Marketing and Children's Food Intake: A Randomized Trial. Paediatrics, 143(4), e20182554. https://doi.org/10.1542/peds.2018-2554*

**Executive Summary**

This study examines influencer advertising of HFSS products on the social network Instagram and its impact on children's short-term consumption. Although the paper is a randomized controlled trial (RCT), it exhibits weaknesses in data collection (convenience sample), scientific rigor (due to time constraints, it did not control for children's intolerances), and reporting of results (only p-values, no effect size). For these reasons, the study's finding which is also referenced by Koletzko (2021) – a significant increase in consumption with exposure to advertising – is scientifically doubtful.

**Content and results**

This is a randomized controlled trial (RCT) with a total of 176 participants aged nine to 11 years. The children were randomly divided into three groups: One group saw two profiles of well-known influencers, on which HFSS snacks were advertised, another group saw influencer marketing for snacks classified as healthy, and a final group saw advertisements for non-food products on the same two profiles.

The experiment was conducted during school hours, for which children were individually taken from their classes to complete a series of measurements on height, weight, acute hunger, and social media behaviour, among others. They were then shown the different Instagram profiles for one minute and given the opportunity to eat a selection of natural and HFSS snacks with no identifiable brand affiliation. The amount consumed was weighed and noted. The study concluded, "Acute experimental exposure to influencers promoting unhealthy foods on social media increases children's immediate intake of unhealthy foods" (p. 1). Children who saw ads for HFSS snacks ate 32% more calories from such foods in the experiment, as well as 26% more calories overall, than children in the control group without food ads. According to the authors, these differences are statistically significant at the 0.001 level.

**Evaluation**

The study by Coates et al. (2019b) is questionable from a statistical point of view. It starts with the data collection. "A convenience sample of 178 participants aged nine to 11 years were recruited via schools in the United Kingdom" (p. 2). The term "convenience sample" signals the lack of representativeness and randomness of the sample. Plus, very unusual for a scientific paper is the explanation that certain procedures were not followed or omitted: "The number of children with food allergies and the number of eligible parents who did not provide consent were not recorded because of researcher time constraints."

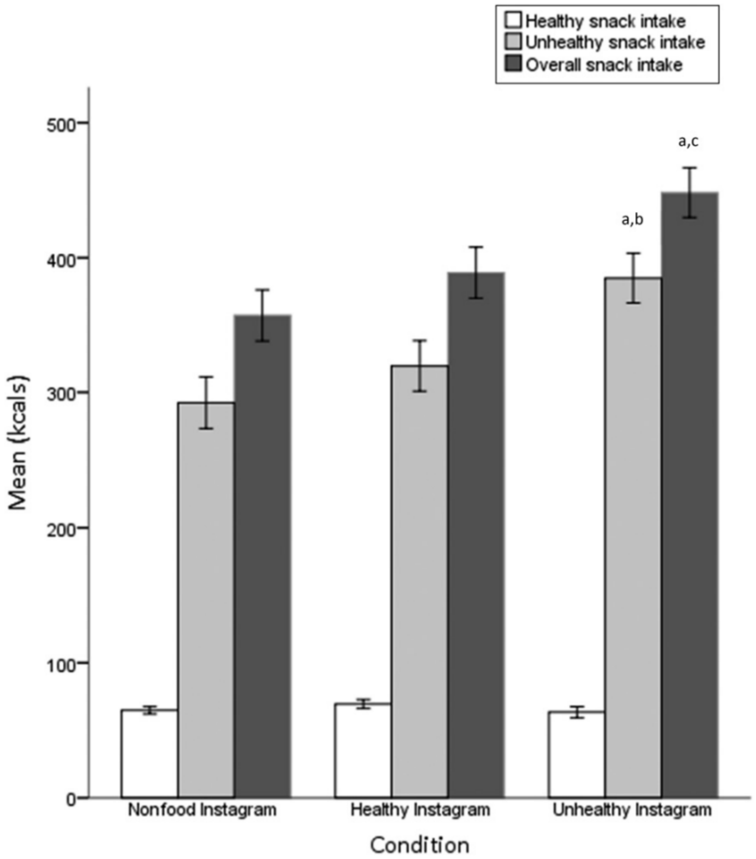


**FIGURE 1**
Mean (± SEM) snack intake (kcals) as a function of Instagram condition. [a] $P$ = .001 indicates increased intake of unhealthy and overall snacks in unhealthy Instagram condition compared with nonfood. [b] $P$ = .027 indicates increased intake of unhealthy snacks. [c] $P$ = .047 indicates overall snacks in unhealthy Instagram condition compared with healthy.

***Figure 4:*** *Mean consumption of different snack types by advertising type (none, healthy, "unhealthy" foods) among children. Source: Coates et al. (2019b).*

During the experiment, on the table in front of the were "jelly candies" and "chocolate buttons" as HFSS products, and "carrot batons" and "seedless white grape" as healthy and low-calorie foods. After exposure to the Instagram profiles, they were allowed to help themselves to any of these, and the total calories consumed were noted for each child. Results: children with HFSS ads consumed a mean of 448 kcal, children with other food ads consumed a mean of 388 kcal, and children without food-related ads consumed a mean of 357 kcal, see also Figure 1 on p. 6 of the study (**Figure 4**). The error bars in the graph indicate the standard error of the mean of calorie intake, i.e., they show how much the mean value of the sample differs from the actual mean value of the population.

The above values are plausible, but reporting p-values for whether these results are statistically significantly different is not statistically appropriate. As the authors themselves quite correctly point out, these differences may be due to other factors. This is because a p-value provides no information about the direction of the statistical relationship or – as in this case – the reasons for a significant difference.

To rule this out, the body mass index BMI and subjective hunger were also recorded for each child, measured on a visual analogue scale (not at all hungry – very hungry). In this respect, this corresponds to the statistical standards employed in comparable studies. Rather unusual, however, are correlations such as those shown in Table 2 (**Figure 5**) and Table 3 of the study, such as between BMI and consumed "healthy" kilocalories. The bivariate value of 0.3 reported here, just like the consumed kilocalories, is without any significance in the absence of a neutralization of other influencing factors.

Even after taking this into account, "a significant effect of marketing-exposure condition on total kcal intake (P = .001)" remained in the case of consumed kilocalories (p. 4). However, the size of this effect, which is of primary importance, is not reported.

**TABLE 2** Pearson's Correlations Between Dependent Variables and Covariables ($n$ = 176)

| | Total Snack Intake, kcals | Healthy Snack Intake, kcals | Unhealthy Snack Intake, kcals |
|---|---|---|---|
| Hunger on VAS, mm | 0.20[a] | 0.12 | 0.18[b] |
| BMI | −0.01 | 0.30 | 0.02 |
| Age, y | −0.04 | −0.11 | −0.02 |
| Sex (female = 1; male = 2) | 0.09 | −0.02 | 0.09 |
| Previous vlogger exposure, yes | 0.15 | −0.01 | 0.15[a] |
| Liking of Instagram profile, yes | 0.16[a] | −0.19 | 0.16[a] |

[a] $P < .05$.
[b] $P < .01$.

*Figure 5: Pearson's correlation between the dependent variable "consumption" and other influencing factors (n = 176).*
*Source:* Coates et al. (2019b, p. 4).

**Reception**

The study is referenced by Koletzko (2021), including **Figure 4** shown above (slide 9). However, due to its limitations regarding sample and reporting, the study is considered to be of little informative value.

5. Boyland et al (2020). Digital food marketing to young people: a substantial public health challenge.

*Boyland, E., Thivel, D., Mazur, A., Ring-Dimitriou, S., Frelut, M.-L., Weghuber, D., & behalf of the European Childhood Obesity Group, O. (2020). Digital Food Marketing to Young People: A Substantial Public Health Challenge. Annals of Nutrition and Metabolism, 76(1), 6–9. https://doi.org/10.1159/000506413*

**Executive Summary**

This editorial of a magazine is a call for more research in the area of advertising effects, listing several political recommendations for action. A reference to this editorial, as in Koletzko (2021), however, is not suitable for justifying a ban on advertising, because on four pages it refers only to an insufficient number of studies (three) that actually specifically investigate an effect of advertising on consumption. Most of the referenced studies are examined in detail in this report and – contrary to the statement in the present text – do not come to unambiguous results.

**Content and results**

Boyland et al. (2020) wrote a four-page editorial for the scientific journal *Annals of Nutrition and Metabolism*. The article is a call for more research into the impact of digital advertising of foods and beverages, but also includes recommendations for action to influence policy for associations and advocacy groups. These recommendations are derived by drawing on some studies to justify that a negative impact of digital marketing of HFSS foods and beverages on children's health exists.

**Evaluation**

The article argues that advertising HFSS foods is harmful to children. This is shown, among other things, by the subtitle "A Substantial Public Health Challenge". The introduction provides a rationale for why digital advertising is considered here. The main argument is that there has been a "media shift" from children to digital media and social networks in recent years. As a result, personalized advertising and advertising by influencers are gaining importance for children compared to television advertising. In the following, some studies are then given to support the thesis, although the study basis on digital marketing seems less dense, as mostly studies on television advertising are used. The only mention of the effect of digital advertising on children's consumption is in the references to Coates et al. (2019b) (cf. 6.3), Halford et al. (2008) (6.9), and Cairns et al. (2013). The limitations of the first two studies are discussed in detail in the corresponding chapters in this report. They are generally not suitable for establishing a causal impact of advertising on consumption. The remainder of this editorial focuses on the impact of obesity and overweight on health and the extent of TV and, in particular, digital advertising.

Statistics are also cited describing the extent of food advertising in digital media "popular" with youth aged 12 to 17, and the share of HFSS food ads in particular. It should be noted here that no consistent distinction between adolescents and children is followed. Finally, recommendations for action and research are given, although only one bullet point out of five actually refers to research. There is also an explicit call here for governments to restrict marketing of certain foods and beverages.

In reference to Buchanan et al. (2018) the authors state that sufficient evidence exists on the impact of digital marketing on young people's health: "Although still in relative infancy, there is sufficient evidence emerging to suggest that concern about the public health implications of young people's exposure to digital marketing for unhealthy foods and beverages is justified" (Boyland et al., 2020, p. 7). However, the referenced study concludes that a link between marketing and young people's health cannot be established beyond doubt. "A definitive relationship could not be determined due to the heterogeneity of the study designs, study factors and outcome measures employed by the included studies" (Buchanan et al., 2018, p. 14). Thus, it remains questionable whether sufficient evidence is available.

**Reception**

The policy proposals adopted from this publication by Prof. Koletzko (2021) of the Stiftung Kindergesundheit, including "mandatory regulatory limits on digital marketing of unhealthy foods and beverages to children and adolescents", are thus not based on sufficient scientific reasoning. In particular, evidence on advertising influences on children's consumption is not sufficiently incorporated.

## 6. Sadeghirad et al. (2016): Influence of unhealthy food and beverage marketing on children's dietary intake and preference: A systematic review and meta-analysis of randomized trials.

*Sadeghirad, B., Duhaney, T., Motaghipisheh, S., Campbell, N. R. C., & Johnston, B. C. (2016). Influence of unhealthy food and beverage marketing on children's dietary intake and preference: A systematic review and meta-analysis of randomized trials: Meta-analysis of unhealthy food and beverage marketing. Obesity Reviews, 17(10), 945–959. https://doi.org/10.1111/obr.12445*

**Executive Summary**

This meta-analysis finds significant excess consumption by children when exposed to advertisements for HFSS foods. However, the study is subject to several weaknesses, particularly a weak data basis. The authors state that four of nine studies that examined increased consumption have a high risk of poor quality. Out of these nine, three studies also examine advergames, which are not expected to be part of an advertising ban. Apart from finding a small increase in consumption among participants, the authors cannot convincingly rule out publication bias. That "even brief exposure to unhealthy food and beverage marketing targeting children results in increased food intake during and after exposure," as the Stiftung Kindergesundheit (2023) states, cannot be scientifically proven with this study.

**Content and results**

The present study by Sadeghirad et al. (2016) includes both a literature review and a meta-analysis in which 27 studies were selected for closer examination from a preliminary sample of 108 studies according to a variety of criteria (including age of subjects, data availability and study design). Of the mentioned 27 studies, only nine studies address actual food consumption; the remaining 17 examine food preference and are therefore not suitable for determining actual excess consumption. These are exclusively randomized controlled trials (RCTs) examining the effect of food and beverage marketing on children's food consumption. The result of the meta-analysis is a mean increase in consumption of 30.4 kcal, or 4.8 g in the intervention group consisting of children exposed to food and beverage marketing. The study finds as well that food preference (asked in the form of a scale) – although not to be regarded as sufficient evidence for an advertising ban – is not significantly influenced by marketing.

**Evaluation**

The quality of the studies examined by the literature review is considered questionable: The authors themselves state that of the nine studies that examine food consumption, four studies are at a high risk to be subject to bias: "The quality of reporting among the included studies was poor [...]. Four of the nine studies on dietary intake were rated as high risk of bias" (p. 948). This does not speak for proper scientific work and strongly impairs the results' generalization. A positive aspect of the study at hand is the transparent handling of the weaknesses of the examined studies.

In addition, the mean excess consumption (in kcal) is calculated from only six studies (the remaining three publish exclusively in grams and a conversion is not possible according to the authors), three of which have a high risk of bias. Another three studies in turn address so-called advergames, which would possibly not be affected by an advertising ban by the legislator, and which differ fundamentally from TV or print advertising both in the degree of interaction and in the type of reception (active vs. passive). In the study by Norman et al. (2018) only advergames ultimately lead to a significant difference in consumption. In total, this leaves three studies that even examine the basis of a possible advertising ban. However, it remains unclear how many of these are considered to be biased. This is by no means a sufficient study base for drawing scientifically sound conclusions about the effect of food advertising on children's eating behaviours and obesity.

According to the authors, the mean additional consumption calculated from studies on both advergames, and other forms of advertising is 30.4 kcal, or 4.8 g. Apart from low significance due to the mentioned limitations, this is a very low value. This represents 1.5% of the German Society for Nutrition's (DGE) daily intake guideline value for girls aged ten to 13 with low physical activity (1900 kcal) (Deutsche Gesellschaft für Ernährung e.V., 2015).

The study has further limitations: The authors state that "[f]or dietary intake reported as either kcal or grams, there were too few studies to assess the risk of publication bias" (p. 953). The authors conclude that further research is needed to "evaluate the impact of unhealthy food and beverage advertising on daily and weekly dietary intake and choices" (p. 957).

In short, due to the small number as well as the quality of the studies investigated ("risk of bias"), no valid statement can be made about the effect of food advertising on childhood obesity.

**Reception**

The study is referenced in the so-called "Fact Sheet – Food and Beverage Advertising Directed at Children" of the Stiftung Kindergesundheit (2023), "A systematic review and meta-analysis shows that even brief exposure to unhealthy food and beverage marketing targeted to children leads to increased food intake during and after exposure. Younger children and male children tend to be more susceptible to food and beverage marketing."

This quote does not correctly reflect the results of the study. Due to the small number as well as the insufficient quality of the examined studies, it cannot be concluded that food marketing exerts a clear effect on the consumption behaviours of children.

## 7. Villegas-Navas et al (2020): The effects of foods embedded in entertainment media on children's food choices and food intake: A systematic review and meta-analyses.

*Villegas-Navas, V., Montero-Simo, M.-J., & Araque-Padilla, R. A. (2020). The Effects of Foods Embedded in Entertainment Media on Children's Food Choices and Food Intake: A Systematic Review and Meta-Analyses. Nutrients, 12(4), 964. https://doi.org/10.3390/nu12040964*

**Executive Summary**

This meta-review is of limited relevance in the context of the advertising ban under discussion because it examines the effects of any mentions and embedding of food in media, such as TV and video games, on children's consumption and food preferences. This does not necessarily equal advertising and thus the results are not suitable for describing the effect of advertising on children. The authors also find evidence of publication bias, so the results of the study should be interpreted with caution.

**Content and results**

The study of Villegas-Navas et al. (2020) is a literature review and two meta-analyses on the influence of references to food contained in entertainment media on food preference and consumption. Entertainment media in the study include movies, TV-series, and television as well as video games and advergames.

The authors first ran a keyword search with over 1600 results across selected databases (Academic Search Ultimate, Business Source Ultimate, PsycINFO, MEDLINE, and PubMed) and conducted systematic literature searches in the references of the results (*backward and forward references searching)*. "Studies were eligible for inclusion in the systematic review if (i) participants were children aged under 12 years [...]; (ii) interventions included foods exposure in entertainment media targeted at children [...]; (iii) they included parallel comparison groups that were not exposed to embedded foods or that were exposed to different embedded foods to the intervention condition; and (iv) reported outcomes included either food choice or food intake" (p. 3). From these results, they then selected 26 studies for further review. Of these, 13 are the subject of a meta-analysis on food choice (preference, not consumption) and seven are included in a meta-analysis on food consumption.

Risk ratios for food preference and the mean difference for consumption are calculated, and the authors conclude that food shown in media has an impact on both preference and consumption. It is also added that the results on food intake are most likely subject to publication bias (cf. Publication bias). This is supported by several tests for asymmetry in the results. A funnel plot is shown in **Figure 6** showing such asymmetry with effect size on the x-axis and standard error on the y-axis. White dots represent published studies, black dots are imputed to illustrate how a distribution of studies by effect size should look without publication bias. The default assumption here is that the results are normally distributed. The larger the sample of studies, the smaller the standard error. Among all the studies included in the review, there are abnormally many publications that find a significant increase in consumption after exposure to advertising. Studies finding the opposite do not exist. According to the authors, there is reason to believe that they were conducted but never published due to the reasons already discussed.

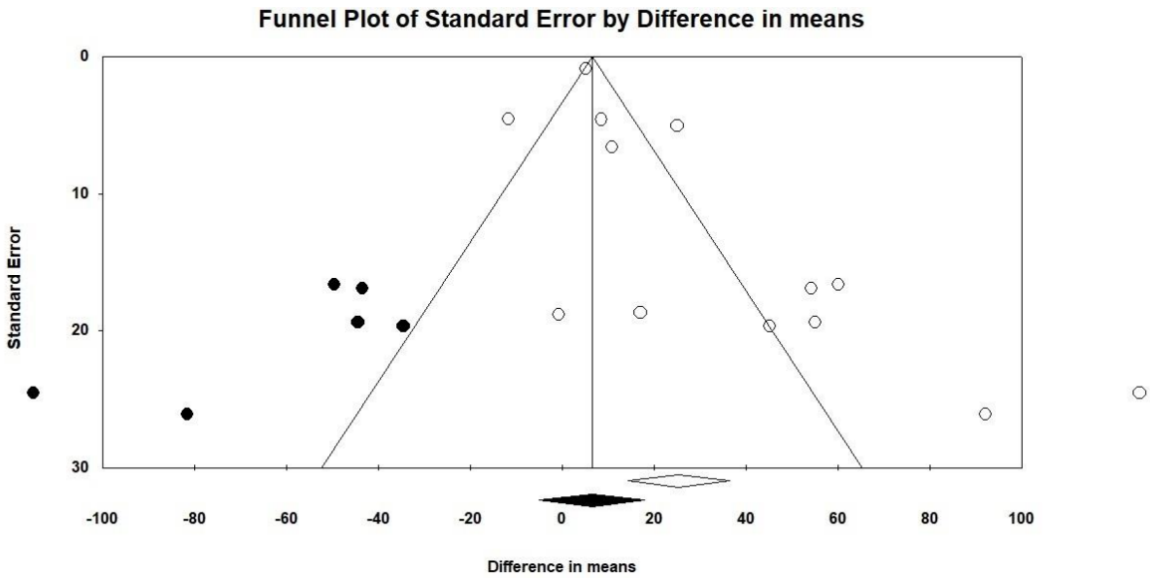


**Figure 6.** Funnel plot based on food intake.

***Figure 6:*** *Funnel plot illustrating potential publication bias in studies of advertising and food consumption among children. Standard error (y) on effect size (x). Black dots are imputed, white represent published studies. Source: Villegas-Navas et al. (2020)*

**Evaluation**

The study's findings should be interpreted with caution given the publication bias identified by the authors.

It is important to note that this analysis does not (exclusively) examine studies on advertising, but rather those on the general occurrence of food in the media, for instance when an actor in a series consumes a soft drink or when food is visible on a shelf behind the characters. The authors remain vague on whether these could also be product placements. At least one study was included in the meta-review on consumption that examined only non-branded products. In addition to the fact that the unpaid simple mention of HFSS products in the media would not fall under the discussed advertising ban, the authors also include studies that look at media such as video games, which would not be affected by the discussed advertising ban either.

It is also striking that the 13 scientific studies examined on the effect of mentions of food on children's consumption came from only three different research groups.

**Reception**

The study is referenced in the so-called "Fact Sheet – Food and Beverage Advertising Directed at Children" of the Stiftung Kindergesundheit (2023), "The embedding of foods and beverages in entertainment media influence children's choice of eating behaviours and also their consumption of food during or after exposure."

What is disregarded here is that the embeddings examined in the study are not only advertising but also possibly product placements, and above all the fundamental appearance of food in entertainment media (exception: advergames). The authors' recommendation is therefore to regulate the embedding of HFSS foods in media per se. This is not part of the advertising ban currently under discussion. Thus, it is questionable to what extent the study is applicable to the current discourse. Also not mentioned is the relativization of the found relationship by the existing publication bias in the field, as stated by the authors of the study themselves (cf. Publication bias).

## 8. Kovic et al. (2018): The impact of junk food marketing regulations on food sales: An ecological study: Junk food marketing regulations & sales.

*Kovic, Y., Noel, J. K., Ungemack, J. A., & Burleson, J. A. (2018). The impact of junk food marketing regulations on food sales: An ecological study: Junk food marketing regulations & sales. Obesity Reviews, 19(6), 761–769. https://doi.org/10.1111/obr.12678*

**Executive Summary**

Viewed in the context of the advertising regulation under discussion, the study at hand exhibits some weaknesses. Since the study refers exclusively to aggregate data, no conclusions can be drawn at the individual level. As no distinction is made between children and adults, the data are not suitable for justifying an advertising ban for children and they do not provide a sufficient basis to establish a causal relationship between advertising bans and HFSS sales. In addition, population health is not examined in this study. Therefore, an "effect of voluntary/mandatory advertising restrictions" (Koletzko, 2021) is not examined in a statistically appropriate manner in the study at hand. At best, it establishes an overview of the effect of advertising bans on HFSS sales at the national level without being able to examine any relationship at the individual level and without the inclusion of control variables.

**Content and results**

This study by Kovic et al. (2018) is an ecological study[7]. It examines the impact of voluntary and mandatory media advertising restrictions on sales of junk food (including baked goods, fast food, and confectionery) in 79 countries from 2002 to 2016. After adjusting for confounding factors, the presence of a policy ($p = 0.013$), type of regulation (voluntary, statutory) ($p = 0.004$), audience restrictions (e.g., 6 a.m.-2 p.m. ban) ($p = 0.024$), and dietary criteria ($p = 0.008$) predict significant differences in the change in per capita junk food sales over time. The key finding is that per capita sales of junk food increased by 13.9% in countries without advertising restrictions and 1.7% in countries with voluntary advertising restrictions, while in countries with legally mandated advertising restrictions, per capita sales of junk food decreased by 8.9% over the study period.

**Evaluation**

The authors have, as far as can be assessed, worked in a scientifically appropriate manner.

It should be noted that the subject of the study is junk food sales in society as a whole. First, sales are not to be equated with consumption. Furthermore, the study does not exclusively refer to children and

[7] "Studies that use spatially or temporally summarized data instead of individual data on exposure and disease" (Breckow et al. 1995).

is therefore not suitable to justify a ban on food advertising to children. It is for example possible – although rather unlikely – that the measures have an exactly opposite effect on children than on adults and therefore both effects cancel each other out in the aggregate. Consequently, it is imperative to examine disaggregated data. Similarly, it is fundamentally not possible to infer individual level effects from aggregate data, i.e., if an effect exists at the population level, this does not mean that the effect also holds true at the level of the studied subjects (if this is inferred, there is a so-called ecological fallacy). In the context of the Kovic et al. study, this means: Even if per capita sales of junk food decreased in the presence of mandatory advertising restrictions in a country, a random person in society does not have a higher probability of decreased sales (if there are more people in society with increased consumption, a person is more likely to have increased consumption).

There is generally a high probability in ecological studies of drawing incorrect conclusions from the data.

Moreover, the study is based on a sample of 79 countries, which is why it is not possible to draw specific conclusions about Germany from this sample due to the large variance (e.g., in cultural, demographic, economic aspects) and lack of comparability. These factors disqualify the study as evidence in the discussion about advertising restrictions.

**Reception**

The study was cited by Koletzko in a press conference (2021) to illustrate the "effect of voluntary/mandatory advertising restrictions" (slide 12). Specifically, for all three scenarios of advertising restrictions examined (none, voluntary, mandatory), the average development of per capita consumption is visualized as a bar chart. By and large, the results are correctly referenced. Nevertheless, it should be noted that the decrease due to mandatory advertising restrictions amounts to -8.6% according to the authors, instead of the -8.9% shown on slide 12. Additionally, Koletzko's presentation talks about "per capita consumption", but the Kovic et al. study only examines per capita sales of junk food. Although similar, these two terms are not synonymous because sales do not equal consumption. These examples illustrate a certain carelessness that is repeatedly found in referencing of key studies by relevant actors.

Moreover, as noted above, the study's exclusive use of aggregate data does not allow us to infer causality or a relationship between advertising restrictions and consumption at the individual level. Additionally, the study is not exclusively about children. However, this impression may be created by Koletzko's presentation to readers who are not familiar with the statistical implications of aggregate data. Therefore, it is important to note the limited significance of such an analysis. In addition, sales figures do not allow us to say whether and how dietary behaviours have changed. In summary, the study does not provide more than a rough overview of the effect of advertising restrictions. However, it does not contribute to the investigation of the relationship between advertising and HFSS food consumption by children.

## 9. Halford et al (2008): Beyond-brand effect of television food advertisements on food choice in children: The effects of weight status.

*Halford, J. C., Boyland, E. J., Hughes, G. M., Stacey, L., McKean, S., & Dovey, T. M. (2008). Beyond-brand effect of television food advertisements on food choice in children: The effects of weight status. Public Health Nutrition, 11(9), 897–904. https://doi.org/10.1017/S1368980007001231*

**Content and results**

This work by Halford et al. (2008) is a cross-over study in which participants are respectively assigned to either the control or the treatment group at two different points over the course of the study. This largely eliminates confounding factors. In the study, this assignment was not randomized, but rather based on school association. In the context of the present study, this means that 59 children (nine - 11 years) were exposed to both advertisements for HFSS foods in one experiment and toy advertisements at another time. In each case, this occurs in the context of a cartoon. Subsequently, in groups of four to five participants, children were provided with several sweet, high-fat, and salty snacks as well as those classified as healthy (e.g., chocolate, crisps, gummy bears, grapes) to eat in an unlimited time period and their consumption was documented. Regardless of their BMI, all children exhibited a statistically significant increase in consumption following food advertising, in contrast to toy advertising.

**Evaluation**

The authors acknowledge that the external validity of the small-sample experiment (n = 59) is low and therefore results should not be generalized: "Caution must be taken when generalizing the results of small-scale experimental studies to real-world behaviour" (Halford et al., 2008, p. 902). However, there is a lack of discussion regarding the "opportunity sample," described as consisting of two school classes, which is not representative for the overall population of children. As a result, this study does not qualify as a randomized cross-over study and thus the risk of bias is considered high.

**Reception**

The study is referred to in Boyland et al. (2020) to justify advertising restrictions for children. However, as explained above, the evidence provided is not sufficiently generalizable to scientifically substantiate such a ban.

## 10. Coates et al. (2019b): Food and beverage cues featured in YouTube videos of social media influencers popular with children: An exploratory study.

*Coates, A. E., Hardman, C. A., Halford, J. C. G., Christiansen, P., & Boyland, E. J. (2019). Food and Beverage Cues Featured in YouTube Videos of Social Media Influencers Popular With Children: An Exploratory Study. Frontiers in Psychology, 10, 2142. https://doi.org/10.3389/fpsyg.2019.02142*

**Executive Summary**

This study is included in this report because of the misrepresentation of the result by Professor Hans Hauner, Chairman of the German Diabetes Foundation. In his expert statement at a press conference of DANK and the AOK Federal Association in March 2021 he speaks of a share of HFSS foods in all foods appearing in YouTube videos of well-known influencers of over 90%. In fact, however, this share is 49.4%.

**Content and results**

This further study by Coates et al. (2019a) is a quantitative investigation of the visual and verbal embedding of food in YouTube videos. The study aims to examine both the overall extent of food integration and, specifically the proportion of HFSS foods based on the UK Nutrient Profiling Model.

In this study, the YouTube videos of two popular influencers (male and female, approximately 10 million subscribers), whose videos are primarily focused on their daily life (e.g., outings) or subscriber interaction, were analysed over the course of an entire year. The analysis aimed to identify the presence of food or brands directly related to food (e.g., McDonald's) in the audiovisual content of the videos. Two different methods were used, ensuring the results were verified through a significant accordance between the two approaches.

Embeddings of – according to the authors – unhealthy (49.4%), healthy (34.5%) and uncategorizable (16.1%) foods were distinguished and the relationship of these categories to the type of presentation was subsequently examined. Foods categorized as less healthy, for example, appeared disproportionately often in paid advertising and tended to be portrayed more positively.

**Evaluation**

As far as can be assessed without access to the data and the concrete methods employed, the study is of high quality. The statistical procedure is sufficiently explained. The results are critically examined, and their limitations are pointed out. The authors note that an examination of the videos of only two different influencers cannot be representative of the totality of YouTube videos. They state that the selection of these two influencers was done for better comparability with previous studies, including

Coates et al. (2019b). It is possible that the specific choice of these two influencers could introduce bias. However, it is difficult to verify this.

**Reception**

In stark contrast to this, is the citation of this study by Prof. Dr. med. Hans Hauner (Institute of Nutritional Medicine, Klinikum rechts der Isar, Else Kröner-Fresenius Center for Nutritional Medicine of the Technical University of Munich and Chairman of the Board of the German Diabetes Foundation (DDS)) in his expert statement on the occasion of a press conference of the German Alliance of Noncommunicable Diseases (DANK) and the AOK Federal Association on Thursday, March 11, 2021 (in German): "In recent years, social media (Facebook, Instagram, YouTube) are increasingly popular among children and adolescents. YouTube is particularly popular with children and most bloggers (influencers) are active there. The topic of food and drink has a high and growing share there. Analysis shows that over 90% of food and drink videos address and promote unhealthy products (according to the UK Nutrient Profiling Model) (Coates et al., 2019a)" (Hauner, 2021).

Obviously, this is a misrepresentation of the facts as instead of the 49.4% mentioned in the article, it states over 90%. Furthermore, the article does not provide the number of videos that contain "unhealthy" foods at all, but only the proportion of HFSS foods in all foods shown in the YouTube videos. There may also be some confusion regarding the percentage of videos that were examined and featured food in general (92.6%). However, this number represents all types of food.

## 11. Yau et al (2022): Changes in household food and drink purchases following restrictions on the advertisement of high fat, salt, and sugar products across the Transport for London network: A controlled interrupted time series analysis.

*Yau, A., Berger, N., Law, C., Cornelsen, L., Greener, R., Adams, J., Boyland, E. J., Burgoine, T., de Vocht, F., Egan, M., Er, V., Lake, A. A., Lock, K., Mytton, O., Petticrew, M., Thompson, C., White, M., & Cummins, S. (2022). Changes in household food and drink purchases following restrictions on the advertisement of high fat, salt, and sugar products across the Transport for London network: A controlled interrupted time series analysis. PLOS Medicine, 19(2), e1003915. https://doi.org/10.1371/journal.pmed.1003915*

**Executive Summary**

This study reports a much-cited positive effect of the advertising ban on HFSS products in London's public transport system. However, this result only comes about through a trick, namely the construction of a counterfactual situation. The result is merely an estimate of the 6% increase in consumption if the advertising were to continue. Moreover, the strength of the observed effect for households with children is only one-sixth (200 kcal) of the average weekly reduction in HFSS product purchases reported for households without children. The significance of this effect is questionable and cannot be substantiated based on the data included in the article. In addition, doubts exist regarding the necessary similarity between the control and experimental groups (the north of England and London), particularly in the category with the greatest influence on consumption, where differences exist. In summary, the results of this study are not robust from a scientific point of view.

**Content and results**

This study is a quasi-experiment conducted using the methodology of a Controlled Interrupted Time Series Analysis (CITS). An estimate is calculated from a control group (north of England) after the intervention and an experimental group (London) before the intervention – this so-called counterfactual course indicates how the experimental group would have developed if the intervention had not occurred. The comparison with the actual course thus yields estimates of the effect of the intervention.

The study focuses on the consumption behaviours of English households, in particular on the demand for HFSS-foods and examines how it is influenced by the corresponding advertising. This advertising was no longer permitted on public billboards of the London public transport network (TfL-network = "Transport for London") from February 2019 on, which inspired the study authors to investigate shopping behaviours of London households.

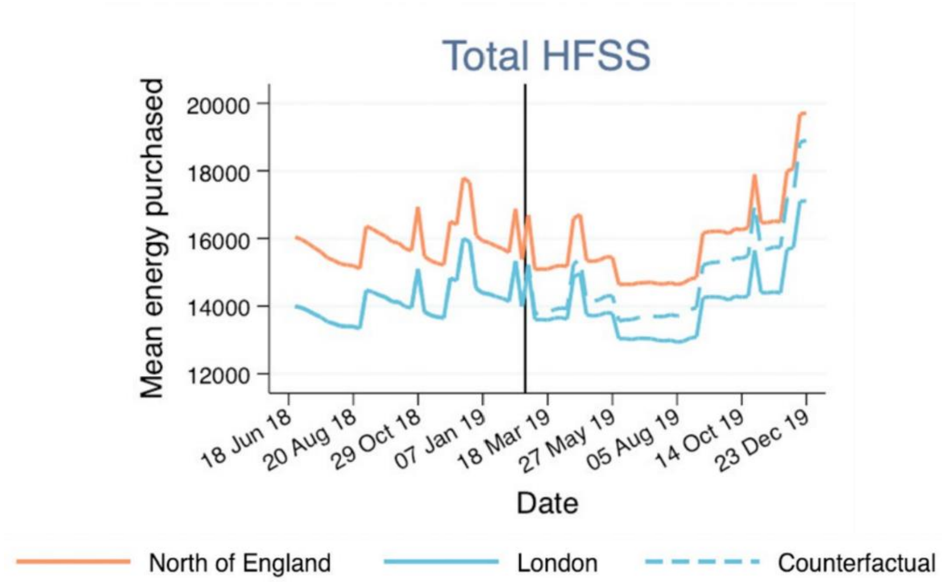


***Figure 7:*** *Example plot of a CITS from the study. Counterfactual is the estimated trajectory of the experimental group (London) based on the trajectory of the control group (North of England) after the intervention (vertical black line).*
*Source: Yau et al. (2022)*

For the study at hand, 977 London households already registered in a Consumer Panel ("Kantar Fast Moving Consumer Goods Panel") were randomly selected. All purchases by these households were recorded 36 weeks before and 44 weeks after the advertising ban. "Our primary outcomes were weekly household purchases of energy (kilocalories), fat (grams), saturated fat (grams), sugar (grams), and salt (grams) from HFSS products." Result: weekly purchases of HFSS products per household were by no means lower after the advertising ban, but actually higher ("Relative reductions are in the context of secular increases in HFSS purchases ...the policy was associated with attenuated growth of HFSS purchases rather than absolute reductions in HFSS purchases" p. 2).

**Evaluation**

The positive effect of the advertising stop, which is reported and frequently cited elsewhere, is only achieved by a trick, the construction of a counterfactual situation: What would have happened if the advertising had continued? The answer provided is, that the consumption of HFSS foods would have increased by an additional 6% (p. 2). However, this is not measured, but estimated, as the actual purchasing behaviours are compared to a purely hypothetical value that may or may not be true. The construction of this counterfactual situation is fraught with all the pitfalls that occur in similar statistical procedures. First, even with a correctly specified model, there are the finite-sample estimation errors for the unknown coefficients of the model. However, this uncertainty can be quantified. Far more dramatic, however, and almost ubiquitous in empirical statistics, are the consequences of an improperly specified model, see Krämer et al. (1985). As demonstrated there, and now accepted as common knowledge in scientific statistics, almost all empirically estimated statistical models are considered to be wrong. Consequently, the consumer behaviours utilized as a basis in the counterfactual situation are also more than questionable. It is particularly relevant that the CITS model relies on a parallel course of the two groups, control and experimental group should thus behave very similarly. The study, however, finds significant deviations in the category "Chocolate & Confectionary", which is particularly serious, as this category is by far the largest (in terms of calorie consumption) and has a strong influence on the significance of the overall result.

Particularly relevant for our consideration is that the calculated effect on total calorie consumption (of HFSS foods) was significantly lower for households with children. Instead of a reduction of approximately 1200 kcal (weekly average) for households without children, households with children only achieved a reduction of around 200 kcal. This corresponds to less than 30 kcal per day, distributed among at least two people. Whether this effect is still significant is questionable and cannot be inferred from the data provided in the article.

In addition to this methodological criticism, all of the studies presented in this report are subject to the fact that the effects on consumption behaviours proven or supposedly proven in these studies only measure short- to at best medium-term consumption effects and at best allow indirect and by no means reliable conclusions to be drawn about long-term consequences for health and body weight.

This is also the view of the study authors themselves: "These findings provide support for policies that restrict HFSS advertising as a tool to reduce purchases of HFSS products”. The extent to which "purchases of HFSS products" impact body weight and health remains open and is not investigated in the study.

**Reception**

Due to the elaborate study design and the significance of the effect found, the study received a great deal of media attention, and the Mayor of London also saw the ban confirmed by the result (Sky News, 2022). A necessary differentiated analysis, as conducted here, was not carried out.

**Note**

A follow-up study exists (Thomas et al., 2022), which uses a model to predict the future public health impact of the temporary advertising ban on the TfL-network. The calculated savings in treatment costs and reduced numbers of people with obesity in Greater London are based on the reduction in consumption per capita calculated in this study at hand and are thus questionable. In addition, "the model is unable to simulate the life course for children aged under 16 due to the differing data requirements for this population" (Thomas et al., 2022, p. 2), as the authors note. Thus, the study is not suitable for evaluating the impact of an advertising ban on children’s health.

## 12. Boyland et al. (2016): Advertising as a cue to consume: a systematic review and meta-analysis of the effects of acute exposure to unhealthy food and non-alcoholic beverage advertising on intake in children and adults.[8]

*Boyland, E. J., Nolan, S., Kelly, B., Tudur-Smith, C., Jones, A., Halford, J. C., & Robinson, E. (2016). Advertising as a cue to consume: A systematic review and meta-analysis of the effects of acute exposure to unhealthy food and non-alcoholic beverage advertising on intake in children and adults1,2. The American Journal of Clinical Nutrition, 103(2), 519–533. https://doi.org/10.3945/ajcn.115.120022*

**Executive Summary**

This literature and meta-review impresses with the quality of their methodological work and reflection. However, the conclusions and recommendations of the authors cannot be scientifically derived from the inconsistent results. In addition, there is a lack of transparency, because almost half of the experiments with children (six out of 13) were conducted by one of the study authors himself. While the authors investigate whether there is a difference between studies from different research groups and note that the experiments of one research group have five times the effect size of the others, no mention is made that the authors themselves are part of this research group. Although the authors are aware of the limitations of their work as well as the volatile effect, and they themselves document a lack of research to prove a long-term effect on obesity, they call for political action. However, considering the methodological weaknesses and gaps mentioned by the authors themselves, there is no solid scientific evidence for this.

**Content and results**

This study by Boyland et al. (2016) conducted both a systematic review and meta-analysis based on the electronic databases SCOPUS, PsycINFO, MEDLINE, Emerald Insight, and JSTOR in 2014. An overview of the selection criteria can be found in **Figure 8**. For example, only experimental papers with control groups were included. Of the 4450 studies initially selected, 22 remain, of which the authors finally analysed 18 using standardized mean difference (SMD). Of the four studies for which

[8] In addition to the two studies discussed in this review, a variety of other studies exist in the area of marketing effects involving E. Boyland, including a WHO-funded literature review evaluating revised WHO guidelines (Boyland et al., 2022). However, it almost exclusively looks at the impact of policy on food marketing, and only one study in the literature review examines children's consumption at all. The evidence for all categories examined is also rated as "low" or "very low certainty of evidence." Therefore, the study is of little value in the context of the proposed legislation and will not be examined further here.

the authors were not provided with data, two found a positive effect of advertising HFSS foods on food intake, while the other two studies found no effect in children or only an effect in overweight girls.

| Criterion | Data extracted |
|---|---|
| Study design | Within or between subjects |
| Random assignment of participants to conditions (between-subjects designs) or randomization of condition order (within-subjects designs) | Yes or no |
| Experimental setting | School, summer camp, or laboratory |
| Advertising medium | Television or Internet |
| Details of advertising medium | Any available information on the length of advertising exposure and types of products depicted |
| Sample size by sex | Number of male participants and number of female participants |
| Participant age | Child (<18 y of age) or adult |
| Participant weight status | Any available information, e.g., the number or proportions of participants who were normal weight, overweight, and obese |
| Test foods used | Type of food and whether it was depicted in the food advertising shown |
| Main outcome | Food intake in ounces, grams, kilocalories, kilojoules, or number of items eaten |

***Figure 8:*** *Selection criteria of the study*

Overall, children were the study subjects in 13 of the papers studied, the majority of which measured food intake with snacks, but also with meals or an optional dessert. The experiments were mostly conducted in schools, two in the laboratory, and two each at a summer camp or in a scout troop.

In the meta-analysis, the study authors find a weak to moderate significant effect of advertising for HFSS foods on food consumption. A Chi-square test is then used to analyse differences between various subgroups, including a significant difference between adults and children. The subsequent SMD analysis shows that advertising has no positive effect on food consumption in adults, unlike in children. The study authors' further analyses presented a heterogeneous picture of the effect of advertising, which varied greatly depending on the study design:

Experiments in which only one group was exposed to food advertising, as opposed to within experiments where the timing of the treatment was varied, showed only a weak (but significant) effect.

Experiments in which only a single food was available as an HFSS snack show no significant effect on food consumption.

Experiments in which the period of potential food intake included viewing the advertisement show no significant effect on food consumption.

Experiments conducted by one particular research group found a five times greater effect of food advertising on children compared to the other studies.

Due to missing data, subgroup analyses based on weight, age, or gender could not be performed. The authors also examined the existence of publication bias (cf. Publication Bias), which was rejected by one test but confirmed by another.

In conclusion, the study authors found a significant moderate effect of advertising on children but noted that this effect is highly inconsistent. The authors offered several possible explanations for this heterogeneity for example, the subjects in within trials might have been aware of the intention of the experiment, causing them to behave accordingly. On the other hand, other factors such as age, gender, and weight could not be included in the analysis. To prevent these methodological limitations in the future, the study authors call for greater methodological consistency in research to establish a clear, replicable, and reliable effect. In addition, they say further research is needed to demonstrate a sustained and long-term effect of advertising and to verify that increased food intake actually leads to obesity and is not compensated for at a later stage. In conclusion, the findings are a solid evidence base to support immediate policy action.

**Evaluation**

The methodology of the study under review is scientifically credible, and it discusses in an exemplary manner the limitations of the review, namely the inconsistency of the observed effect, and the lack of consistency in the conducted experiments. It is precisely because of this successful critical reflection that the vehemence with which political action is called for in the conclusion is surprising. After all, only a few sentences earlier, further studies were demanded that go beyond a short-term increased consumption, exclude a later overcompensation, and investigate a long-term effect on body weight. At the same time, it is highly questionable whether such an inconsistent effect should serve as evidence for policy action: for example, advertising had no significant effect on food intake when viewing the ad was part of the period during which participants were allowed to eat. Similarly, the significance of the observed effect fizzled out when participants had only one HFSS snack available, rather than several or even an entire buffet, as would otherwise be the case.

Publication bias must be criticized as well: This is discussed in an exemplary manner – the authors of the included studies were even asked about unpublished material – and two tests were conducted, one of which indicated publication bias. However, when discussing the results and their implications, publication bias, which cannot be ruled out, is not mentioned at all. Similarly, the study lacks basic transparency principles by failing to mention that nearly half of the experiments with children (six out of 13) were conducted by one of the study authors himself, among others. While they investigate whether there is a difference between studies from the different research groups and note that experiments from one research group have five times the effect size of the others, the authors do not mention that they themselves are part of this research group.

| Study or Subgroup | Std. Mean Difference | SE | Weight | Std. Mean Difference IV, Random, 95% CI |
|---|---|---|---|---|
| **1.2.1 Adults** | | | | |
| Anschutz 2011 (27) | -0.05259 | 0.11043 | 5.0% | -0.05 [-0.27, 0.16] |
| Bellisle 2009 (38) | -0.0704 | 0.1118 | 5.0% | -0.07 [-0.29, 0.15] |
| Boland 2013 (31) | -0.16752 | 0.10911 | 5.0% | -0.17 [-0.38, 0.05] |
| Harris 2009b (19) | 0.13823 | 0.12217 | 5.0% | 0.14 [-0.10, 0.38] |
| Martin 2009 (28) | 0.0269 | 0.10206 | 5.0% | 0.03 [-0.17, 0.23] |
| van Strien 2012 (46) | 0.00742 | 0.08805 | 5.0% | 0.01 [-0.17, 0.18] |
| Wonderlich-Tierney 2013 (47) | 0.20587 | 0.13868 | 4.9% | 0.21 [-0.07, 0.48] |
| **Subtotal (95% CI)** | | | **34.8%** | **-0.00 [-0.08, 0.08]** |
| Heterogeneity: Tau² = 0.00; Chi² = 6.54, df = 6 (P = 0.37); I² = 8% | | | | |
| Test for overall effect: Z = 0.00 (P = 1.00) | | | | |
| **1.2.2 Children** | | | | |
| Anschutz 2009 (29) | 0.02625 | 0.09129 | 5.0% | 0.03 [-0.15, 0.21] |
| Anschutz 2010 (30) | -0.09752 | 0.1118 | 5.0% | -0.10 [-0.32, 0.12] |
| Boyland 2013a (39) | 0.44744 | 0.1191 | 5.0% | 0.45 [0.21, 0.68] |
| Boyland 2013b (39) | 0.03059 | 0.12856 | 4.9% | 0.03 [-0.22, 0.28] |
| Dovey 2011 (21) | 2.07638 | 0.08704 | 5.0% | 2.08 [1.91, 2.25] |
| Folkvord 2013 (23) | 0.4908 | 0.08639 | 5.0% | 0.49 [0.32, 0.66] |
| Folkvord 2014 (22) | 0.35674 | 0.08737 | 5.0% | 0.36 [0.19, 0.53] |
| Folkvord 2015 (24) | 0.34122 | 0.10426 | 5.0% | 0.34 [0.14, 0.55] |
| Halford 2004 (18) | 1.0697 | 0.10911 | 5.0% | 1.07 [0.86, 1.28] |
| Halford 2007 (25) | 0.53218 | 0.07332 | 5.1% | 0.53 [0.39, 0.68] |
| Halford 2008 (26) | 1.71047 | 0.09206 | 5.0% | 1.71 [1.53, 1.89] |
| Harris 2009a (19) | 0.41517 | 0.09206 | 5.0% | 0.42 [0.23, 0.60] |
| Harris 2012 (20) | -0.12621 | 0.09901 | 5.0% | -0.13 [-0.32, 0.07] |
| **Subtotal (95% CI)** | | | **65.2%** | **0.56 [0.18, 0.94]** |
| Heterogeneity: Tau² = 0.47; Chi² = 625.43, df = 12 (P < 0.00001); I² = 98% | | | | |
| Test for overall effect: Z = 2.92 (P = 0.003) | | | | |
| **Total (95% CI)** | | | **100.0%** | **0.37 [0.09, 0.65]** |
| Heterogeneity: Tau² = 0.40; Chi² = 788.63, df = 19 (P < 0.00001); I² = 98% | | | | |
| Test for overall effect: Z = 2.57 (P = 0.01) | | | | |
| Test for subgroup differences: Chi² = 8.14, df = 1 (P = 0.004), I² = 87.7% | | | | |

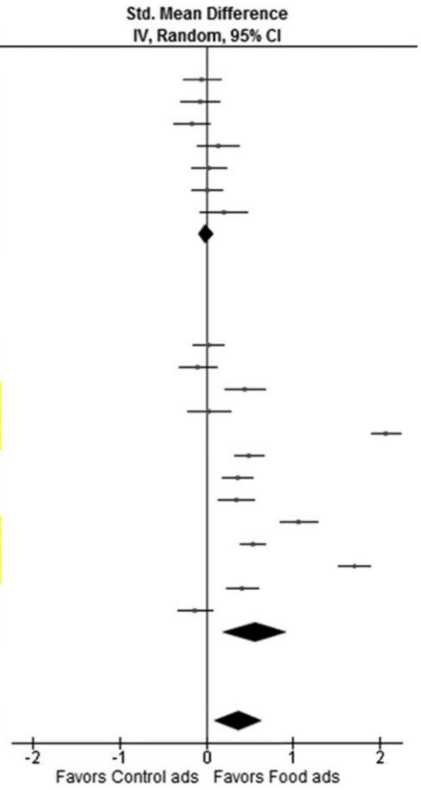


**FIGURE 2** Forest plot of subgroup analysis by age of participant (adult and children). An IV meta-analysis with the use of an SMD was used. $I^2$ is an indicator of between-comparison heterogeneity. IV, inverse variance; SMD, standardized mean difference.

***Figure 9:*** *Table showing the included studies and their SMD. In the studies marked in yellow (six out of 13), some of the study authors themselves collaborated. Source: Boyland et al. (2016)*

In summary, the quality of the methodological work and its reflection deserves praise, but the lack of transparency and the conclusions and recommendations cannot be derived from the results in a scientifically serious manner. Although the authors are aware of the limitations of their work as well as the inconsistency of the effect and they themselves acknowledge the need for further research to demonstrate long-term effect on overweight, they call for political action. However, considering the methodological weaknesses and gaps mentioned by the authors themselves, there is no solid scientific evidence for this.

### Reception

The study under review is frequently cited (in 542 studies according to Google Scholar) and was included as one of three sources in the WHO European Regional Obesity Report 2022 as evidence for the statement "Digital marketing of HFSS products has a direct effect on children's eating habits which can lead to childhood overweight and obesity" (2022, p. 94). However, this study examined here does not provide any evidence for the statement that advertising has an influence on children's eating habits and can lead to overweight and obesity. It neither demonstrates a long-term influence on eating behaviours, nor does it make any statements about the effect of advertising on overweight.

13. Smith et al. (2019): Food marketing influences children's attitudes, preferences, and consumption: A systematic critical review.

*Smith, R., Kelly, B., Yeatman, H., & Boyland, E. (2019). Food Marketing Influences Children's Attitudes, Preferences and Consumption: A Systematic Critical Review. Nutrients, 11(4), 875. https://doi.org/10.3390/nu11040875*

**Executive Summary**

According to Koletzko (2021) this literature review provides a "convincing scientific data situation." However, the authors acknowledge the risk of publication bias without examining it in more detail and insufficiently document the data situation as well as the scientific quality of the studies examined. A large majority of the included studies also contains only one measurement point. The study also fails to provide evidence of a long-term effect of advertising on children's consumption or any health effects of advertising consumption. In summary, from a statistical point of view, it is not possible to speak of a convincing data situation.

**Content and results**

This study by Smith et al. (2019) is a literature review. The authors first ran a keyword search with several 1000 results across selected databases (SCOPUS, PsycINFO, MEDLINE, Business Source Complete, and Web of Science). "Articles were required to adhere to the following criteria: they were peer-reviewed journal articles, published in English, and were published in the period 1970-2018" (p. 874). From this pool, they then selected a very small percentage for further analysis: "71 eligible articles were identified. Significant detrimental effects of food marketing, including enhanced attitudes, preferences and increased consumption of marketed foods were documented for a wide range of marketing techniques, particularly those used in television/movies and product packaging." Overall, the authors find evidence of an effect of marketing elements (mainly TV, packaging, video games) on the eating behaviours of children and adolescents.

**Evaluation**

The concession that only those studies were selected in which advertising for HFSS products was the focus raises suspicions. "Exclusion criteria precluded studies that: Focused on examining marketing techniques to promote good nutrition or studies focused on outcomes other than attitudes, preference, or consumption such as purchasing requests or body weight" (p. 3). Even if we do not want to assume that only studies with favourable results were included, it should be noted that only studies with statistically significant results had a chance to be included in the review, with all the erroneous conclusions that such a publication bias generates (cf. Publication Bias): Studies without significant results (i.e., with the result: advertising has no effect) had little chance of being published in reputable journals during the selection period considered. This is acknowledged by the authors ("There is a possibility of publication bias that studies which did not find any signification associations may not have been published", p. 7), but then ignored. Therefore, the probability of a chance finding for significant associations is much higher than the commonly claimed 1% or 5%, casting doubt on all statements referenced in this article. Moreover, 62 of the papers examined only have a single measurement point, and three studies are merely qualitative investigations. A causal long-term relationship between food advertising and increased consumption cannot be derived from these studies, regardless of the outcome. Therefore, the authors also conclude that both more extensive studies of the long-term effect of food marketing on children's weight are needed and that new media and their marketing techniques should be studied more (p. 1).

Furthermore, the scientific quality of the examined studies is not summarized, but only presented in individual cases, and there is a complete lack of consideration of the data quality of the selected studies. Likewise, the study results are only presented in isolated cases, so that it is not clear how the authors arrive at such a positive overall assessment ("Overall, the identified studies present a strong, comprehensive body of evidence demonstrating the powerful influence of food marketing exposure" (p. 7)). In addition, the literature review also includes studies dealing with so-called advergames (n = 13), which would possibly not be affected by an advertising ban by the legislator, and which differ fundamentally from TV or print advertising both in the degree of interaction and in the type of reception (active vs. passive). Therefore, these studies cannot be used as a scientific basis for the advertising ban. Additionally, it must be criticized that some studies, since they only assess participants' eating preferences, cannot provide any information on potential increased consumption or, even more so, on health effects.

In total, the central conclusion of the literature review ("Together, these studies contribute strong evidence to support the restriction of food marketing to children" (p. 1)) is not supported by the statistical facts.

**Reception**

Koletzko (2021), in a presentation during a press conference of Foodwatch e.V. on August 25, 2021, talks about a "convincing scientific data situation" in reference to the study and claims there is allegedly "very strong scientific basis for restricting food advertising to children and adolescents" (slide 10). As previously shown, this is not the case due to several limitations such as publication bias, inadequate presentation of the results and the scientific quality of the studies examined, and the inclusion of studies that are irrelevant in the context of the advertising ban.

# 7. Tabular summary of studies

| [Study] | Type of study | Result | Sample size, high sensitivity for individual participants | Compensation of increased calorie intake | Control on effect of food in general | Quantitative result | General significance | Anomalies in the Study Design | Source/ relevance |
|---|---|---|---|---|---|---|---|---|---|
| Coates et al. (2019a) | RCT | Increased snack consumption through Instagram ads | n = 176, individual relevant groups n = 59 | Not considered | Yes, by means of advertising for snacks classified as healthy | Mean increase of 91 kcal from control to intervention | Sig. effect of type of advertising; medium effect size | Children were given only fixed amounts of each snack; during school → children talk about content of study | Koletzko (2021) |
| Kovic et al. (2018) | Ecological study[9] | The presence of an advertising restriction is associated with declines in per capita sales of HFSS products | n = 79 (countries) | *Not applicable* | *Not applicable* | In countries with legal regulations, sales of HFSS products decreased by 8.9% on av. (2002-2016) | Given | Not only consumption by children recorded | Koletzko (2021) |
| Norman et al. (2018) | Within subject CT | Increased calorie consumption through TV advertising and advergames | n = 154, after division into weight groups only n = 11 obese | Examined only at another meal, not during the day | No, only toy advertising as control | Mean increase of 201 kJ (~ 48 kcal) for TV + advergame vs. control | No sig. association between TV-commercial and food; sig. with additional watching of advergame | Some defects (see separate description) | Koletzko (2021) |
| Coates et al. (2019b) | Descriptive analysis | In a large majority of the videos studied, food is mentioned or consumed. Of these, just under half are HFSS products | n = 380 videos | *Not applicable* | *Not applicable* | 92.6% of 380 videos from 2 Youtubers show food, of which 49.4% are HFSS; explicitly paid ads only for 0.6% of food shown in videos | Sig. difference between frequency of HFSS products and other foods | Study is acceptable, but wrongly received by Prof. Hauner ("Analyses show that over 90% of videos on food and drink address and promote unhealthy products") | Hauner (2021) |
| Halford et al. (2008) | Cross-over study | Increase in snack consumption after TV commercials. Stronger increase for obese children | n = 59 | No | No | Average consumption of various snacks in different groups | Sig. increase in consumption after advertising HFSS products for all weight categories; sig. difference btw. obese and others | Sig. higher proportion of overweight and obese children than population average; small sample size | Boyland (2020) (ref. in Koletzko (2021)) |
| Yau et al. (2022) | Quasi-experiment and CITS | London Underground ad ban reduced calorie consumption from HFSS foods | n = 1970 | *Not applicable* | *Not applicable* | On average, ~1000 kcal less consumed pw per hh; 200 kcal less in households with children | Sig. effect for general households, no data for households with children | Comparability of experimental and control groups unclear (essential in this study design) | Used to confirm ad ban in London; great media response |

[9] A descriptive epidemiologic study in which data are analyzed at the level of populations or population groups rather than at the individual level.

# 8. Conclusion and Outlook: Recommendation for a Scientific Study as a Basis for Evidence-Based Policy.

This report has comprehensively demonstrated that no scientific-statistical basis exists in the literature to support a causal impact of advertising foods on children's health that do not meet the requirements of the WHO Nutritional Profile model for Europe in terms of their sugar, salt or fat content (WHO, 2015, 2023). In fact, this relationship has been scarcely investigated. The object of investigation of current research is only the time-limited immediate consumption of HFSS foods by children after their exposure to HFSS food advertisements and not possible medium- and long-term health effects of this. Furthermore, the majority of all studies in the literature are subject to extensive limitations with respect to reliably estimating the long-term impact of advertising. These include a too small sample size and too short duration of the study as well as only selective reporting of the results.

According to the assessment of the authors of this scientific opinion, the conditions for an evidence-based ban on certain HFSS food advertisements are not met for these reasons. Following calls in the literature, a more in-depth and longer-term investigation of the relationship between food advertising and children's health is therefore recommended (Boyland et al., 2016; Kovic et al., 2018; Sadeghirad et al., 2016; Smith et al., 2019; Yau et al., 2022).

Due to the limitations of all current studies explained in the previous chapters and the resulting insufficient state of research, it is imperative to conduct a comprehensive and scientifically sound study to evaluate the scientific evidence for a potential advertising ban. An appropriate study investigating the impact of HFSS food advertising on children's health should possess the following characteristics:

First and foremost, the use of a randomized controlled trial (RCT), which is considered the gold standard of medical studies, is necessary. This involves randomly assigning participants to a control group and an experimental group. To prove causality, it is necessary – as described in the chapter on Causality – to conduct a long-term study that goes beyond the duration of the existing experiments of a few minutes to a few hours. A period of at least a few months to, as recommended by the DGE, years seems reasonable in this context: "For the evaluation of primary preventive effects with regard to diet-related diseases, however, a study duration of at least one year, preferably several years, is necessary" (Deutsche Gesellschaft für Ernährung e.V., 2014, p. 10). This enables the comprehensive recording of the subjects' diet as well as controlling for further factors influencing their health on an individual level. These include the lifestyle, the amount of exercise, the socioeconomic status, and the genetics (presence of chronic diseases) of the test subjects as well as the lifestyle of their parents.

In addition, the study should measure certain health indicators (e.g., BMI) at regular intervals to document the dependent variable health over time. In this context, it is important to focus on the actual health of the participants as the dependent variable, rather than just the increased consumption compared to the control group, as is currently common practice. HFSS advertising consumption should act as the independent variable, which differs between the control and experimental groups and is measured. Using appropriate technology, control, and variation of advertising on the study participants' electronic devices, although not simple, is possible. At the very least, exposure of the control group to HFSS advertising should be limited as much as possible; billboard advertising in public spaces, for example, is difficult to banish. Ideally, the stimulus "advertising HFSS products" should be integrated in the participants' everyday life as much as possible and no selection of such products should be provided beyond their everyday exposure to HFSS foods – unlike the current typical study design in the literature, which usually allows children to consume unlimited amounts of food during the experiments. If children have their own budget with which they can easily purchase food, then they should continue to do so in the study. However, if parents largely determine children's consumption habits, then children should not suddenly have access to a wide range of HFSS snacks.

In conclusion, it should be mentioned that evidence-based policy requires the systematic analysis and integration of as many empirical findings from high-quality scientific research as possible to answer a specific question. Accordingly, the study recommended here represents only the beginning of the investigation of advertising effects on children's nutrition. To derive political decisions and achieve true evidence-based policymaking, undoubtedly multiple high-quality studies are necessary.

## Literature


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# Glossary

## A

**"Accountability"** (Ethical Principle for Health Promotion and Public Health No. 10)

Accountability for:

- Actions and outcomes
- Making good use of/fostering/safeguarding/conserving financial, human, and other resources/the environment
- Operating in accordance with ethical principles

Involves 5 dimensions of governance:

1. Health governance
2. Financial governance
3. Staff governance
4. Environmental governance
5. Ethical governance

(Tannahill, 2008, p. 386)

**Advergame**

Advergames are computer games or cell phone games in which the manufacturer links brand logos, the product itself or design aspects or characters associated with the product or brand. Children then "learn" through play how to deal with the product or brand. This type of game is generally free.

**Alpha error/Type I error**

Refers to an incorrect decision in statistical tests. When testing a hypothesis, an error of Type I occurs when the null hypothesis is rejected although it is in fact true (based on false positive results). The probability of this corresponds to the ***significance level*** of usually <5%.

## B

**BMI (Body Mass Index)**

The body mass index (BMI) is the most common formula for evaluating body weight. It results from the ratio of the body weight in kilograms and the height in meters squared. The German Nutrition Society (Deutsche Gesellschaft für Ernährung - DGE) distinguishes between five categories: Underweight, normal weight, overweight, extreme overweight (obesity) and massive obesity. However, the BMI has weaknesses in that it does not consider age and gender, as well as physical activity and muscle mass.

## C

**Causality**

Causality describes the relationship between cause and effect, i.e., a change in one variable (A) results in a change in another variable (B). Thus, A causes or is causally related to B. Causality implies a ***correlation*** of both variables, but this does not apply vice versa for correlation.

**Confounding factor**

A confounding factor or confounder is a variable that influences a relationship between two other variables, being correlated with them. In this case, the independent variable does not solely influence the dependent variable. The observed effect is at least partially attributable to a confounder.

**Control group**

In experimental research, control group refers to the group of study participants who are untreated or treated according to a usual treatment concept (treatment as usual), but in all other respects identical with the subjects of the treatment group. In the specific case of the studies on advertising effects of HFSS products in children, the control group gets to see either no advertising or only advertising that does not promote food.

**Controlled Interrupted Time Series Analysis (CITS)**

This is a quasi-experimental study design in which time series data are subject to an intervention at a specific time point. The data before and after the intervention are compared and additionally matched with a control group that was not exposed to an intervention. This ensures that a possible trend in the experimental group is detected, even if it has nothing to do with the intervention.

**Convenience Sample**

Convenience sampling is a sampling method in which subjects are selected for their convenient accessibility and proximity to the researcher. Accordingly, the resulting sample is not random. The results of a study based on convenience sampling cannot be generalized (low ***external validity***).

**Correlation**

Two metric variables are called correlated (correctly: positively correlated) if they systematically run in the same direction. If one increases, so does the other; if one decreases, so does the other. Not in every individual case, but overall. An example is height and weight: the taller a person, the more it weighs. Not in every individual case, of course, but overall. Two variables, on the other hand, are called negatively correlated if they systematically move in the opposite direction. Important: Correlation does not imply ***causality*** (see ***ecological fallacy***).

# D

**"Do not harm"** (Ethical Principle for Health Promotion and Public Health No. 2).

Besides positive effects, actions or interventions may also have negative effects on certain individuals. There may be a need to appropriately balance harm and benefits to the population. Measures to mitigate potential harms should be identified as feasible (Tannahill, 2008, p. 386).

# E

**Ecological Fallacy**

Ecological fallacy is the term used when incorrect conclusions are drawn from aggregate data. An example can be found in chapter 6.8 on page 45.

**Experiment**

Different types of experiments can be distinguished. Laboratory experiments allow extensive control of possible confounding variables whereas field experiments take place in the "natural" environment.

Randomized experiments are characterized by a randomized distribution of the subjects to the experimental and control groups. In quasi-experiments, pre-existing characteristics of the subjects (e.g., daily television viewing or geographic location) determine whether they are counted as part of the experimental or control group.

In medicine, experiments are usually referred to as clinical trials (which can be interventional or observational studies).

**External validity**

Describes the generalizability of a study's results beyond the sample (to the entire ***population***).

# H

**HFSS**

Refers to products that are "high in (saturated) fat, salt or sugar" (short: HFSS)

# K

**kcal**

Calorie (unit symbol cal) is an (obsolete) unit of energy. According to a common definition, a calorie is the amount of heat required to increase the temperature of 1 gram of water by 1 degree Celsius (under certain conditions). Nowadays, calories are mainly used to indicate the physiological calorific value of food. When calories are referred to colloquially, usually kilocalories are meant (1 kcal = 1000 calories). However, the new common SI unit is joule (J) / kilojoule (kJ) (1 kcal = 4.2 kj).

# L

**Linear regression**

Linear regression attempts to predict the values of one variable using one or more other variables. The variable to be predicted is called dependent variable. The variables used to predict are called predictors or independent variables.

To predict the dependent variable, its relationship with the predictors is examined. The closer the relationship, the better is the prediction of the dependent variable. In linear regression, however, only linear relationships are considered. If several independent variables are examined in the model, it is called a multivariate linear regression.

# M

**Meta-Review**

A meta-analysis (meta-review) is a summary of primary research on metadata that uses quantitative and statistical means. It attempts to summarize and present previous research quantitatively or statistically. The difference to the systematic review (also called "review" or literature review) is that a review critically examines the previous research data and publications, whereas the meta-analysis only includes the quantitative and statistical processing of the previous results.

# N

**Normal distribution (test for…)**

The normal distribution is an important type of continuous probability distribution and is used to represent frequencies of data and observations. It is called Gaussian distribution (after the German mathematician Carl Friedrich Gauss) or bell curve due to the course of the graph. The special significance of the normal distribution is based, among other things, on the central limit theorem, according to which distributions that result from the additive superposition of many independent influences are approximately normally distributed under weak conditions.

# R

**Randomized Controlled Trial (RCT).**

In an experiment, there are two or more groups – usually a control group and at least one treatment group. The treatment group receives the intervention or manipulation, while the control group is held constant.

If study participants are randomly assigned to the control or experimental group, the trial is called a randomized controlled trial (RCT).

# S

**Significance level**
The significance level or probability of error is the maximum probability, defined before a hypothesis test, that the null hypothesis is rejected based on the test results, although the null hypothesis is true (***alpha error/Type I error***).

**Standardized mean difference (SMD)**
The Standardized Mean Difference (SMD) is used as an effect measure in meta-analyses. The common calculation is via Cohen's d. The larger the effect size, the larger the difference between the average individual of the groups studied.

**Statistical significance**
Statistical significance indicates how likely it is that a result is based on chance. Significance is usually indicated by a p-value. The ***significance level*** to which the p-value is compared is determined by the researchers themselves and is usually 0.05 or 0.01. If the p-value is smaller than the selected significance level, the result is said to be statistically significant.

**Sample**
A sample is a subset of the ***population*** selected based on certain criteria. The aim of scientific studies with samples that are as random (representative) as possible is to obtain knowledge about the entire population from which the sample originates.

# P

**Population**
Set of all objects from which a conclusion is to be drawn. The ***sample*** is taken from the population but is usually only a subset. Example: The population of the studies in this report is usually all children in Germany of a certain age.

**Primary prevention**
Disease prevention that begins before the onset of the disease and aims to prevent an illness from occurring in the first place. Primary prevention is aimed at risk groups, healthy people, and people without symptoms of disease.

**Publication Bias**
Publication bias occurs because studies with statistically significant or positive effects are published more frequently in peer-reviewed journals. In addition, selective reporting of results, manipulation of data or methods of analysis, and pressure to confirm pre-existing hypotheses can also contribute to publication bias (Thornton & Lee, 2000). This undermines the goodness-of-fit criteria of statistical tests, i.e., random effects are disproportionately reported (Schüller, 2015, p. 111). Publication bias results in studies with invalid or negative results being underrepresented, which can distort the available evidence base and in turn lead to inaccurate or biased conclusions. In fact, the statistical significances reported in the relevant studies, in terms of probabilities of falsely positive effects (*false positives*), are in fact much larger than the 5% or 1% used as the basis for

hypothesis testing. See also chapter 5 Publication bias.