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THE IMPACT OF FOOD MARKETING ON CHILDREN'S DIETARY BEHAVIOUR: A SYSTEMATIC REVIEW

MASTER THESIS

Submitted by

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ABSTRACT

Background: The prevalence of childhood obesity has grown to an alarming rate globally and marketing of unhealthy foods is a contributor to the obesogenic environment which is a key driver of the rising rates of childhood obesity. The food industries have targeted children in the past few years and have viewed children as future potential consumers. Evidence has shown that food marketing has severe and long-lasting impact on children's dietary behaviour.

Purpose*:* This review aims to explore evidence of the impact of food marketing on children's dietary behaviour as well as explore existing policies and strategies restricting marketing of unhealthy food to children.

Method*:* A comprehensive search of electronic databases (Medline, Cochrane Library, Web of Science, SCOPUS) was conducted and supplemented with manual searches of articles from reference lists of identified articles. Primary studies (experimental and non-experimental) assessing effect of food marketing on children's dietary behaviour were included in the review. Secondly a document analysis for existing policies and strategies restricting child-targeted food marketing was conducted. The quality of the studies was assessed for risk of bias, the results were synthesized, and the review was reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA).

Results: Twenty-seven studies met the inclusion criteria. The study design was heterogenous including 16 experimental, 8 Cross-sectional and 3 Cohort studies which provided data on 40156 participants aged 2 to 18 years. Out of 27 studies 26 demonstrated significant association between the different exposure variables (television, internet-advergames, peer video, media character on packaging) and outcomes (food intake, preference, purchase request, brand recognition). One study found no significant associated association between Television food advertising and increased food intake.

Countries like the UK, Ireland, among others have set policies and regulations restricting child-targeted food marketing among which include prohibition of marketing of any unhealthy food in school environment as well as banning of unhealthy food marketing on children's television programme, and on movies.

Conclusion: Evidence to date shows that acute exposure to food marketing increases food intake, preference and purchase request for advertised food in children. Regulations and Public health policy to reduce exposure of children to unhealthy food marketing need to be strengthen.

Key Words: Children, Food marketing, Food intake, Dietary behaviour, Obesity.

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LIST OF ABBREVIATIONS

AHA	American Heart Association
ANGELO	Analysis Grid for Environments Linked to Obesity
AXIS	Appraisal Tool for Cross-Sectional Studies
CASP	Critical Appraisal Skills Program
CVD	Cardiovascular Disease
DCP	Disease Control Priorities
HFSS	High in Fats, Sugar and Salt
IASO/IOTF	International Obesity for the Study of Obesity/International Obesity Task Force
NGO	Non-Governmental Organisation
PRISMA	Preferred Report Items Systematic Reviews and Meta-Analyses
RCT	Randomised Controlled Trial
ROB-2	Revised Cochrane Risk of Bias Tool for Randomised Controlled Trial
TV	Television
US/USA	United States of America
WHA	World Health Assembly
WHO	World Health Organisation

DEFINITION OF TERMS AND CONCEPTS

Childhood/Adolescence: "Childhood" is the period of life between infancy and onset of puberty and is usually between 2 -10 years inclusive. While "Adolescence" is that period of life between onset of puberty and adulthood exclusive (11/12-18 years): In this review, childhood is considered between 2-18years.

Overweight/Obesity: "Childhood Obesity" refers to BMI equal to or above the age-gender-specific 95th percentile of the growth chart in Children. "Overweight" refers to BMI equal or greater than 85th percentile but less than the age-gender specific 95th percentile of growth chart[1].

Dietary Behaviour: Dietary/Eating behaviour is a broad term that encompasses food choices and motives, feeding practices, dieting, and eating-related problems such as obesity, eating disorders, and feeding disorders. This review focuses on food choices, motives, and feed practices[2].

Marketing: According to World Health Organization "marketing" refers to any form of commercial communication or message that is designed to, or has the effect of, increasing the recognition, appeal and/ or consumption of particular products and services[3,4].

Advertising: Advertising is the 'paid public presentation and promotion of ideas, goods, or services by a sponsor that is intended to bring a product to the attention of consumers through a variety of media channels such as broadcast and cable television (TV), radio, print, billboards, the Internet, or personal contact[3].

In this review the terms "Marketing" and "Advertising" were used interchangeably

Unhealthy Food: There is no single definition of unhealthy foods. For example, WHO describes unhealthy foods both in broad terms, as "energy-dense, nutrient poor foods and sugar-sweetened beverages" (WHO, 2016), and more specifically as foods high in saturated fats, trans-fatty acids, free sugars or salt (WHO, 2010). The latter definition is often abbreviated as HFSS foods (WHO EURO, 2016). To define and classify unhealthy foods with the purpose of e.g. restricting food marketing, the use of nutrient profiling schemes has been recommended (WHO, 2010).

Obesogenic Environment: Obesogenic environment refers to any condition, opportunity, surrounding or any characteristic that acts as a barrier to maintaining a healthy weight[5,6].

INTRODUCTION

1.1 Background

Childhood obesity is one of the most serious public health challenges of the 21st century with global trends reaching alarming proportions such that overnutrition rivals undernutrition as chief food problem even in developing countries[7].

Globally, according to IASO/IOTF, up to 200 million school-aged children are estimated to be either overweight or obese with a 10-fold increase from 11 million in 1976 to 124 million in 2016[1]. The number of overweight and obese children below age of 5 increased globally from 32 million in 1990 to 41 million in 2016, and if appropriate actions are not taken, this trend is projected to increase to 70 million by 2025 (WHO,2017)[8]. Lobstein and Jackson-Leach (2016) estimate that in 2025, the prevalence of overweight and obesity will increase from approximately 14% to 16%[9]. Currently in the US, 1 in 3 children is afflicted with either overweight or obesity[9].

Reports show that overweight or obesity accounts for at least 2.6 million deaths per year worldwide[10]. Studies have also shown that, without intervention, childhood obesity tracks strongly into adulthood, and this comes along with multiple comorbidities such as premature death, disability, as well as non-communicable diseases that often do not become apparent until adulthood[7]. Moreover, obesity does not only affect the health-related quality of life of those affected but also places a large strain on the health care system with an estimated economic burden of 19000 USD/ obese child[11].

Obesity is a multifactorial condition usually associated with energy imbalance that results from a complex interaction among a set of factors related to the environment, genetics, lifestyle, and individual behaviour[12]. It is well documented that genetic factors are non-modifiable whereas environmental and individual factors (lifestyle/behaviour) are the game changers in the global epidemic of obesity. Swinburn and colleagues highlighted two key contributors to the growing prevalence of childhood obesity and overweight[10]: On one hand the micro-obesogenic environment which include local settings like schools, home/family, and community with which individuals directly interact and these micro obesogenic environment are in turn influenced by broader macro-obesogenic environment and actors such as

government policies, food industries, and health care systems which are often beyond control of individuals making it extremely difficult to address individual factors without considering the context in which food related decisions are being made[6].

Globally, marketing of high-sugar, high-fat foods to children has been identified as a risk factor for childhood obesity and there is growing evidence that, children's food preferences, purchase requests/power, and consumption are influenced by exposure to child-targeted food marketing[13]. In recent years, the food industry has viewed children and adolescents as a major market force and they are now the target of intense/specialized food marketing because of their spending power, purchasing influence, and are seen as future adult consumers[7]. The extent of food marketing targeting children is striking with the use of multiple channels to reach youths beginning when they are toddlers, to foster brand-building and influence purchase. These marketing channels keep on growing from television advertising, billboards, in-school marketing, product placement, kids' clubs, internet, toys, brand logos, celebrity brand-ambassador, youth-targeted promotions, internet-based advertising to mobile phone apps and video-games[8]. In addition, the content of the food marketed to children also alarms health experts due to its high-fat, high-sugar and/or salt contents which are inconsistent with national dietary recommendations.

Evidence has shown that child-directed food marketing results in two main obesity related effects: firstly, reduction in energy expenditure usually linked to screen time and secondly increase in energy intake[14]. Controlled studies on children choices/preferences have consistently shown that children who are exposed to advertising, choose advertised food products at significant higher rates and are prone to consume similar products in the same category compared to those not exposed[15,16]. This beyond brand phenomenon of food marketing suggests that, when an individual is exposed to commercials, it primes their desire to eat all foods within the same category[17].

Despite regulations to restrict marketing of unhealthy foods, children are still exposed significantly to more advertisements for foods high in saturated fats, trans-fatty acid, free sugar or salt (HFSS) than those that promote high nutrient and low-calorie alternatives[18]. This presents a significant problem for health professionals attempting to instil healthy eating programmes at population level. Ample evidence suggest that less than 1% marketed foods are of high-nutrient, low calorie. The figure below depicts the reality of children-targeted food

marketing[6]:

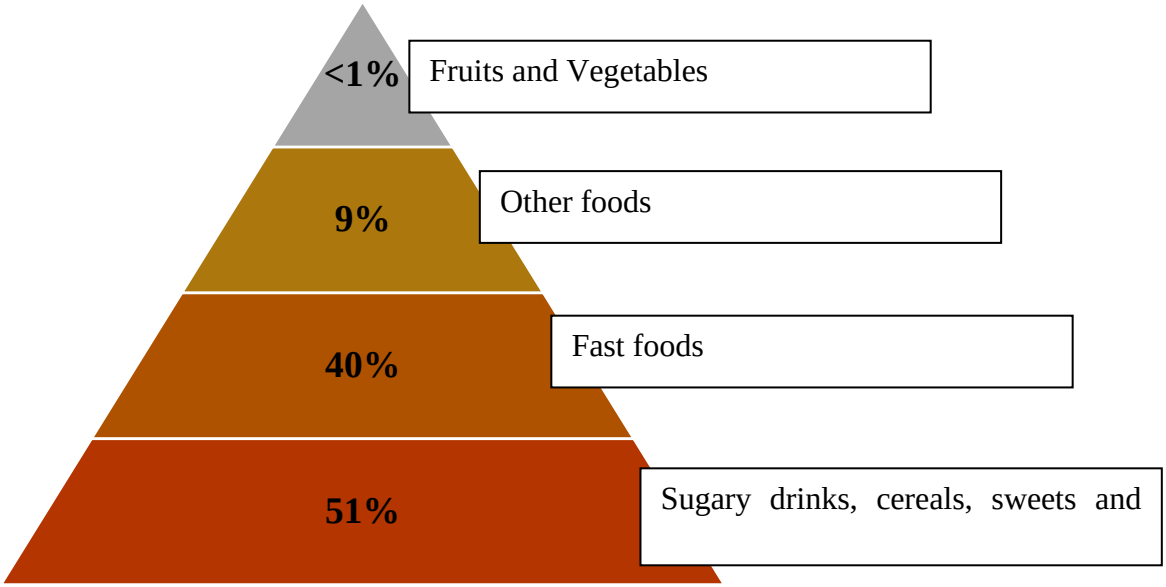

Figure 1:Extent and Content of Food marketed to Children

1.2 Problem statement

In 2010, the WHO published a set of recommendations for the marketing of food and non-alcoholic beverages to children that was endorsed by the 63rd World Health Assembly (WHA 63.14)[19]. Later in 2016, a report by the commission on ending childhood obesity noted with concern the failure of member states to give significant attention to the WHA 63.14 resolution[19]. This failure was attributed to the multifactorial origin of obesity which discourages action from member states because institutions such as the food industry and government can claim exemption from responsibility[20]. On the other hand, parents are often considered to have the responsibility to make healthy nutritional choices for their children, however the current food environment which should support and enable parents make healthy choices stand as barrier to choose and buy healthy foods[21].

It is important to note that, rapid increase in prevalence of childhood obesity cannot be attributed to genetic changes or worldwide failures in personal responsibility and neither can children themselves be held accountable for this unfortunate development.

Childhood and adolescence are significant developmental life stages during which health behaviours are often established and become habitual[22], as a result, reducing the extent and persuasive power of marketing unhealthy foods to children worldwide are important obesity prevention goals.

1.3 Justification

It must be acknowledged that a few systematic reviews have analysed the effects of food marketing on children's dietary behaviour. However, these reviews did not comprehensively address all food marketing channels but focused on only one marketing media/channel (Television advertisement) leaving out other marketing channels (bill boards, placement, internet, video games) which have shown to have great influence on children's dietary behaviour[10,15,23,24]. Sonntag D. and colleagues addressed all marketing channel but limited their search strategy to European and US based studies and also focused on studies which enrolled only children between 3 and 11 years of age[10]. Based on consumer development research, it is true children younger than 8 years are more influenced by advertising since they do not possess the cognitive abilities to understand the biased view behind food marketing[22]. Recent studies have shown that older children and adolescents are as well greatly influenced but in less direct ways like sponsorship of sport events, promotion

by celebrities, and brand logos[25,26]. Secondly it should be noted that low- and middle-income countries are presently experiencing faster increase in prevalence of overweight and obesity compared to high income countries[8].

Moreover, no study has been carried out to gather evidence of regulations/policies that have been put in place to restrict the food marketing to children both in terms of quantity and quality.

Considering the above shortcomings, an understanding of how exposure to food marketing through any media channel affects children's food related behaviours and ultimately contributes to obesity is deemed necessary to provide evidence to inform policy decisions for appropriate actions.

This study will contribute to knowledge, raise awareness on the consequences of child-directed food marketing, and secondly, provide evidence of regulations and policies/strategies which have been successfully implemented to restrict marketing of unhealthy food to children which will serve as baseline lessons for other countries.

1.4 Aim of study

This review aims to gather and summarize existing evidence on the effects of unhealthy food marketing on children's dietary behaviour as well as explore existing policies and strategies to limit marketing of unhealthy food to children in order to inform and guide public health practitioners/policy makers in supporting a society that promotes healthy eating behaviours and to curb the growing childhood obesity burden.

1.5 Research questions

This review will be designed in a bid to answer the following research questions:

- How does food marketing influence children's dietary behaviours?
- What strategies, regulations and policies exist in limiting marketing of unhealthy foods to children?

1.6 Research objectives

- To explore with a literature review of evidence the effects of food marketing on children dietary behaviours.

- To explore with document analysis current strategies, regulations and policies used to limit children directed food marketing.

1.7 Research scope

Although many factors can be understood to influence children's dietary behaviour, this study only focused on food marketing. Hence other factors that affect dietary behaviour were beyond the scope of this study. Secondly only a summary of existing strategies and policies to limit marketing of unhealthy food to children were addressed, therefore an in-depth analysis of obesity prevention policies was beyond the scope of this study.

THEORETICAL FRAMEWORK AND CONCEPTUAL FRAMEWORK

2.1 The obesogenic environment

Defining the obesogenic environment is in itself complex as the factors that influence individual weight are many and varied. This creates difficulties in identifying opportunities for action, and at what level, to create supportive environments for obesity prevention[7]. Hence an articulation and understanding of appropriate theoretical frameworks surrounding obesity is deemed necessary to guide preventions efforts. Indeed, a proposed definition and framework appeared in 1999 when Swinburn et al described the 'obesogenic environment' as '**the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations**', or simply put, **any characteristic that acts as a barrier to maintaining a healthy weight**[5]. Accompanying this definition was a comprehensive framework for conceptualizing the obesogenic environment and prioritizing potential areas for intervention, called the Analysis Grid for Environments Linked to Obesity (ANGELO)[27]. This framework dissects the environment on two dimensions: size (micro or macro) and type (physical, economic, political and socio-cultural).

Micro-environmental settings are those where groups gather and that relate to food, physical activity or weight. These settings are usually geographically distinct, relatively small and influenced by individuals. As the most frequently researched environment 'size', the concept of the microenvironment allows us to investigate factors related to individuals or groups in a clearly defined setting such as schools, workplaces, homes and neighbourhoods[5].

Macro-environmental sectors are groups of industries, services or supporting infrastructure that may influence diet, physical activity or weight. These are usually geographically diffuse, large and influenced by private and public sectors[5]. Each environmental size consists of four possible dimensions. The physical dimension (e.g. what is available) is the most commonly studied and has also been defined as the summation of urban design, land use and transportation systems. The economic dimension includes factors such as food insecurity, income and education. The political dimension comprises factors that shape regulations for any age group at the micro- or macrolevel (e.g. rules or policies). Lastly, the socio-cultural dimension explores context and includes factors such as neighbourhood crime or social support from family and/or friends for healthy behaviours. The strength of using ANGELO is that all environmental

elements are considered, while providing a relatively simple characterization of an immeasurably complex entity[5].

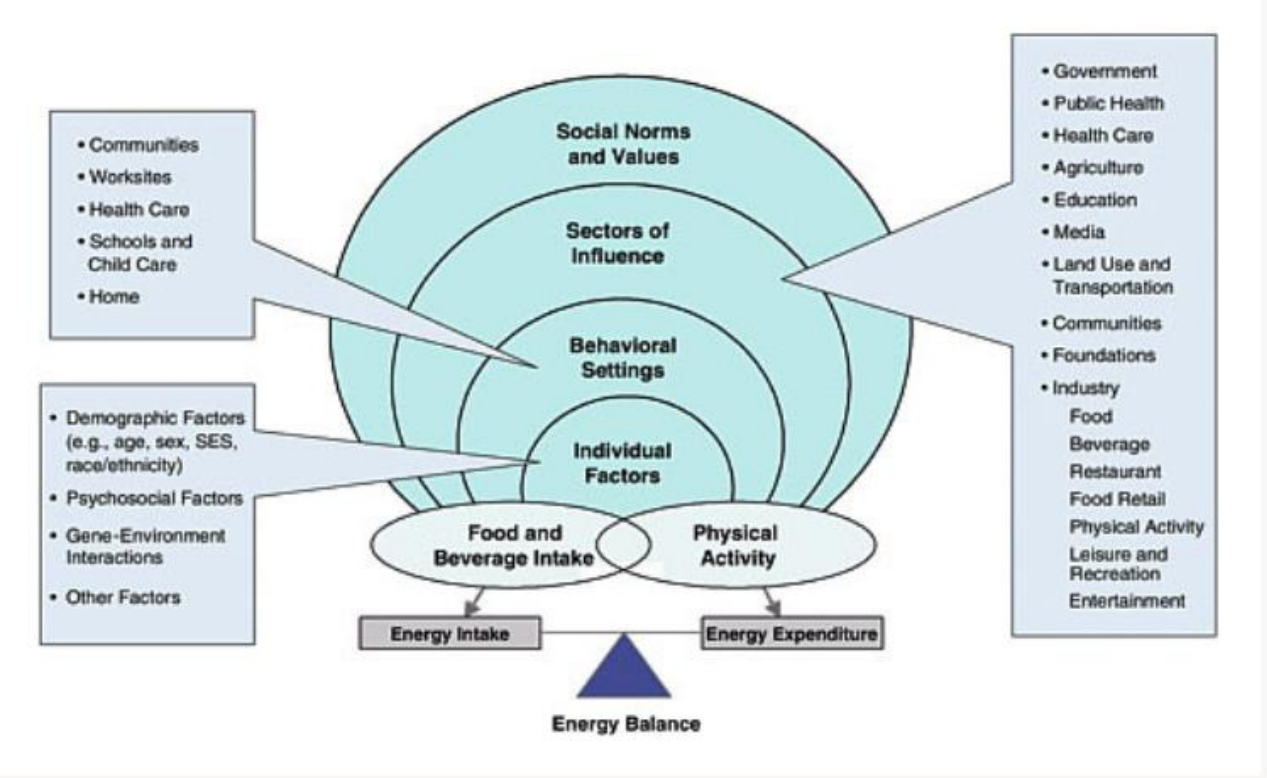

Figure 2:The Obesogenic Environment

2.2 Different perspectives on the causes of obesity

There are different perspectives on what causes obesity, and several governance actors object to the concept of food environments as a structural factor that contributes to unhealthy diets and obesity. Public health actors tend to describe obesity as a structural problem where overweight and obesity in populations is a normal response to unhealthy or obesogenic food environments[12]. On the other hand, food industry and marketing actors commonly explain causes of obesity as issues of self-control, individual lifestyles and especially lack of physical activity[28]. There is strong evidence that unhealthy food environments undermine the ability of individuals to choose healthy foods[19]. For example, Cohen et al explains that unhealthy food environments stimulate automatic responses that increase energy intake without peoples' conscious awareness, thereby driving the obesity epidemic[29].

Even if important organisations like WHO apply a systems approach to obesity, obesity seems to be a challenging policy issue with political and moral implications, being referred to as for example "a wicked policy problem"[30].

2.3 Diet as a cause of childhood obesity

In the simplest sense, overweight and obesity is a result of expending too little energy in relation to how much energy is consumed[8]. Multiple factors contribute to obesity, including physical inactivity, societal and cultural factors, and to some extent genetic predisposition[5]. The focus in this thesis is on the contribution of unhealthy diets, which is regarded as one of the major causes to obesity worldwide.

Unhealthy diets are described as diets low in fruit and vegetables but high in unhealthy foods like fast food and sugar-sweetened beverages[12]. Unhealthy foods are high in energy and frequently low in fibre and protein, so that they are less satiating than healthy, low-energy foods. Because they are often highly palatable, they challenge the intake of healthy foods and contribute to increased energy intake. Children are particularly susceptible to unhealthy foods because they have a strong preference for sweet taste[22]. Thereby, unhealthy diets contribute to a positive energy balance that subsequently causes overweight and obesity in adults and children[4].

2.4 Food environments as determinants of unhealthy diets

The food environment is an important determinant for unhealthy diets[5,6]. Swinburn et al state that the food industries have a central role in forming food environments by determining the food supply, marketing their food and affecting social norms[31]. Governments, from global to local levels, provide laws and regulations that set the limits for the food industries' operations[20]. Governments can also impact societies and social norms by promoting health. Lastly, societies establish cultural norms for food and cuisines. The three actors also interact at several levels, for example when the food industry lobby to impact food policies that affect them[31].

Children have several characteristics that make them susceptible to unhealthy food environments, e.g. an innate preference for sweet tastes and a lack of nutritional knowledge[32]. In the context of child obesity and unhealthy diets, it is often maintained that parents have the responsibility to take healthy nutritional choices for their children[9]. However, Lobstein et al. (2015) argue that food environments should support and enable parents to make healthy choices and that current food environments often are barriers to choose and buy healthy foods[9]. It can also be argued that food environments target children directly, for example in the case of food marketing.

In this thesis, the concept of food environments and their consequences on diets builds on a conceptual framework developed by Swinburn et al., where food environments are defined as:

"The collective physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status." [31].

Food environments interact with individual factors to affect food choices and diets[12]. Unhealthy food environments are characterised by widely available, heavily promoted, inexpensive unhealthy foods[33]. Unhealthy food environments are also referred to as obesogenic because they promote unhealthy diets, excess energy intake and subsequently drive overweight and obesity in populations[27]. Food environments encompass four dimensions[31]:

1. Physical: the availability, accessibility and promotion of food

2. Economic: the cost of food

3. Policy: rules and regulations concerning food

4. Socio-cultural: populations' norms and beliefs concerning food.

Figure 3 depicts how food environments are mainly formed by the actions of three groups of **governance** actors: food industry, governments and society. A dotted line not originally included in the model by Swinburn et al. has been added to suggest that food marketing may also have an impact on individual factors like preferences.

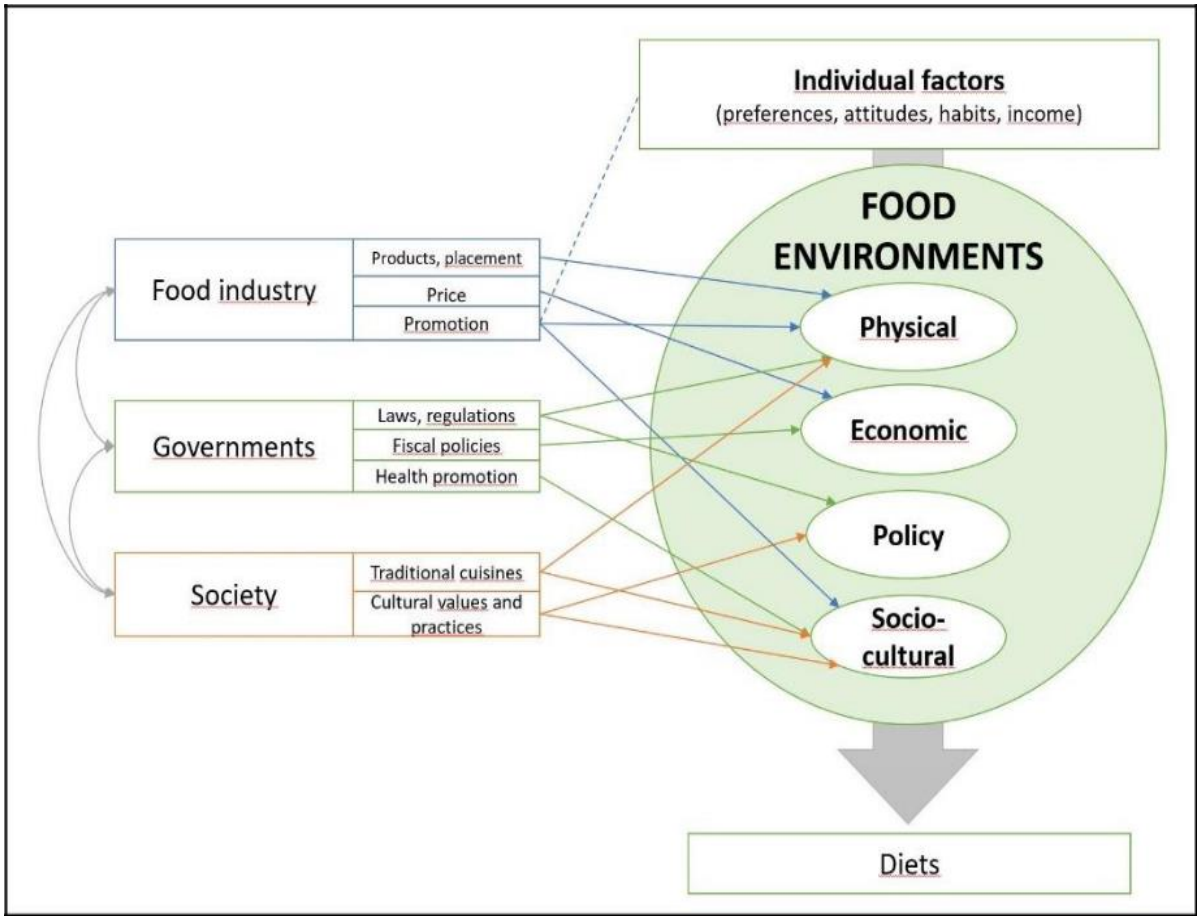

Figure 3: Conceptual framework of factors influencing food environments and diets. The figure is adapted from Swinburn et al. (2013)

2.5 Defining marketing and advertising

When discussing food and beverage marketing and advertising to children, it is important to distinguish between these terms. In this context, the World Health Organization has defined marketing as 'any form of commercial communication or message that is designed to, or has the effect of, increasing the recognition, appeal and/ or consumption of particular products and services[3,4]. It comprises anything that acts to advertise or otherwise promote a product or service.

Advertising, on the other hand is the 'paid public presentation and promotion of ideas, goods, or services by a sponsor that is intended to bring a product to the attention of consumers through a variety of media channels such as broadcast and cable television (TV), radio, print, billboards,

the Internet, or personal contact'. According to this definition, advertising therefore is only one form of marketing[4].

Integrated marketing campaigns employ a range of techniques across different media platforms, designed to assure that all activities produce a unified and customer-focused promotion message. This may include sponsorship, product placement and branding, direct marketing, product design and packaging, and point-of sale promotions[34]. An example of an integrated marketing strategy would be a food brand with an on-pack promotion of a multi-platform (PC, mobile phone) brand-promoting game (advergame), accompanied by a YouTube video that promotes the branded game and opportunities to share game scores on Facebook and Twitter[4].

2.6 Marketing strategies and techniques

Marketing communication is based on two main elements: the communication channels, which influence the exposure to a specific marketing message, in turn dependent on its reach and its frequency, and the content of the communication message, including the creative strategies used, which influences the power (WHO 2012) of the marketing communication[3]. As a result, the effectiveness of a marketing communication depends on both its exposure and power; these are also the main elements targeted by the various policy recommendations and implemented policies designed to address the issue of food marketing to children.

2.7 Food marketing aimed at children

Food marketing constitutes an important factor that contributes to food environments and unhealthy diets. According to WHO, children is an important target group for food marketers[4]. They can affect product sales positively in three ways; by influencing household food expenditure, by having independent purchasing power, dependent on age, and by constituting a future adult market. Thus, building brand loyalty from early age is a valuable investment for food companies[35].

A distinct majority of food marketing to children promotes foods high in fats, sugar or salt (HFSS foods), like sugar-sweetened soft drinks, sweet or savoury snacks and fast foods[36]. Food marketing has been internationally acknowledged as an important, modifiable risk factor for childhood obesity due to its ability to change children's dietary behaviour, purchase requests and consumption patterns[26]. Children are regarded as susceptible to food marketing because they do not have the cognitive capacity to understand the intent behind food marketing and to resist such marketing[22]. Also, children cannot take informed choices regarding nutrition and will often prioritise short-term enjoyment over long-term negative health impacts[37]. WHO (2016) also suggests that food marketers, particularly in digital media, employ strategies that stimulate emotional responses that are processed differently than cognition and that are subsequently harder for children to recognise and resist[4,33].

The effectiveness of marketing depends on interaction of two factors: exposure and power[3]. Exposure includes the reach and frequency of a marketing message, meaning how many of the target group are exposed to the marketing and how often they are exposed to it. Exposure will also depend on the choice of the communication channel, e.g. television, product placement or computer games. Power means how well the marketing affects the target audience and is influenced by the marketing content and creative strategies used to promote the product, e.g. colours, imagery and branded toys[3]. Power is sometimes equated with persuasiveness and persuasive power.

2.8 The role of civil society in the context of food marketing

Civil society organisations, NGOs and academics can have important roles in monitoring marketing practices among food businesses[24]. Such actors have for example addressed weaknesses in self-regulatory initiatives and emphasised the lack of accountability mechanisms for business marketing conduct. Also, civil society may have important roles in supporting

governments to restrict food marketing, advocate for strengthened accountability systems, and building public support for regulations that limit food marketing [8].

2.9 Human rights, child obesity and food marketing

In the human rights system, states or governments have the obligation to respect, protect and fulfil the human rights of its citizens[38]. The **obligation to respect** imply that states must refrain from interfering with the human rights of individuals or groups. The **obligation to protect** means that states must prevent third parties, like corporations, from violating human rights. Finally, the **obligation to fulfil** requires states to establish systems that enable the enjoyment of human rights[38]. There has been growing recognition of the fact that states are not the only actor that may violate human rights. The business sector has a potential to impact human rights negatively for individuals or groups in a variety of ways[39].

METHODOLOGY

3.1 Study design

The study was a systematic literature review which assessed existing evidence on the effects of food marketing on children's dietary behaviour as well as existing evidence on policies and strategies to limit unhealthy food marketing to children.

3.2 Study period

The study was carried out over a period of 8 months (July 2019 – March 2020)

3.3 Study Population and Eligibility Criteria

Our targeted population was children aged 5 to 18 years. Hence only studies targeting this age group were considered eligible.

3.3.1 Inclusion Criteria

The following studies were included:

- Quantitative/Qualitative studies (primary studies) with data on the effects of all forms of food marketing on children's dietary behaviour.
- Quantitative/Qualitative studies, reviews, grey literature, and reports with data on strategies and policies to limit marketing of unhealthy food to children.
- Articles published between January 1947 (earliest date of databases) and October 2019.
- Articles published in French or English.
- Primary studies from allover the world (No geographical limitation).

3.3.2 Exclusion Criteria

The studies excluded were:

- Articles focusing on the effect of food marketing on dietary behaviour in adults.
- Articles with proposed strategies and policies addressing other risk factors of childhood obesity other than food marketing

3.4 Information Sources

The databases searched for relevant articles included: Medline via Pubmed, Web of Science, SCOPUS, Cochrane Library, and website of research organisations such as Disease Control Priorities (DCP), and WHO-CHOICE were also searched for grey literature. Furthermore, the reference lists of eligible articles were screened to further compliment the databases. Articles retrieved from the search were then saved on the Zotero referencing manager.

3.5 Search Strategy

A comprehensive search of literature databases was conducted from 1st to 10th of November 2019 (date of last search). A search strategy was designed to address each key research question. This was done as follows:

Firstly, key concepts were derived from each research question and their respective synonyms obtained through a trial search on Google Scholar, Wikipedia, and Google. Each key concept and its synonyms (MesH terms) were then combined in an advanced search using Boolean Operators (OR, AND, NOT). The developed search terms were searched using advanced search on Medline database and these terms were thereafter adapted to other databases.

3.5.1 Detailed Electronic Search Strategy on Medline

Research Question One

Table 1:Detailed search terms used for the electronic search strategy on Medline

Search #	Search Terms
1	"Childhood" OR "Child" OR "Children" OR "Adolescent" OR "Youth" OR "Childhood and Adolescent" OR "Paediatric"
2	"Childhood Obesity" OR "Paediatric Obesity" OR "Childhood Overweight" "Obesity, Infantile" OR "Infantile Obesity" OR "Infant Overweight" OR "Infant Obesity" OR "Overweight, Infant" OR "Obesity, Infant" OR "Obesity in Adolescence" OR "Adolescent Overweight" OR "Adolescent Obesity" OR "Overweight, Adolescent" OR "Obesity, Adolescent" OR "Obesity, Child" OR "Obesity, Childhood Onset" OR "Child Obesity" OR "Obesity, Childhood" OR "Overweight, Childhood" OR "Obesity in Childhood" OR "Childhood Onset Obesity" OR "Obesity, Paediatric"
3	#1 OR #2
4	"Food" OR "Food and Beverages" OR "Beverages"
5	"Marketing" OR "Advertising" OR "Branding" OR "Advertisement" OR "Brand" OR "Media" OR "Television" OR "Social marketing"
6	"Dietary behaviour" OR "Feeding behaviour" OR "Food habits" OR "Dietary habits"
7	#4 AND #5 AND #6
8	#3 AND #7

Research Question Two

Table 2:Detailed search terms used for the document analysis to answer research question two

Search #	Search Terms
1	“Policies” OR “Strategies” OR “Approach” OR “Program” OR “Stance” OR “Code” OR “Guidelines” OR “Scheme” OR “Plan” OR “Procedure” OR "Proposed action" OR "Plan of action" OR "Master plan"
2	“Limit” OR “Limitation” OR “Bound” OR “Curb” OR “Restrict” OR “Restrain” OR “Demarcation” OR “Ceiling” OR “Check” OR “Regulate” OR “Govern” OR “Freeze” OR “Delimit” OR “Ration” OR “Arrest” OR “Control” OR “Inhibit”
3	"HFSS Food" OR "Unhealthy Food" OR "Junk Food" OR " Nutrient-poor-food"
4	“Food” OR “Food and Beverages” OR “Beverages”
5	#3 OR #4
6	“Marketing” OR “Advertising” OR “Branding” OR “Advertisement” OR “Brand” OR “Media” OR “Television” OR “Social marketing” OR “Promotion” OR “Publicity” OR “Commercial”
7	“Childhood” OR “Child” OR “Children” OR “Adolescent” OR “Youth” OR “Childhood and Adolescent”
8	“Childhood Obesity” OR “Paediatric Obesity” OR “Childhood Overweight”
9	#7 OR #8
10	#1 AND #2 AND #5 AND #6 AND #9

3.5.2 Date of Search for each Database

Table 3: Periods of coverage for each database

Database	System providing Access for Database	Periods of coverage
Medline	Pubmed	From 1946- October 31, 2019
Central	Cochrane Library	From 1998- October 31, 2019
Web of Science		From 2004- October 31, 2019
Scopus		From 2004- October 31, 2019

3.6 Data Screening

The titles and abstracts of all identified studies were initially screened for eligibility and duplicates removed simultaneously. To identify and eliminate duplicates several methods were used. Firstly, the automatic tool for identification and elimination of duplicates for the databases Medline and Cochrane Library was used which consisted of choosing the function "Remove duplicates". Since this tool was not available on other databases, duplicates were eliminated manually by merging the list of included studies from each database and duplicates identified using the "Find and Replace" function of the software "Open Office Writer" and the duplicates were subsequently replaced.

This was followed by reviewing of the full texts of retained studies to further identify eligible studies. For transparency of the screening process, a table of exclusion based on the exclusion criteria was developed and the rationale for exclusion of each full text that was reviewed was stated. In cases of doubts, the opinion of supervisors was soughted.

3.7 Data Extraction and Management

The eligible studies were then classified based on the research question and saved on Zotero. A pilot form of data extraction form was first tested on four randomly selected studies. Thereafter each eligible full study was detailly reviewed and the corresponding data were extracted and saved on a pre-conceived Microsoft Excel spread sheet which was subsequently double-checked for accuracy.

3.8 Data Items

To answer research question one, the extracted data consisted of:

- Information about Study: first name of the author, year of publication, journal reference, country/place of study, year of study, study setting/design
- Characteristics of Study: sample size, study population (age, gender),
- Main findings of the study: food marketing channel, effects of food marketing on children's dietary behaviours;

For research question two, the extracted data consisted of:

- Information about Study/Report: first name of the author, year of publication.
- Main findings of the study/report: proposed strategies/policies to limit children directed food marketing.

3.9 Quality Assessment and Appraisal of Individual Studies

Bias is a systematic error that can influence the results of an intervention, whether by overestimation or underestimation of its real effects[40]. Assessment of quality and risk of bias in studies is necessary because it helps to understand validity of findings[40]. Several tools are available for quality and risk assessment of bias. In this review, the reporting and methodological quality of experimental studies were assessed using the Revised Cochrane risk of bias assessment tool for randomised trials[41]. ROB 2 is structured into a fixed set of domains of bias, focusing on different aspects of the trial design, conduct and reporting. Within each domain a series of questions ('Signalling questions') aim to elicit information about features of the trial that are relevant to risk of bias. The proposed judgement about the risk of bias arising from each domain based on the answers to the signalling questions was used and each study was rated as either of 'low' or 'high' risk of bias or can express 'some concerns'.

While the respective Critical appraisal skills program (CASP) checklist (A 9-item checklist for quality assessment of systematic literature) was used to assess quality and risk of bias in non-experimental studies (Cohort Studies) [42]. The CASP has a total of 10 questions distributed under 3 major sections covering aspects of study design; sources and quality of data; data analysis; and interpretation of results. These questions have "Yes", "No", and "Not clear" as possible responses. A proposed adapted scale was used to rate the overall quality of each study based on an overall score of 10 as "++" for good quality (>7); "+" for moderate quality (6-7); and "-" for poor quality (<6) studies which denoted low, moderate, and high risk of bias respectively. Lastly the appraisal tool for cross-sectional studies (AXIS) was used to assess quality and risk of bias within Cross- sectional studies[43]. The AXIS tool has a total of 20 questions which focus mainly on the presented method and results of each study. A scoring scale was adapted for the purpose of this review as "++" for good quality (>15); "+" for moderate quality (10-15); "-" for poor quality (< 10) studies which denoted low, moderate, and high risk of bias respectively.

3.10 Data Analysis and Synthesis

The two principal outcomes of interest were:

- Effects of food marketing on children's dietary behaviours
- Strategies/policies limiting children-directed food marketing

A thematic content analysis approach was adopted for data analysis and synthesis. Initial coding framework on Microsoft Excel was developed by reading through all the eligible studies and identifying main themes. The main themes were developed based on the two principal outcomes of interest. The coding framework were then progressively amended to incorporate more main- and sub-themes emerging as each eligible study were reviewed.

A narrative approach was then used to summarise the abstracted data. This review was reported in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2009 guidelines[44].

RESULTS

4.1 Prisma Flow Diagram

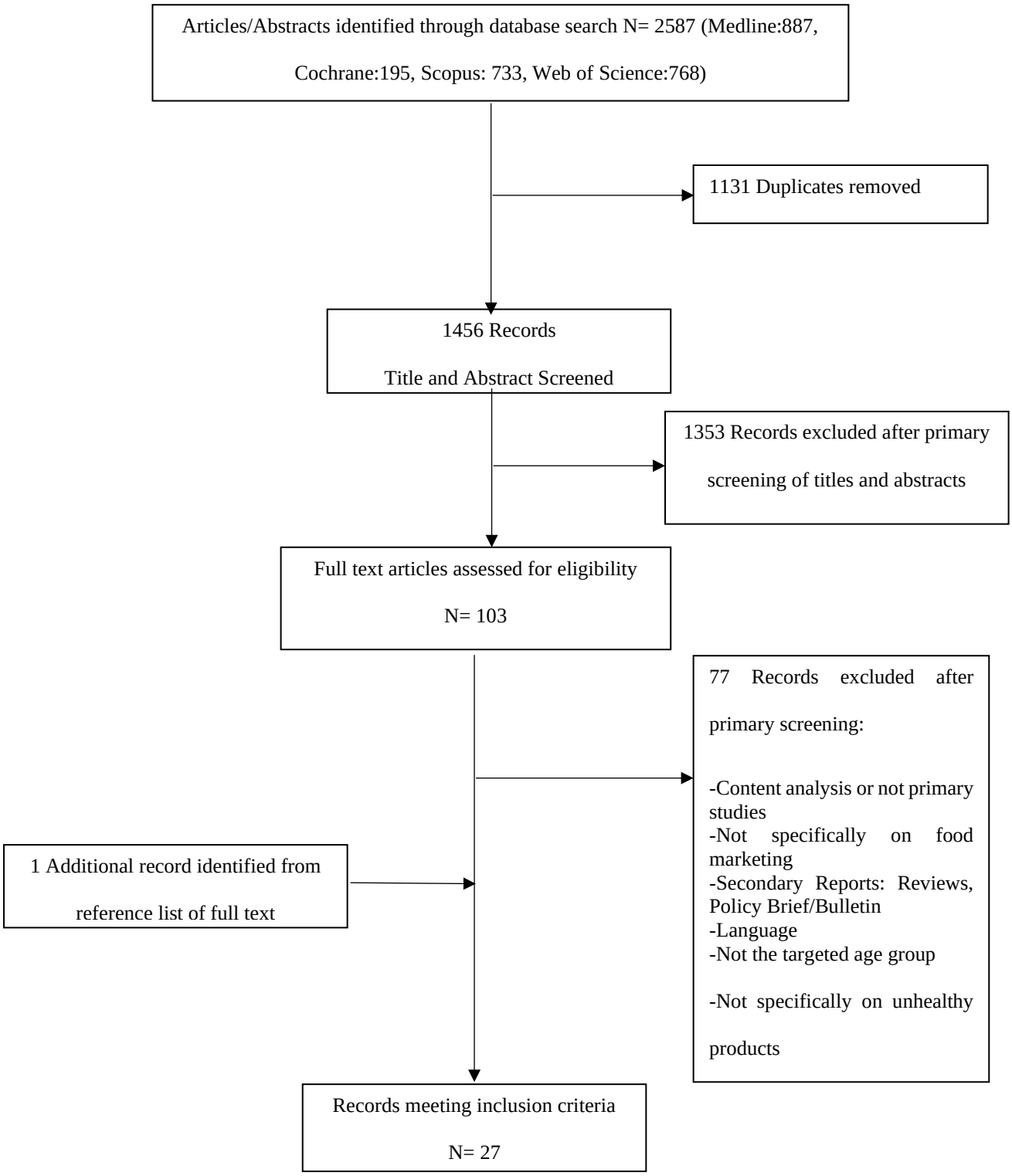

Figure 4: Prisma Diagram depicting Study Selection

4.2 Literature Search

Regarding Question-1:

The search strategy returned a total of 2587 studies. 1456 studies were retained after removal of duplicates. 103 potentially relevant studies in full text were identified after screening titles and abstracts. Following full text review, 26 studies were eligible for inclusion in the synthesis. An additional 1 study was identified after reviewing the reference list of included studies This yielded a total of 27 studies. Table- depicts a flow chart of searches, screening, and study inclusion process.

4.3 General Characteristics of Studies

There was a wide variation among included studies in terms of target population, methodology, and location. The included 27 studies were published between 2006 and 2018. Majority of the studies were conducted in economically developed countries with only 3 studies conducted in economically developing countries [45–47] (Letona et al 2014, Guatemalan; Lwin et al 2017, Indonesia; Ueda et al 2012, South India). 10 studies were conducted in USA[48–57] followed by Netherland (n=4)[58–61], Australia(n=3)[62–64] and one study each was conducted in Argentina[65], Spain[66], Chile[67], United Kingdom[68], Georgia[69], and Malaysia[70]. One multi-country study was conducted in Germany, Belgium, Estonia, Italy, and Spain[71].

The 27 included articles provided data on 40156 participants aged between 2 and 18 years. While majority of the studies were school-base, two studies obtained data from State-wide/national sample.

With respect to methodology 16 studies were Experimental (randomized controlled trials)[48–52,58–62,62,63,65–70] and 11 studies were Non-experimental studies (Cross-sectional (n=7)[45–47,54,57,64,70], Cohort studies (n=3)[53,56,71], Cross sectional with semi structured observation[55].

All studies utilised exposure to or receptivity of food advertising and promotion (healthy and/or unhealthy) in a variety of ways. Each study used disparate measures of exposures with some relying on self-reported exposures. There was variation in the degree of exposure to food advertisement.

All studies utilised outcome measures related to food consumption, and in addition some studies used outcome measures such as brand recognition, food preference, purchase request,

desire to consume, and taste preference. Details of the characteristics of included studies are shown on Table below.

4.3.1 Characteristics and Results of included Randomised Control Studies

Table 4:Characteristics and Results of included Randomised Control Studies

Reference (Author, Date, Country)	Participants	Study Design	Advertising Media and Manipulation (Intervention)	Comparison	Outcome	Relevant Results
Norman et al 2018, Australia[62]	n=160 Age range: 7-12 years Mean Age: 9.3	Experimental within subject random assignment	6 × 10-minute cartoon with food adverts (10 × 30-second) and 5-minute advergame	Non-food adverts/advergames	Post-intervention, ad libitum consumption of high-fat savoury, low fat savoury, high fat sweet, low fat sweet foods, fruit and vegetables	- TV food adverts significantly increased intake of food in all children in the multiple media condition; - An increased effect was reported
Gregori et al 2013, Argentina[65]	n=600 Age range: 3-10 years Mean Age:	Experimental school based within subject random assignment	Toy Packaged food, Movie Cartoon with TV Commercials	Movie Cartoon without TV Commercials	Post Intervention, ad libitum consumption of toy packaged food	- No significant difference in overall energy intake between control and exposed.
Staiano et al 2016, South Dakota USA[48]	n=42 Age range: 3-5 years Mean Age:	Experimental screen-based modelling on preschool children	Video of peers consuming a model	No video	Preference for modelled products. Ad libitum Consumption of modelled products	Significant higher preference for modelled products in children exposed to video of peers. Significant higher consumption of modelled products among exposed group

Mora et al 2016, Spain[66]	n=3291 Age range: 12-13 years Mean Age:	Experimental school based within subject random assignment	After nutritional training workshop, promotion of unhealthy products with Voucher	No voucher	Post intervention Breakfast choices	Significant higher choice of unhealthy products compared to controlled group. Promotion of unhealthy products counteracted the positive impact of the workshop
Folkvord et al 2016, Netherlands[58]	n=270 Age range: 7-10 years Mean Age: 8.9 years	Experimental school-based within subject random assignment	5min Internet advergames with unhealthy food (Candy, chocolate) commercials	Non-food advergames	Post intervention consumption of advertised products (jelly candy, chocolate)	Increased consumption of advertised products compared to controlled group (Exposed group: 197.2+/-111.4kcal Control group: 128.9+/-83.4kcal)
Brown et al 2017, North Carolina USA[49]	n=110 Age range: 9-11 years	Experimental within subject random assignment	Movie with high products placement (Alvin and Chipmunks)	Movie with low product placement	Post intervention snack choices Snack consumption	Participants exposed to high product placement had 3.1 times the odds of choosing Cheese balls (most featured snack) compared to control group. Snack consumption was significantly associated with high product placement
Uribe et al[67] 2015, Chile	n=483 Age range: 9, 12, 15 years	Experimental within subject random assignment self-reported measures	Film with scenes depicting McDonald Restaurant (Eating fries, hamburgers).	Film with non-food scenes. Breaks with advertising of	Post intervention brand recall Food preference	Product placement significantly increased brand awareness. Significant increased preference for product in movie.

			Breaks with advertising of similar products	non-food products		Significant synergy effect between placement and advertising
Halford et al 2004, United Kingdom[68]	n=93 Age range: 5-7 years Mean age: 6.3	Experimental within subject counter-balance design	Cartoon with a collection of food related adverts	Cartoons with a collection of non-food related adverts	10 minutes post adverts food intake Food choice	Advertisement exposure significantly increased total calorie intake among exposed group compared to control group. Food choices were significantly associated with food advertisement
Lorenzoni et al 2017, Georgia[69]	n=60 Age range: 3-11 years Mean Age: 6	Experimental within subject random assignment	22 minutes Cartoon with 3 food related advertisement	No TV, Cartoon with no advertisement	During intervention ad libitum consumption of chocolate-based snacks	No significant increase in consumption of food between adverts conditions
Emond et al 2016 USA[50]	n=60 Age range: 2-5 years Mean Age: 4.1	Experimental within subject random assignment	14 minutes TV program embedded with food advertisement	No food advertisement	Post intervention food intake Food preference and choice	Food consumption was greater among exposed group compared to control group. Exposed group had significant higher preference/choice for advertised food compared to control group.
Ogle et al 2016, USA[51]	n=149 Age range: 6-9 years	Experimental within subject random assignment	Licenced Cartoon Media Character on package of food products	Food product packaging without Cartoon	Post intervention visual attention Product Choice	Visual attention was greater for products with Cartoon Media Character.

	Mean Age: 7.36			Media Character		Product choices were significantly associated with Cartoon Media Character.
Folkvord et al 2014, Netherlands[59]	n=261 Age range: 7-10 years Mean Age:	Experimental within subject random assignment	Advergames promoting energy-dense snacks	Advergames promoting non-food products	Post intervention food consumption	Advergames containing food cues increased food intake compared to advergames promoting non-food products
Harris et al 2009, USA[52]	n=118 Age range: 7-11 years Mean Age: 8.8	School-based experimental study with individually randomised parallel group trial	Cartoon with food advertising. Participants received snack while watching cartoon	Cartoon with commercial for non-food products. Participants received snack while watching cartoon	Amount of snack food consumption during and after advertising exposure	Children exposed to food advertising consumed more snacks during and after exposure compared to control group
Pettigrew et al 2013, Australia[63]	n=1302 Age range: 8-14 years Mean Age:	Experimental with questionnaire based on self-reported measures	Internet and TV exposure to control pictures of 4 commonly advertised energy dense, nutrient poor food	No exposure	Frequency of food consumption Food preference Desire to consume advertised products	Children exposed to food commercials reported higher frequency of consumption, higher desire to consume as well as higher preference for advertised products
Anschutz et al 2009, Netherlands[60]	n=120 Age range: 8-12 years Mean Age: 9.8	School-based experimental study with individually randomised trial	20 minutes nature film with 3 food commercials and 2 non-food	20 minutes nature film with 5 non-food commercials	During intervention ad libitum consumption of peanut M&M	TV food commercials was significantly associated with increased food intake in exposed group compared to control group

			commercials (total 5minutes)	(total 5minutes		
Anschutz et al 2010, Netherlands[61]	n=121 Age range: 8-12 years Mean Age: 10.4	School-based experimental study with individually randomised trial	20 minutes nature film with 4 food commercials and 1 non-food commercials (total 5minutes)	20 minutes nature film with 5 non-food commercials (total 5minutes	During intervention ad libitum consumption of chocolate coated peanuts	TV food commercials was not significantly associated with increased food intake in both groups

4.3.2 Characteristics and Results of included Non-experimental studies (Quantitative and Qualitative)

Table 5:Characteristics and Results of included Non-experimental studies (Quantitative and Qualitative)

Reference (Author, Date, Country)	Participants	Study Design	Advertising Media and Manipulation	Outcome	Relevant Results
Lapierre et al 2011, USA[55]	n=80 Age range: 4-6 years Mean age:	Between subject study design with questionnaire on self-reported measures using a 5-point smile/liked scale	Exposure to food with licensed cartoon character on package (Cereal)	Preference for ready to eat cereals under 4 conditions: -Healthy Bits cereals versus sugar Bits cereal. -Character preference (penguin versus no character)	Children preferred cereals with licensed cartoon character on the package. Children preferred sugar Bits cereals with licensed cartoon character on package compared to the health Bits cereals. (suggesting that character is a more powerful influence than nutritional content of the cereals)
Letona et al 2014, Guatemalan [45]	n=121 Age range: 4-11 years Mean age:7.4+/-1.9 SD	Cross-sectional between subject study design. Questionnaire with self-reported measures	Exposure to food with 3 Licensed cartoon media characters on food packaging.	Recognition of popular characters Taste Prefence Snack preference for 3 foods (potato chips, crackers baby carrots) Purchase request	Children showed high recognition of familiar media character The use of familiar media characters on food package increased children´s taste and snack preferences. Younger children (4-6) were more likely to prefer food with licensed media character

					compared to older children (7-11)
Ng Hoe et al 2015, Malaysia[70]	n=402 Age range: 7-12 years Mean age:9.85+/-1.38 SD	School-based cross-sectional study with questionnaires on self-reported measures using food album of 24 advertised food products	Commercials using 24 album/Pictures of food products	Purchase request Product preference	Food products on the album were significantly associated with higher Purchase request for the products as well as product preference.
Powell et al 2017, USA[56]	n=8340 Age range: 5th grade followed up for 3 years up to 8th grade Mean age:	Cohort study with detailed self-reported survey information on consumption patterns	TV programmes with exposure to cereal advertisement	Frequency of consumption of soft drinks/ sugar sweetened beverages	Exposure to soft drinks and sugar sweetened beverage as significantly associated with high frequency of soft drink consumption
Reisch et al 2013,[71] Germany 21%, Belgium 26.2%, Estonia 10,9%, Italy 20.5%, Spain21.4%	n=229 Age range: 6-9 years Mean age: 7.83	Cohort with data from IDEFICS Study 2 years follow up	Exposure to food cards showing healthy foods and unhealthy foods	Food knowledge Food Preference	Advertising has divergent effect on food knowledge and food preference. Food knowledge is unrelated to food preference
Dalton et al 2017, USA[57]	n=548 Age range:3-5 years Mean age: 4.4	Pre-school cross-sectional survey. Questionnaire with self-reported measures on children´s exposure to child targeted TV commercials for the following chain fast food restaurants (McDonald, Subway, Wendy)	Child targeted TV Commercials for chain fast food restaurants MSW (McDonald, Subway, Wendy)	Past week fast food consumption	Children´s MSW ´was significantly associated with their advertisement exposure but not over TV time

Lwin et al 2017, Indonesia[46]	n=394 Age range: 8-10 years Mean age: 9.4	Guided in-class cross-sectional survey. Paper questionnaire with mother self-reported measures for fast food consumption and parental mediation	Advertising exposure estimated from self-reported TV, Online/Phone games, Print Media/Billboards, Social media time	Fast food Consumption	Fast food consumption was positively associated with exposure to TV advertising among metropolitan children and with online advertising among suburban children
Andreyeva et al 2011, USA[53]	n=9760 Age range:5-14 years Mean age: 11.2	Early childhood longitudinal survey (1998-2007) Kindergarten Cohort (ECLS-K, the Nielsen Company Data)	TV commercials on cereals, fast food restaurants and soft drinks	Consumption of advertised products	Exposure to incremental TV commercials for sugar sweetened carbonated soft drinks was associated with arise in children´s consumption of soft drinks.
Ueda et al 2012, South India[47]	n=306 child-parent pair Age range:3-13 years Mean age: 4.4	Cross-sectional survey with questionnaire on self-reported measures	Digital Logo recognition Test. Digital games for children Community Billboards	Brand recognition Brand preference Purchase request Brand consumption	Significant Brand logo recognition ability. Older children had a significant higher brand recognition score compared to younger children. Participants had higher preference for unhealthy marketed products. 27% always and 20% often request for and purchase advertised products. Increased consumption of advertised products and this

					was positively associated with increased age but not gender.
Scully et al 2012, Australia[64]	n=12188 Age range:12-17 years Mean age:	Cross-sectional web-based self-reported questionnaire on eating behaviour, food choices, commercial TV viewing, Prints/Billboards	Self-reported exposure to TV commercials, prints/Billboards for healthy and unhealthy food products	Preference and Consumption advertised food products.	Exposure to TV commercials for food products was associated with preference and consumption of the advertised food products.
Longacre et al 2016, USA[54]	n=548 Age range:3-5 years Mean age:	Cross-sectional self-reported (mother) questionnaire TV commercial exposure and consumption of advertised products	TV program with child targeted high sugar breakfast cereals) SBC advertisement	Advertised Cereal consumption. SBC advertisement exposure.	The number of SBC brands consumed was positively associated with their SBC advertisement exposure. SBC advertisement exposure was greatly associated with increased demand/Purchase request.

4.4 Quality and Risk of Bias within Studies

The risk of bias was assessed separately for experimental and non- experimental studies.

4.4.1 Quality and Risk of Bias within Experimental Studies (Randomised and Non-Controlled Trials)

The revised Cochrane risk of bias assessment tool for randomised trials (ROB 2) [40,41]was used to assess risk of bias in experimental studies. The assessment was done separately in the following domains: sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other bias. The summarized results of assessment of individual RCTs are shown in the Table 3 below.

Domain 1&2: Sequence generation and Allocation concealment

Majority of the studies employed a random allocation sequence, and the allocation sequence was concealed until participants were enrolled and assigned to intervention, and lastly there was no baseline difference between intervention groups except for 2 studies in which it was not clear the allocation sequence was random.

In all included studies, the participants were not aware of their assigned intervention, however the investigators were fully aware of participants' assigned intervention.

Domain 3: Blinding of Participants and Investigators

It was not clearly stated if there was blinding or not and details were not given as to who was blinded. Failure to blinding the investigators was attributed to the fact that the researcher served to facilitate the advertising exposure and assess consumption and thus there is risk of experimental bias. However, the risk was relatively low since the outcome measures were objectively measured (by weighing and /or counting the food items).

Domain 4 & 5: Incomplete outcome data and Selective reporting

All outcome of interest was complete and reported clearly. There was complete outcome reporting

Table 6: Quality and Risk of bias within Experimental Studies

Reference	Domain 1 (Random Sequence Generation)	Domain 2 (Allocation Concealment)	Domain 3 (Blinding of Participants and Personnel	Domain 4 (Incomplete Outcome)	Domain 5 (Selective Reporting)	Other bias	Risk of bias judgement
Normann et al 2018, Australia	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Gregori et al 2013, Argentina	**Some Concerns**	**Some Concerns**	**Some Concerns**	low	low	None	**Some concerns**
Staiano et al 2016, South Dakota USA	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Mora et al 2016, Spain	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Folkvord et al 2016, Netherlands	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Brown et al 2017, North Carolina USA	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Uribe et al 2015, Chile	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Halford et al 2006, United Kingdom	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Lorenzoni et al Georgia	low	**Some Concerns**	**Some Concerns**	low	low	None	Low

Edmond et al 2016 USA	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Olge et al 2016, USA	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Folkvord et al 2014, Netherlands	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Harris et al 2009, USA	**Some concerns**	**Some Concerns**	**Some Concerns**	low	low	**Hunger was not controlled for**	**High**
Pettigrew et al 2013, Australia	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Anschutz et al 2009, Netherlands	low	**Some Concerns**	**Some Concerns**	low	low	None	Low
Anschutz et al 2010, Netherlands	low	**Some Concerns**	**Some Concerns**	low	low	None	Low

4.4.2 Quality and Risk of bias within Non-experimental studies (Cohort Studies)

The critical appraisal skill programme checklist for cohort studies was used to assess risk of bias in non-experimental studies[42]. The assessment was done by separately for each study by answering the list of 10 questions which basically divided in 3 Sections: Section A (Validity of the study results); Section B (What are the results); Section C (Will the results help locally). The summarized results of assessment of individual studies are shown in the Table 3 below:

Most of the studies had a clear and focused research question and the methods used were appropriate for the research questions. Generalizability of the findings to different settings was limited due to the non-representative samples used in the respective studies.

4.4.3 Quality and Risk of Bias within Non-experimental Studies (Cross-Sectional Studies)

The appraisal tool (AXIS) was used to critically appraise cross-sectional studies. The assessment was done by separately for each study by answering the list of 20 questions which basically divided in 5 Sections: Introduction, Methods, Results and Discussion. The summarized results of assessment of individual studies are shown in the Table:

Table 7:Quality and Risk of Bias within Cohort studies

CASP Checklist	Powell et al 2017, USA	Reisch et al 2013,	Ueda et al 2012, South India	Andreyeva et al 2011, USA
Was the research question or objectives in this paper clearly stated and appropriate	✓	✓	✓	✓
Was the cohort recruited in an acceptable way?	✗	✗	N/A	✓
Was the exposure accurately measured to minimize bias	✗	✓	✗	N/A
Was the outcome accurately measured to minimize bias	✓	✓	✓	✓
Have the authors identified all important cofounding factors/have they taken into consideration the cofounding factors in the design and for analysis	✓	✓	✓	N/A
Was the follow up of subjects complete enough/Was the time frame sufficient so that one could reasonably expect to see an association between exposure and outcomes if it existed	✓	✓	✓	✓
Were the exposure measures clearly defined, valid, reliable, and implemented consistently across all study participants?	✓	✓	N/A	N/A
Were the outcomes measures clearly defined, valid, reliable?	✓	✓	✓	✓
Can the results be applied to the local population?	N/A	N/A	✗	✗
Do the results of this study fit with other available evidence?	✓	✓	✓	✓
Overall rating	Moderate	Good	Moderate	Moderate

Key:
✓ *=Yes*
N/A= Not clearly stated
✗ *=No*

Table 8: Quality and Risk of Bias within cross- sectional studies

AXIS tool Checklist	Lwin et al 2017, Indonesia	Scully et al 2012, Australia	Lapierre et al 2011, USA	Letona et al 2014 Guatemalan	Ng Hoe et al 2015, Malaysia	Dalton et al 2017, USA	Longacre et al 2016, USA
Were the aims/objectives of the study clear?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the study design appropriate for the stated aim(s)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the sample size justified?	N/A	Yes	Yes	N/A	N/A	N/A	N/A
Was the target population clearly defined?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the sample frame taken from an appropriate population base so that it closely represents the target population under investigation?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Was the selection process likely to select subjects/participants that were representative of the target population under investigation	Yes	N/A	N/A	N/A	N/A	N/A	N/A
Were measures undertaken to address and categorise non-responders?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Were the risk factor and outcome variables measured appropriate to the aims of the study?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialled, piloted or published previously?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Is it clear what was used to determined statistical significance and/or	Yes	Yes	Yes	Yes	Yes	Yes	Yes

precision estimates? (e.g. p-values, confidence intervals)							
Were the methods (including statistical methods) sufficiently described to enable them to be repeated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the basic data adequately described?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Does the response rate raise concerns about non-response bias?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
If appropriate, was information about non-responders described?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Were the results internally consistent?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Were the results presented for all the analyses described in the methods?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the authors' discussions and conclusions justified by the results?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the limitations of the study discussed?	N/A	N/A	Yes	N/A	N/A	Yes	Yes
Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?	No	No	No	No	No	No	No
Was ethical approval or consent of participants attained?	Yes	Yes	Yes	Yes	Yes	Yes	YES
Overall Rating	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

4.5 Synthesis of Results of The Impact of Food Marketing on Children's Dietary Behaviour

There was variation in the marketing media used among all 27 included studies with the majority (10 studies) using television program/movie embedded with food product advert [49,50,53,54,56,57,60,61,63,67]; 5 studies used Cartoons embedded with food product adverts[52,62,65,68,69]; 3 studies used Packaging of food products with licenced cartoon media characters[45,51,55]; 2 studies reported on Internet with advergames[58,59]; 1 study used video with peer consuming a model food product[48]; 2 studies used billboards/Pictures/food cards[70,71]; 1 study used voucher as advertising medium[66]. Meanwhile 3 studies used mixture of self-reported Television advert exposure, online games/advergames and print media/billboards[46,47,64]. Below is a synthesis of results on how each marketing technique was found to influence children's dietary behaviour. The graph below shows the different marketing media used in all 27 included studies.

4.5.1 Different marketing media used in the 27 included studies

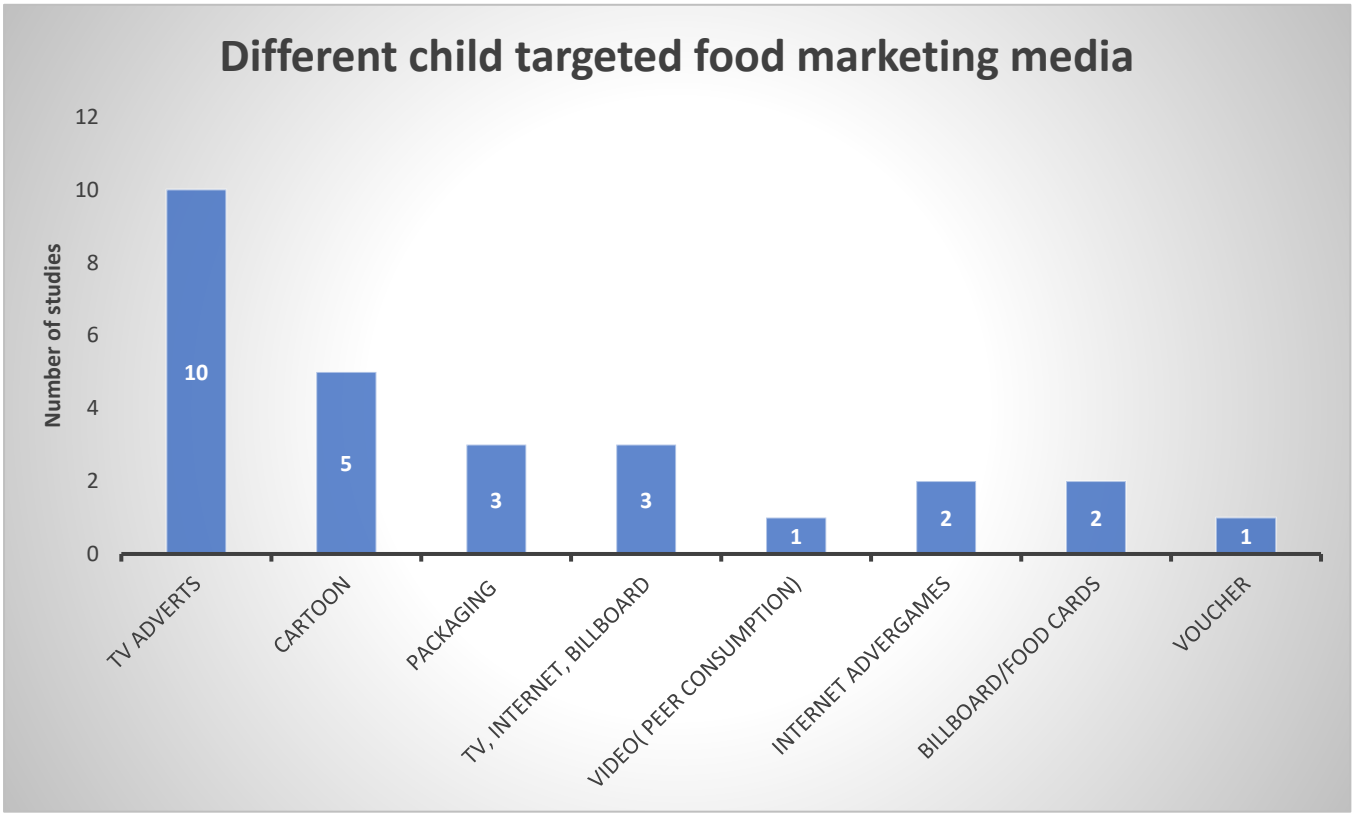

Figure 5:Different child targeted food marketing media

- **Television Program/Movies**

Ten relevant studies examined the influence of food marketing using Television. Participants were exposed to Television program or Movie which was embedded with 5 minutes food product advert. It was observed that children who watched TV programs/Movie with food product adverts showed significantly higher food consumption, preference, purchase request as well as brand recognition score compared to children exposed to TV programs/Movies without food commercials. Longacre et al reported that the number sugar breakfast cereals (SBC) consumed was positively associated with the number of TV programs/SBC advertisement. On the contrary Anschutz et al did not observe any significant association between TV food commercials and increased intake of the advertised food in both controlled and exposed groups. Uribe et al examined food product placement in movies and noted that not only does product placement significantly increased brand awareness especially when used by famous celebrities but it also has a synergy effect with advertising on children's preference.

- **Cartoon**

Five studies analysed the effect of food marketing on children's dietary habits using Cartoons. Young children < 8 years of age are cognitively not able to recognise the real purpose of advertising and are highly susceptible to such influence. Young children could easily remember contents of advertisement and recognise brands. All 5 studies observed an increased in brand awareness following exposure to food products using cartoons. Harris et al found that children consumed more in the presence of food brands and there exist a significant association between brand recognition and their consumption. On the other hand, Lorezoni et al as well as Gregori et al reported no significant difference in food consumption between controlled and exposed groups.

- **Internet advergames**

Two studies analysed the effect of internet advergames on children's dietary behaviour. Both studies noted that increased exposure to internet advergames especially with food commercials was associated with more frequent consumption of the advertised food products. It was also confirmed that children are more likely to choose and purchase highly processed food (high sugar, salt and fat content) which are advertised as nutritious, healthy, and tasty during as well as after exposure to internet advergames.

- **Packaging with licenced cartoon media character**

All 3 studies which used packaging with licensed cartoon media character observed significant association between product choices/consumption with Cartoon media character packaging. Olge et al noted that the visual attention for products with cartoon media character on their package was greater than for products without any character on their package. Lapierre et al reported that children preferred sugar Bits cereals with licensed cartoon character on package compared to the health Bits cereals suggesting that character is a more powerful influence than nutritional content of the cereals.

- **Peer Consumption**

Staiano et al analysed the effect of video of peers consuming a model food product and observed a significant higher preference for- as well as consumption of modelled product in children exposed to the video compared to the controlled group.

- **Voucher**

Mora et al conducted a nutritional training workshop alongside promotion of unhealthy food products using vouchers. They noted that children exposed to the voucher following the training workshop had significant higher preference for unhealthy food products compared to those without voucher after the training workshop. It was also observed that the promotion of unhealthy product counteracted the positive effect of the training workshop.

Regarding research question 2:

4.6 Search strategy on existing policies and regulations regarding child-targeted food marketing restrictions

A total of 15 Reports and/or Bulletins were identified for the document analysis. 7 policy reports from the official website of public health organisations like AHA, WHO as well as 8 articles on state regulations addressing extent of food marketing to children.
The findings from the document analysis were synthesized into categories as follows:

- Policy Recommendations regarding Child-targeted food marketing restriction.
- Ongoing Country Regulations regarding Child-targeted food marketing restriction.

4.6.1 Strategies/Policies limiting children-targeted food marketing (Recommendations)

A comprehensive children-targeted food marketing restriction movement requires a widespread acceptance of and concerns about the health consequences of unhealthy food marketing to children[72]. This section examines existing strategies/policies limiting children-targeted food marketing as recommended by WHO, AHA, other public health organisations.

4.6.1.1 WHO Policy Recommendations related to marketing of food to children

The WHO recommendation acknowledges the relationship between food marketing and children's preferences, purchase request and consumption[3]. As such calls on all governments to restrict the marketing of unhealthy food to children as comprehensive as possible. The recommendation provides a framework that draws attention at all stages of policy development, implementation, monitoring and evaluation. The main purpose of the recommendation was to guide efforts of member states in designing new and/or strengthening existing policies on food marketing communication to children in order to reduce the impact of marketing HFSS foods.

4.6.1.2 Rationale[3]

- The policy aim should be to reduce the impact on children of marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt.
- Given that the effectiveness of marketing is a function of exposure and power, the overall policy objective should be to reduce both the exposure of children to, and power of, marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt.

4.6.1.3 Policy development[3,4]

- To achieve the policy aim and objective, Member States should consider different approaches, i.e. stepwise or comprehensive, to reduce marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt, to children.
- Governments should set clear definitions for the key components of the policy, thereby allowing for a standard implementation process. The setting of clear definitions would facilitate uniform implementation, irrespective of the implementing body. When setting the key definitions Member States need to identify and address any specific national challenges so as to derive the maximal impact of the policy.
- Settings where children gather should be free from all forms of marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt. Such settings include, but are not limited to, nurseries, schools, school grounds and pre-school centres, playgrounds, family and child clinics and paediatric services and during any sporting and cultural activities that are held on these premises.
- Governments should be the key stakeholders in the development of policy and provide leadership, through a multistakeholder platform, for implementation, monitoring and evaluation. In setting the national policy framework, governments may choose to allocate defined roles to other stakeholders, while protecting the public interest and avoiding conflict of interest.

4.6.1.4 Policy implementation[3,8]

- Considering resources, benefits and burdens of all stakeholders involved, Member States should consider the most effective approach to reduce marketing to children of foods high in saturated fats, trans-fatty acids, free sugars, or salt. Any approach selected should be set within a framework developed to achieve the policy objective.

- Member States should cooperate to put in place the means necessary to reduce the impact of cross border marketing (in-flowing and out-flowing) of foods high in saturated fats, trans-fatty acids, free sugars, or salt to children in order to achieve the highest possible impact of any national policy.
- The policy framework should specify enforcement mechanisms and establish systems for their implementation. In this respect, the framework should include clear definitions of sanctions and could include a system for reporting complaints.

4.6.1.5 Policy Monitoring and Evaluation[3,19]

- All policy frameworks should include a monitoring system to ensure compliance with the objectives set out in the national policy, using clearly defined indicators.
- The policy frameworks should also include a system to evaluate the impact and effectiveness of the policy on the overall aim, using clearly defined indicators.
- Member States are encouraged to identify existing information on the extent, nature and effects of food marketing to children in their country. They are also encouraged to support further research in this area, especially research focused on implementation and evaluation of policies to reduce the impact on children of marketing of foods high in saturated fats, trans-fatty acids, free sugars, or salt.

4.6.2 Policy Recommendation by American Heart Association (AHA)[73,74]

- Advertising, marketing and brand awareness strategies used by industries should not be allowed in schools or on educational materials.
- Licenced characters should only be used to market healthy foods to children.
- Toy companies and the movie industries should not be able to partner with fast food industries to market unhealthy meals to children.
- Product placement of food brands should be discouraged in the multiple media technologies including movies, videogames, advergaming, television programs geared to children.
- Only healthy foods should be advertised and marketed to children and should meet criteria that AHA has set for nutrients that affect CVD risk.
- Various states should restore a third party oversight system to strengthen enforcement as much as possible to minimize non-compliance and establish a uniform nutritional standard.

4.6.3 Examples of Implemented policies/Strategies addressing food marketing geared to children

Table 9: Examples of Country related Implemented policies/Strategies addressing food marketing geared towards children

Ireland	Advertising, sponsorship, and product placement of HFSS foods are prohibited during children's TV/radio programmes to children < 18 years. Food advertising to children <18 years must not feature celebrities, characters and personalities from children's programmes.[3]
Sweden	General prohibition of TV advertising during programmes appealing to children <12 years[75].
United Kingdom	Licensed characters and celebrities popular to children as well as healthy/nutritious claims may not be used in HFSS product advertisement for pre-school or primary school children[76]. Advertisement must not directly advise or ask children/parents to purchase for them.
Norway	General advertising including food/beverages on children's programmes on TV is prohibited. Advertising cannot include Persons/Figures with prominent role on TV programmes for children in Norway[77].
Iran	Broadcast advertising of soft drinks has been prohibited since 2004[78,79].
Mexico	Restricted advertising of food/sweetened beverages on TV programmes between 2:30pm -7pm on weekdays and between 7 am – 7:30pm on weekends[78,79].
Canada	In the Canadian province of Quebec, Section 248 of the Consumer Protection Act bans advertising of any goods directed at children under the age of 13[80,81].

DISCUSSION, CONCLUSION, AND RECOMMENDATION

5.1 Discussion of Results and Methods

This systematic review of 16 experimental studies, 8 cross-sectional studies and 3 cohort studies on over 40,156 children shows evidence that exposure to food marketing was consistently associated with subsequent changes in children's dietary behaviour (increase dietary intake, preference, and purchase request for advertised products). The included studies used a variety of study designs and a range of exposure (different marketing media) and outcome measures (consumption, preference, purchase request). Despite the heterogeneity of the designs and exposure measures, the results were consistent across all studies.

Two emerging features were identified from the evidence. Firstly, most of the food products marketed were products high in sugar, salts and fats such as chocolates, unhealthy cereals, snacks and sweetened beverages. Secondly, the food industry uses persuasive techniques such as TV-programmes, Internet, Videogames, Advergames, Toys, Cartoon character packaging, Vouchers, promotional campaigns, product placement in movies as well as sponsorship to create long lasting relations with children and forge brand loyalty in short and long term. There was less focus on other marketing methods like children's magazines, in-store placement, premiums/free samples, and in-school marketing. In summary this review probably underestimate children's true exposure to food marketing.

Most of the studies assessed the short-term effects of acute exposure to child-targeted food marketing except the 3 cohort studies which assessed effect of long-term exposure to child-targeted food marketing. However, it is argued that the effect of food marketing is underestimated in most studies since in real life continued exposure may lead to the amplification and cumulation of these effects that cannot be quantified particularly when the marketing is repetitious and delivered over multiple platforms[82,83]. Hence policy options restricting children-targeted food marketing are evidence based and warranted.

The findings of this review are consistent with prior research[10,15,23,24,24,84] which also pointed out the link between food marketing and children's dietary behaviour. Despite these findings, several food marketing researchers address the gaps in research relating to the effects of food marketing to children and childhood obesity. For example Cairns et al 2009 stated that "*evidence relating food marketing and childhood obesity is not complete and perhaps this will always be the case*"[85] while Norman et al 2016 reported that the lack of causal link between

food marketing and childhood obesity is one of the reasons for policy hesitance regarding this issue[86].

With respect to methods, it is difficult to scientifically quantify the relation between food marketing and childhood obesity[85,87,88]. Firstly, obesity is multifactorial, and it is usually challenging to isolate the effect of food marketing from other obesity-mediating factors. Secondly, methodological challenges pertaining to the different types of epidemiological studies make it difficult to attribute effects to any one cause in observational studies (lack of causal effect in cross-sectional studies) or to achieve ecological validity in experimental studies[85]. The use of experimental studies is also criticized because of lack of ecological validity in experimental studies (Laboratory settings are different from real life situations) and the use of correlational studies (cross-sectional studies) were also criticized for not establishing a causal relationship between food marketing and obesity[83]. Hence it is scientifically appropriate to use evidence on the effects of food marketing on children's dietary behaviours to investigate the relationship between food marketing and childhood obesity.

Despite the gaps in research and the methodological challenges, several public health organisations have published documents[4,39,73,79] which appraise the evidence of the effects of food marketing as sufficient and robust to inform policies regarding childhood obesity and food marketing. Evidence has expanded since the World Health Organisation in 2003 categorised heavy marketing of energy-dense foods as a probable cause of childhood obesity and this led to the development of the WHO set of recommendation in 2010. Since then, its implementation has been encouraged by the Global action plan for the control of NCDs 2013-2020 as well as the Policy recommendation in the report of the commission on ending childhood obesity 2016.

5.1.1 Strengths and Limitations

The strengths of this review were: novelty and comprehensive search strategies
which covers most of the available studies on food marketing and children's dietary behaviour. Firstly, the review is novel. To the author's knowledge this is the only and the most recent systematic review on food marketing and children's dietary behaviour taking into account the different marketing strategies/techniques used by the food industry as well as highlighting the different recommendations and strategies used by different states to limit child-targeted food marketing.

However, several limitations should be considered when interpreting the results of this review. Firstly, the review is limited to studies in English language and there may be other studies that have been published in other languages which could have informed the findings. Secondly, due to the heterogeneity of the studies included, the studies cannot be easily combined into meta-analysis in order to derive an estimate of the true effect size. Also, the literature review was carried out by only one investigator which could increase risk of bias and data entry error. However, the search strategy was carried out under supervision. Moreover, the possibility of publication bias cannot be ruled out, since studies which may have failed to detect significant associations may not have been published, or studies for which selective reporting of only positive associations were published. Of course, it is also possible that studies showing positive associations, if sponsored by the food marketing industry or other commercial organisations with a vested interest in advertising or marketing of food, may not have been published. Therefore, it is not possible to predict the likely impact of unpublished data on the results of this review. It is also possible that published studies were not found by the search as a fully comprehensive search of databases other than Medline, Cochrane, Scopus and Web of science covering other social science literature was not possible within the scope of this review due to limited funds. Attempts, however, were made to locate all available studies by supplementing searches of databases with hand searching reference lists of key reviews and primary studies.

5.2 Conclusion

Based on the strength and specificity of association, evidence of consistency of findings across the numerous observational and experimental studies included in this review as well as theoretical plausibility regarding impact of food marketing, it can be concluded that children's exposure to food marketing is associated with changes in their dietary behaviours (increase dietary intake, request and preference for advertised products). It is time to shift the bearing of responsibility of childhood obesity away from individuals towards those that control the food system and resultant obesogenic environment. States and various government are therefore called to take strict actions involving all stakeholders including the food industries, parents, schools, communities in implementing the comprehensive set of recommendations to provide a healthy environment for our future generation.

5.3 Recommendations

To create an environment that allows individuals especially children to have healthy choice as the only option, it is therefore recommended to:

5.3.1 Clinicians and Healthcare providers

- To educate parents about the subtle persuasiveness of food marketing along with the negative effects of increased commercial exposure in children.
- To encourage parents to monitor their children's exposure to marketing communication.

5.3.2 Policy Makers

- Considering the challenges that children face understanding the ever changing and often confusing persuasive environment, policy makers are called to increase pressure on the food industries to ensure that their practices are developmentally appropriate and transparent.
- To implement policies that increase taxations on marketing of unhealthy foods and hence encourage marketing of healthy products.

5.3.3 To Educators

- Those working directly with children and/or developing curricula for children should include programmes to increase children's advertising knowledge and help them engage critically with commercial messages so they can understand the real aim behind marketing.

5.3.4 To Future Research

- Longitudinal research exploring how children process marketing messages across media platforms should be carried out.
- Research to determine the most effective method to enhance receptivity to healthy messages and increase protection against unhealthy marketing messages should be carried out.
- Effectiveness studies demonstrating the impact (Success/challenges) of advertising bans/restrictions would contribute to what is known in this area.

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APPENDIX

7.1 Prisma 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

7.2 Appraisal tool for Cross-Sectional Studies (AXIS)

Critical appraisal (CA) is used to systematically assess research papers and to judge the reliability of the study being presented in the paper. CA also helps in assessing the worth and relevance of the study [1]. There are many key areas to CA including assessing suitability of the study to answer the hypothesized question and the possibility of introducing bias into the study. Identifying these key areas in CA requires good reporting of the study, if the study is poorly reported the appraisal of suitability and bias becomes difficult.

The following appraisal tool was developed for use in appraising observational cross-sectional studies. It is designed to address issues that are often apparent in cross-sectional studies and to aid the reader when assessing the quality of the study that they are appraising. The questions on the following pages are presented in the order that they should generally appear in a paper. The aim of the tool is to aid systematic interpretation of a cross-sectional study and to inform decisions about the quality of the study being appraised.

The appraisal tool comes with an explanatory help text which gives some background knowledge and explanation as to what the questions are asking. The explanations are designed to inform why the questions are important. Clicking on a question will automatically take you to the relevant section in the help text. The appraisal tool has areas to record a “yes”, “no” or “don’t know” answer for each question and there is room for short comments as well.

Appraisal of Cross-sectional Studies

	Question	Yes	No	Don't know/ Comment
Introduction				
1	Were the aims/objectives of the study clear?			
Methods				
2	Was the study design appropriate for the stated aim(s)?			
3	Was the sample size justified?			
4	Was the target/reference population clearly defined? (Is it clear who the research was about?)			
5	Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?			
6	Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?			
7	Were measures undertaken to address and categorise non-responders?			
8	Were the risk factor and outcome variables measured appropriate to the aims of the study?			
9	Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialled, piloted or published previously?			
10	Is it clear what was used to determined statistical significance and/or precision estimates? (e.g. p-values, confidence intervals)			
11	Were the methods (including statistical methods) sufficiently described to enable them to be repeated?			
Results				
12	Were the basic data adequately described?			
13	Does the response rate raise concerns about non-response bias?			
14	If appropriate, was information about non-responders described?			
15	Were the results internally consistent?			
16	Were the results presented for all the analyses described in the methods?			
Discussion				
17	Were the authors' discussions and conclusions justified by the results?			
18	Were the limitations of the study discussed?			
Other				
19	Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?			
20	Was ethical approval or consent of participants attained?			

7.3 Critical Appraisal Skills Programme Cohort Study Checklist

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Summertown Pavilion, Middle Way Oxford OX2 7LG

CASP Checklist: 12 questions to help you make sense of a Cohort Study

The 12 questions on the following pages are designed to help you think about these issues systematically. The first two questions are screening questions and can be answered quickly. If the answer to both is "yes", it is worth proceeding with the remaining questions. There is some degree of overlap between the questions, you are asked to record a "yes", "no" or "can't tell" to most of the questions. A number of italicised prompts are given after each question. These are designed to remind you why the question is important. Record your reasons for your answers in the spaces provided.

Referencing: *Critical Appraisal Skills Programme (2018). CASP (insert name of checklist i.e. Cohort Study) Checklist. [online] Available at: URL. Accessed: Date Accessed.*

Paper for appraisal and reference: .....

Section A: Are the results of the study valid?

1. Did the study address a clearly focused issue?

Yes ☐
Can't Tell ☐
No ☐

HINT: A question can be 'focused' in terms of
- the population studied
- the risk factors studied
- is it clear whether the study tried to detect a beneficial or harmful effect
- the outcomes considered

Comments:

2. Was the cohort recruited in an acceptable way?

Yes ☐
Can't Tell ☐
No ☐

HINT: Look for selection bias which might compromise the generalisability of the findings:
- was the cohort representative of a defined population
- was there something special about the cohort
- was everybody included who should have been

Is it worth continuing?

Comments:

3. Was the exposure accurately measured to minimise bias?

Yes ☐

Can't Tell ☐

No ☐

HINT: Look for measurement or classification bias:

- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- were all the subjects classified into exposure groups using the same procedure

Comments:

4. Was the outcome accurately measured to minimise bias?

Yes ☐

Can't Tell ☐

No ☐

HINT: Look for measurement or classification bias:

- did they use subjective or objective measurements
- do the measurements truly reflect what you want them to (have they been validated)
- has a reliable system been established for detecting all the cases (for measuring disease occurrence)
- were the measurement methods similar in the different groups
- were the subjects and/or the outcome assessor blinded to exposure (does this matter)

Comments:

5. (a) Have the authors identified all important confounding factors?

Yes

Can't Tell

No

HINT:

- list the ones you think might be important, and ones the author missed

Comments:

5. (b) Have they taken account of the confounding factors in the design and/or analysis?

HINT:

- look for restriction in design, and techniques e.g. modelling, stratified-, regression-, or sensitivity analysis to correct, control or adjust for confounding factors

Comments:

6. (a) Was the follow up of subjects complete enough?

HINT: Consider

- the good or bad effects should have had long enough to reveal themselves
- the persons that are lost to follow-up may have different outcomes than those available for assessment
- in an open or dynamic cohort, was there anything special about the outcome of the people leaving, or the exposure of the people entering the cohort

6.(b) Was the follow up of subjects long enough?

Comments:

Section B: What are the results?

7. What are the results of this study?

HINT: Consider
- what are the bottom line results
- have they reported the rate or the proportion between the exposed/unexposed, the ratio/rate difference
- how strong is the association between exposure and outcome (RR)
- what is the absolute risk reduction (ARR)

Comments:

8. How precise are the results?

HINT:
- look for the range of the confidence intervals, if given

Comments:

9. Do you believe the results?

Yes
Can't Tell
No

HINT: Consider
- big effect is hard to ignore
- can it be due to bias, chance or confounding
- are the design and methods of this study sufficiently flawed to make the results unreliable
- Bradford Hills criteria (e.g. time sequence, dose-response gradient, biological plausibility, consistency)

Comments:

Section C: Will the results help locally?

10. Can the results be applied to the local population?

Yes
Can't Tell
No

HINT: Consider whether
- a cohort study was the appropriate method to answer this question
- the subjects covered in this study could be sufficiently different from your population to cause concern
- your local setting is likely to differ much from that of the study
- you can quantify the local benefits and harms

Comments:

11. Do the results of this study fit with other available evidence?

Yes
Can't Tell
No

Comments:

12. What are the implications of this study for practice?

Yes ☐

Can't Tell ☐

No ☐

HINT: Consider

- one observational study rarely provides sufficiently robust evidence to recommend changes to clinical practice or within health policy decision making
- for certain questions, observational studies provide the only evidence
- recommendations from observational studies are always stronger when supported by other evidence

7.4 Revised Cochrane risk-of-bias tool for randomized trials (RoB 2): Version of 22 August 2019

Study details

Reference	

Study design

X Individually-randomized parallel-group trial

☐ Cluster-randomized parallel-group trial

☐ Individually randomized cross-over (or other matched) trial

For the purposes of this assessment, the interventions being compared are defined as

Experimental: | Comparator:

Specify which outcome is being assessed for risk of bias	
Specify the numerical result being assessed. In case of multiple alternative analyses being presented, specify the numeric result (e.g. RR = 1.52 (95% CI 0.83 to 2.77) and/or a reference (e.g. to a table, figure or paragraph) that uniquely defines the result being assessed.	

Is the review team's aim for this result…?

☐ to assess the effect of *assignment to intervention* (the 'intention-to-treat' effect)

☐ to assess the effect of *adhering to intervention* (the 'per-protocol' effect)

If the aim is to assess the effect of *adhering to intervention*, select the deviations from intended intervention that should be addressed (at least one must be checked):

☐ occurrence of non-protocol interventions

☐ failures in implementing the intervention that could have affected the outcome

☐ non-adherence to their assigned intervention by trial participants

Which of the following sources were obtained to help inform the risk-of-bias assessment? (tick as many as apply)

☐ Journal article(s) with results of the trial
☐ Trial protocol
☐ Statistical analysis plan (SAP)
☐ Non-commercial trial registry record (e.g. ClinicalTrials.gov record)
☐ Company-owned trial registry record (e.g. GSK Clinical Study Register record)
☐ "Grey literature" (e.g. unpublished thesis)
☐ Conference abstract(s) about the trial
☐ Regulatory document (e.g. Clinical Study Report, Drug Approval Package)
☐ Research ethics application
☐ Grant database summary (e.g. NIH RePORTER or Research Councils UK Gateway to Research)
☐ Personal communication with trialist
☐ Personal communication with the sponsor

Risk of bias assessment

Responses underlined in green are potential markers for low risk of bias, and responses in red are potential markers for a risk of bias. Where questions relate only to sign posts to other questions, no formatting is used.

Domain 1: Risk of bias arising from the randomization process

Signalling questions	Comments	Response options
1.1 Was the allocation sequence random?		Y / PY / PN / N / NI
1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?		Y / PY / PN / N / NI
1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?		Y / PY / PN / N / NI

Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias arising from the randomization process?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 2: Risk of bias due to deviations from the intended interventions (*effect of assignment to intervention*)

Signalling questions	Comments	Response options
2.1. Were participants aware of their assigned intervention during the trial?		Y / PY / PN / N / NI
2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?		Y / PY / PN / N / NI
2.3. If Y/PY/NI to 2.1 or 2.2: Were there deviations from the intended intervention that arose because of the trial context?		NA / Y / PY / PN / N / NI
2.4 If Y/PY to 2.3: Were these deviations likely to have affected the outcome?		NA / Y / PY / PN / N / NI
2.5. If Y/PY/NI to 2.4: Were these deviations from intended intervention balanced between groups?		NA / Y / PY / PN / N / NI
2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention?		Y / PY / PN / N / NI
2.7 If N/PN/NI to 2.6: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to deviations from intended interventions?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 2: Risk of bias due to deviations from the intended interventions (*effect of adhering to intervention*)

Signalling questions	Comments	Response options
2.1. Were participants aware of their assigned intervention during the trial?		Y / PY / PN / N / NI
2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?		Y / PY / PN / N / NI
2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?		NA / Y / PY / PN / N / NI
2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?		NA / Y / PY / PN / N / NI
2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?		NA / Y / PY / PN / N / NI
2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to deviations from intended interventions?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 3: Missing outcome data

Signalling questions	Comments	Response options
3.1 Were data for this outcome available for all, or nearly all, participants randomized?		Y / PY / PN / N / NI
3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biased by missing outcome data?		NA / Y / PY / PN / N
3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?		NA / Y / PY / PN / N / NI
3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to missing outcome data?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 4: Risk of bias in measurement of the outcome

Signalling questions	Comments	Response options
4.1 Was the method of measuring the outcome inappropriate?		Y / PY / PN / N / NI
4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?		Y / PY / PN / N / NI
4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants?		NA / Y / PY / PN / N / NI
4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?		NA / Y / PY / PN / N / NI
4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias in measurement of the outcome?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 5: Risk of bias in selection of the reported result

Signalling questions	Comments	Response options
5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?		Y / PY / PN / N / NI
Is the numerical result being assessed likely to have been selected, on the basis of the results, from...		
5.2. ... multiple eligible outcome measurements (e.g. scales, definitions, time points) within the outcome domain?		Y / PY / PN / N / NI
5.3 ... multiple eligible analyses of the data?		Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to selection of the reported result?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Overall risk of bias

Risk-of-bias judgement		Low / High / Some concerns

Optional: What is the overall predicted direction of bias for this outcome?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

7.5 Declaration of Authorship

I hereby certify that, I am the sole author of this thesis and that neither any part of this thesis nor the whole of the thesis has been submitted for a degree to any other institution. I declare that, to the best of my knowledge this thesis does not violate any proprietary rights and that any ideas, quotations or any other material from other sources included in this thesis are fully acknowledged and properly referenced.

Hamburg May 2020.