



A Double-Edged Sword: The Effects of Cartoon Media on the Development of Children's Eating Habits

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Abstract

The global childhood obesity epidemic has been a rising health concern over the past two decades. Obesity is associated with premature death, type 2 diabetes, and many other serious diseases and health conditions. Developing healthy eating habits early at a young age is a way to prevent diet-related diseases. Given the substantial increase in the prevalence of childhood obesity, various research studies have been conducted to treat this public health issue. Health campaigns worldwide have depended on multiple methods to reduce this crisis, including physical activity and diet-control programs, medicine, and surgery. Recent studies have found an additional promising and encouraging way to promote healthy eating among children: cartoons. Cartoons can affect cognitive development and encourage positive behaviors in children. Cartoons promoting a healthy diet can influence the food choices of children. However, cartoons have drawbacks as consuming media creates a sedentary lifestyle and could also be used to promote unhealthy foods to children. This review analyzes the effects of cartoons on children, how exposure to cartoon images can change children's behaviors and the underlying mechanisms of graphic media. Although using cartoon images is a promising way to reduce the prominence of childhood obesity, due to limited data concerning the long-term benefits of exposure to media, the combination of healthy eating cartoons with other traditional healthy eating techniques should also be considered.

Keywords: *Cartoons, childhood obesity, healthy eating habits, body mass index (BMI), cognitive development, food choices.*

Introduction

Childhood obesity has become a rising global public health crisis, especially over the past two decades. Obesity is a serious health condition in which someone's body mass index (BMI) is significantly higher than the average weight for age and height. The number of those affected by obesity and health problems related to being overweight continues to rise at an alarming rate (**Figure 1**). In 2016, approximately 124 million children and adolescents ages 5-19 were obese and about 25% of children are overweight, and this percentage is still getting larger ^[1]. It is estimated that by 2050, more than 43% of children and adolescents in the U.S. will be overweight or obese ^[2]. Children who are overweight experience many significant physical, psychological, and social consequences ^[3]. Due to these reasons, the World Health Organization (WHO) poses childhood obesity as one of the most threatening global public health challenges of the 21st century ^[4]. Children spend a significant portion of their day in front of screens and cartoons are one of the most consumed and appealing types of media by children. Cartoon characters can be defined as anything from generic cartoon imagery, brand mascots, to popular characters created and licensed by entertainment media companies. Studies have shown that children receive many food messages while watching various media through cartoons and television ^[4]. Food companies often work with

children's media to promote junk food or other foods low in nutritional value through advertisements or by endorsing them with their favorite characters. In contrast, healthy products are rarely promoted or advertised to children. Children and adolescents throughout the world consume far below the recommended amount of fruit and vegetables per day. Instead, they are overindulging in sugary and processed products that can negatively affect their BMI and their overall health ^[5]. In addition, children greatly impact a family's food budget, so encouraging them to try healthier foods can significantly alter their family's diet. Media can be used to make children and adolescents open to consuming more nutritious foods by familiarizing and promoting them through the use of their favorite characters.

Since cartoon media can significantly impact a child's diet, health campaigns and programs can create cartoons to promote a healthier diet. The media can be used to advertise not only junk food but also healthier food options. Through this review, we will analyze the changes in children's diets over time and the effects of various media on promoting healthy products. Cartoon media influence brain development, especially at an early age, and which can have a long-lasting impact on someone's diet as they age. Therefore, it is important to familiarize children with healthy foods to help them develop healthy eating habits throughout the rest of their lives.

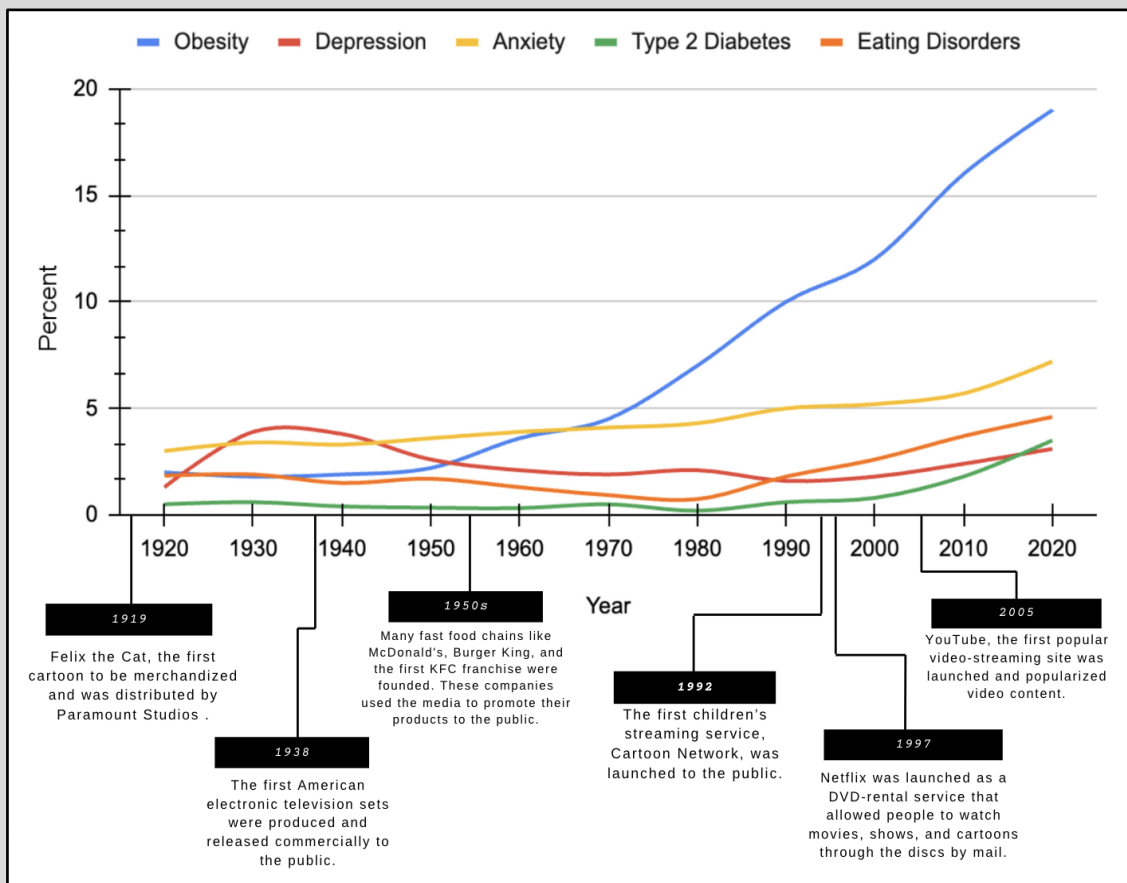


Figure 1: Trends in obesity and related disorders among American children and adolescents aged 4–17 from 1980-2020 [6–10]

1. Children’s Diet Habits and Changes to Their Health

1.1 The Global Impacts and Health Risks of Childhood Obesity

Obesity among children is an international health problem, especially within affluent societies. According to the WHO, the number of overweight people has doubled since 1980. In 2014, nearly 41 million children ages 5 or under around the world were estimated to be obese or overweight [11]. In 2024, the Centers for Disease Control and Prevention (CDC) estimated that this number has increased to \$173 billion annually in the U.S. healthcare system alone. Treating obesity can be extremely costly and financially draining. A past marketing study estimated that about 10 billion dollars are spent yearly on diet foods, weight loss medications, technology, and programs to treat obesity in the U.S. [12]. Obesity and being overweight can also affect children’s self-esteem and confidence. Many overweight children exhibit personality characteristics such as withdrawal, passivity, negative self-image, and the expectation of rejection. Furthermore, children with a high BMI have a heightened probability of becoming overweight adults; childhood obesity is also linked with a higher rate of disease and mortality later in life [1]. Obesity can be prevented through various methods, such as maintaining regular physical exercise, managing stress, getting adequate sleep, and creating a healthy diet [13]. A healthy diet includes eating plenty of fruits and vegetables while also limiting the intake of highly processed or sugary foods. Therefore, two additional important obesity prevention objectives include reducing the extent to which children are exposed to all forms of unhealthy food marketing and reducing the persuasiveness of these advertisements and promotions.

1.2 The Long-Term Impacts of Consuming Unhealthy Foods on Children and Adults

The prolonged consumption of sweet and high-caloric foods in an American diet leads to many health problems. Studies have found a connection between the long-term consumption of products rich in sugar, saturated fats, and salt, and the prominence of numerous diet-related issues such as type-2 diabetes, heart disease, sleep apnea, stroke, arteriosclerosis, and various types of cancer [12]. Some prominent consequences of a high-sugar diet are obesity and tooth decay, especially among children. Multiple sources estimate that most American children have tooth decay, commonly caused by poor dental care and prolonged consumption of sugary foods [12]. This rising problem impacts not only children but also adults, as these health problems can persist into adulthood, especially if poor health and diet habits are not changed. For example, people who are overweight during their youth are more likely to develop cardiovascular diseases and diabetes as they age. Thus, it is essential to encourage people to develop healthy habits during childhood to prevent potential health problems later on in life.

1.3 The Influence of Unhealthy Promotions on Children's Food Preference

Children's media is full of unhealthy food influences. Children are often shown depictions of less healthy foods such as sweetened snacks, sweets, and sodas. The majority of television advertisements are for food high in sugar, processed chemicals, and calories [14]. For instance, the most commonly advertised foods and beverages worldwide are carbonated sodas, flavored drinks, and sweets. Past research has indicated that unhealthy products were promoted four times more than healthy foods [14]. Due to the prominence of unhealthy foods being promoted on television, researchers have started to investigate the effects of these commercials on children’s eating habits [12]. Studies conducted by Halford *et al.* have found that

direct exposure to foods high in fat and sugar through children's media can contribute to the rise of child obesity. In their study, 42 children were separated into 3 groups based on their BMI, and their intake of foods was investigated after they were exposed to food advertisements. The results of the experiment indicated that the majority of children consumed more food after witnessing the ad, especially in the overweight and obese groups. This study suggests that advertising foods on television or in stores is a major indirect influence on children's food preferences and intake [15].

In addition to the increased intake of unhealthy products, children and adolescents in the U.S. consume fruits and vegetables far under the recommended amount [16]. Not only are children shown more unhealthy foods than healthy food options in media content directed at them, but the specific presentations of processed foods are also more persuasive than those of healthy foods [5]. Past research has shown that unhealthy eating behavior is greatly impacted by the presentation of less healthy food in entertainment media, such as TV, movies, and cartoons. For example, food companies widely use cartoon characters on television advertisements or product packaging to encourage children to consume unhealthy products rich in saturated fats, sugars, or salt [17]. While food companies' use of cartoon characters in their advertisements and product packaging is often blamed for promoting unhealthy diets in children, these techniques can also be used to promote healthy foods like fruits and vegetables [17]. An improved approach to food marketing is needed to shift the balance from less healthy promotions to more nutritious ones. This is essential to encouraging healthier eating habits among children as media can significantly impact someone's food choices. Positive types of media that encourage healthy foods can thus help promote more nutritious food choices. The global childhood obesity epidemic can be properly addressed by combining the promotion of healthy foods through children's media and other efforts, such as higher quality school meals, regular exercise, and clear nutrition labeling, as well as reducing the promotion of unhealthy foods in the media [2].

2. Promotion of Healthy Eating Habits

2.1 The Importance of a Healthy Diet and Familiarizing Children with Healthy Foods

Children who develop a healthy and varied diet have a better chance of maintaining these healthy food preferences throughout the rest of their lives. According to WHO, fruits and vegetables are crucial to a healthy and balanced diet. Consuming at least five portions of fruit or vegetables daily can drastically reduce someone's risk of developing chronic diseases [18]. A nutritional study conducted by Lin and Morrison surveyed more than 2000 children between the ages of 2 to 12 for their BMI and their food intake over two days. The results found that children and adolescents who do not eat their daily intake of fruits and vegetables generally have higher BMIs than ones who do and are thus more susceptible to being obese or overweight [19]. This shows the relative importance of meeting daily fruit and vegetable intake and why it is essential to encourage children to eat healthier.

Food neophobia is the avoidance or reluctance to try new foods. In recent studies, researchers have indicated that food neophobia is an essential factor in determining a child's eating behavior. Children who were found with food neophobia generally consume a much lower amount of healthy foods and mainly consume a limited variety of foods often high in fat, salt, or sugar [20]. A study conducted by Binder *et al.* investigated the role of food neophobia when children were either shown a cartoon where no food was present or a cartoon displaying children eating raspberries. This study concluded that children who scored high in food neophobia

often avoided choosing healthy snacks despite being aware of their peers' preference for raspberries. This shows the strong effects of food neophobia and explains why it is essential to reduce this fear when trying to encourage children to eat novel foods. Thus, it is important to familiarize children with healthy foods to make them more comfortable trying them. However, encouraging healthy eating behaviors in children through the presentation of healthy foods in media content is much more challenging than unhealthy foods. People have a biological preference for less healthy foods and tend to prefer sweet and salty foods over those that are bitter or bland [20]. This preference is strengthened by cues shown in the media given the prevalence of unhealthy promotion. Most children have an immense influence over the foods a family purchases. Studies show that children can influence up to eighty percent of a family's food budget [3]. Therefore, it is important to encourage healthy eating habits in children as they can play a tremendous part in a family's overall diet.

2.2 The Effects of Food Cues Within Children's Media

Television shows, advertisements, and other forms of media often contain visual cues that encourage the consumption of unhealthy products (Table 1). On the contrary, the media can also encourage children to consume healthier foods through the presentation of nutritious foods, which are not biologically preferred. According to the social learning theory, people learn new behaviors by observing and imitating those around them, especially during childhood [21]. Children typically learn new behaviors by replicating the behavior of role models, which are the people or characters that they look up to, such as their parents or their favorite cartoon characters. As a result, the eating behavior or the promotion of certain foods by their favorite cartoon characters is likely to impact their eating behavior [20]. Various studies have indicated that children exposed to multiple fruits and vegetables in their childhood developed healthy eating habits and preferred those foods later in life. One particular study conducted by Binder *et al.* found that including heroic cartoon characters consuming vegetables and fruits within audiovisual cartoons had a positive impact on children's vegetable and fruit intake [20]. Thus, children's food neophobia and their rejections of unfamiliar foods can be overcome if they are provided with opportunities to taste them or repeatedly presented these foods in a positive context, which can increase their liking for that food. This shows that children's food choices are linked to their familiarity with foods during their early years; the more familiar they are with the food, the more it is liked and will be consumed [22].

2.3 Addressing Childhood Obesity Through Media, Incentives, and Parental Influence

Due to the risks of childhood obesity and its lasting impacts on someone's adult life, preventing obesity and being overweight among children is a major concern that struggles to be addressed. Some recent approaches have tried to promote healthy eating behaviors among elementary students at school, such as providing different types of incentives using rewards for consuming one serving of fruit or vegetables. These rewards could be special tokens that could be spent at the school store or stickers and small gifts for selecting healthy lunch items. These studies discovered a positive increase in fruit and vegetable consumption, but these effects were short-term and often diminished after the incentives were removed [1]. A 2019 study found popular children's cartoon TV series often project foods of low nutritional value, such as sweets, salty snacks, and sodas. These foods are commonly displayed in an appealing way, either being consumed or discussed by cartoon characters, which makes children more attracted to these foods despite how unhealthy they might be [23]. This raises concerns about whether

certain controls regarding the display of food in children’s media, such as those currently enforced in advertisements, should be applied to reduce these negative influences. In addition, health educators and parents should also be notified of the food messages conveyed in cartoon series to prevent possible detrimental consequences on their children’s diet [23].

Parents and guardians are one of the biggest driving forces of their children’s diet, as they can control or limit the foods a family eats to a significant extent. Although many parents try their best to encourage their children to eat healthier foods, some may be reluctant or incapable of providing their children with the exposure

necessary to familiarize them with new foods. Healthy or organic products are often costly and can be hard to access in many parts of the world, which makes it difficult to familiarize children with nutritious foods. A common strategy parents use to get their children to consume healthy foods is to disguise vegetables as more appealing foods. Although this method can effectively achieve short-term goals, like getting children to eat their daily intake of fruits or vegetables, it fails to help them build desirable long-term behaviors [22]. Further research needs to be done to find a way to make healthy promotional media or nutritious foods in general available to more people to help improve global health.

Table 1: Types of Cartoon Media and Their Influences on Children’s Behaviors

Types of Media	Description of Media	Impacts on Children’s Eating Behaviors
Television	Children’s television often shows cartoons in TV series, movies, and other animations.	Television can shape children’s food choices by promoting certain foods through advertisements and by featuring their favorite characters consuming or interacting with a specific food item.
Product Packaging	Many products are packaged using bright colors, cartoon characters, and interactive images to attract children.	Bright, eye-catching designs, and loved characters present on food packaging affect how children view the food as children are naturally drawn to visually stimulating imagery, which can encourage them to consume the product within the packaging.
Popular Characters	Well-known cartoon characters are used in television advertisements, food packaging, store posters, etc to attract children.	Food companies license popular children’s media characters to promote unhealthy snacks or beverages. These characters appeal to children and make them prefer the foods endorsed by their favorite characters.
Advertisements	Both digital and physical advertisements use cartoon images to persuade children to purchase or consume the promoted products.	Advertisements can promote foods through repetition and misleading claims to persuade parents and attract children. Children are more susceptible to advertisement’s persuasiveness given their immature critical thinking skills and their lack of impulse inhibition.
Well-Known Brands and Mascots	Children tend to associate the appeal of certain foods with a brand if a popular brand is present.	Brands can convince children and parents to consume or purchase certain goods because they create trust and comfort. These brands are often supported by unhealthy food industries which use these popular brands to convince families to buy their products.
Social Media and Streaming Apps	Streaming apps and social media platforms like YouTube, TikTok, or Netflix can influence children’s behaviors by showing them examples of how to act in various scenarios.	Social media platforms use specific algorithms to target children with advertisements for food products. They also create social pressures and influencer marketing to convince people of all ages to consume certain products that may be beneficial or harmful to them.

3. Impact of Media on Children’s Food Choices

3.1. Popular Characters Effects on Children’s Food Choices

The media can impact children’s food choices in various ways. Messages transmitted to children through the media they consume can significantly impact their perception of foods and their willingness to consume certain foods. One notable way the media makes certain foods attractive or appetizing to children is by portraying a popular or a favorite character. Advertisements or packaging containing these specific characters make the product more eye-catching and appealing, as children associate the promoted food with these characters. Additionally, children may see these cartoon characters as role models and follow what they do. If these characters are shown consuming or promoting a specific food item, children will like that food more and have an increased willingness to consume it.

Studies have determined that television and the internet mainly use popular characters to advertise less healthy foods such as salty snacks, sugary beverages, and sweets, while these commercials rarely feature the fruits and vegetables essential to people’s diets [23]. Licensed characters such as SpongeBob SquarePants, Mickey Mouse, and Scooby-Doo have been widely used in commercials and food packaging to endorse unhealthy products to children. Their popularity among children makes the products and brands associated with these characters more appealing. A frequently used marketing strategy for packaging children’s food products is to add images of

popular cartoon characters on the products [24]. Food companies often use these well-known characters to promote their sugary or junk food products, such as Tony the Tiger, which promotes Kellogg’s Frosties with more than a third of 100 grams being sugar, and Quicky the Bunny, who is featured on the majority of Nesquik’s unhealthy products [2]. These characters make the product more attractive to children, increasing their likelihood of purchasing and consuming the marketed food. Other licensed cartoon characters created by entertainment productions, such as movies (e.g. Frozen, the Minions) or video games (e.g. Pokémon, Mario Bros) have been used to promote food items as well. Hémar-Nicolas *et al.* conducted a cross-cultural study with 8 to 11-year-old Danish and Indonesian children to examine their responses to snack and vegetable packaging. They concluded that packaging displaying a cartoon character improves children’s liking, choice, and intake of healthy foods (e.g. cucumber) much more than those that do not. Their study has reported that popular licensed characters create familiar and emotional links with children that encourage them to consume the product endorsed by the character [17]. Other studies have been done to investigate the extent popular characters can affect children’s food choices. In a set of experiments conducted by Kotler *et al.*, they determined that well-known children’s characters can successfully sway children into selecting one food over another. In their first experiment centered around children’s self-reported preferences, children tended to show a preference for one particular food over others if it was associated with a character that they liked and were

familiar with. The second experiment that focused on their actual choices suggested that children are more willing to try healthy food items that are promoted by a favored character rather than an unknown character [25]. The results from these studies suggest that cartoon characters can make the endorsed product more appealing to children, making them more likely to want to purchase and consume the food.

Healthy food items packaged using these commonly loved characters can attract children at the store to buy and consume the food. Currently, popular characters are often used by junk food companies to promote their products, but they should also be used within cartoons or advertisements to promote more nutritious products. However, one hitch in this idea is that many fruit and vegetable producers cannot afford to use licensed or popular cartoon characters because they are often expensive and require a high financial investment in licensing. For the same reason, health campaign programs may also struggle to incorporate these popular children's characters to aid in their efforts to promote healthier eating. Further studies need to be done to examine the extent producers and health programs can use less popular and less costly cartoon characters to encourage children to eat healthier products [17].

3.2. The Impact of Digital Advertisements and Television on Children's Choice

One of the most frequent ways children consume media is through television. In 2017, the National Institute of Medicine (NIH) reported that advertisements on television influences children's preferences for certain foods, purchase requests, and their diets. Furthermore, TV is also associated with heightened rates of obesity among children and adolescents [24]. The presentation of unhealthy foods throughout children's media has been an important topic of research given its harmful effects on a child's diet and food choices. Various experimental studies done by Auty *et al.* established that children prefer to consume products and change their eating behavior to match what they see in media content [26]. Studies have found a positive relationship between childhood obesity and TV viewing among children and adolescents [27]. This relationship is often thought to be because of the sedentary nature of consuming digital media but research has shown it could also be due to the predominance of unhealthy foods that are being promoted within the media. Dixon *et al.* investigated the influences of television advertisements on children's food choices for both nutritious foods and junk food. Their study indicated that exposure to television was associated with more positive attitudes toward junk food by creating the perception that their peers are often consuming these foods [2]. Additionally, when shown commercials promoting healthy foods, children showed a much smaller increase in liking towards healthier foods. The result of this study suggests that exposure to television food advertisements creates beliefs and attitudes that support the promoted foods, but it is much easier to promote unhealthy foods than more nutritious options. Several surveys and correlational studies have discovered that on average every week, children watch around 28 hours of television and witness more than 11 thousand junk food advertisements every year on television [12]. Since children's brains are not completely developed, they tend to believe what commercials are telling them and they will often recall the advertisements and request for the foods presented in the advertisements. As a result, advertisements can greatly influence children and impact their family's consumer behavior.

Even before they can read, children from the ages of two or three can recognize and remember familiar characters or products. By the time they're in preschool, they start to recall brands or products they've seen on television advertisements, especially those

with appealing visual cues like bright colors, pictures, or cartoon characters. Braun-LaTour *et al.* found evidence that childhood exposure to a promotional device such as advertisements is essential for creating positive feelings such as warmth and affectionate attitudes toward the promoted object [28]. Past research has indicated that consuming media, such as watching movies and TV shows, are among children's favorite and most commonly performed activities. This can severely affect children's food choices because the media contains numerous food cues that promote certain products, especially unhealthy ones [18]. For instance, a survey monitoring commercials on four popular Chicago TV stations found that 70% of the advertisements directed toward children were for food products rich in fats, cholesterol, and sugars. They also discovered that only 3% of all the advertisements were for fruits and vegetables [12]. Television food commercials can negatively impact children's health and diet by encouraging long-lasting preferences for unhealthy foods that possess little nutritional value, such as those high in calories, fats, and sugar. These commercials have also been shown to be able to encourage healthy eating behaviors but to lesser extents. Binder *et al.* examined the effect of nutritional messages on 6 to 10-year-old children's healthy eating behavior in Austria. They found that audio-visual cartoon movies containing gain-framing messages (focusing on achieving a desirable outcome or avoiding an undesirable outcome) can be an effective way to influence children's healthy food preferences as the children that were exposed to the gain-framing messages had an increased fruit intake compared to those who weren't shown the messages [18]. Additionally, Dikmen *et al.* reported that around 70% of adolescents in the U.S. stated that they were influenced by food commercials on television and 66.4% of them purchased the advertised products [29]. However, many children and adolescents today have shifted towards online content-sharing platforms or video-on-demand subscription services like YouTube and Netflix rather than traditional television. As adolescents have started transitioning towards social media and other streaming platforms and away from television, the average exposure of children and adolescents to food commercials has decreased by an astounding 31% [14]. Despite this change in media consumption, social media and streaming platforms like YouTube or Netflix still contain numerous food cues that can impact children's eating behaviors.

Advertisements and television commercials are not the only way foods are broadcasted in children's media as movies and TV series found on these platforms project scenes in which food appears with verbal and visual comments. Dialogues promoting certain foods or actors interacting with these foods within entertainment platforms can easily promote the food presented in the media, creating negative side effects. Due to the dominance of unhealthy food items high in sugar and processed fats in children's television and movie programming, regulations should be set to control the number of food cues presented to people, especially children [23]. Children shown junk food advertisements display more favorable attitudes and attractions towards unhealthy foods than children not exposed to the advertisements. Likewise, children exposed to commercials featuring healthy food exhibit more favorable attitudes toward healthy foods and are more willing to consume more nutritious products. Television advertisements can provide children with higher nutrition knowledge, helping them make healthier eating decisions [27]. However, children's food preferences can also be strongly shaped by parents as they can play a huge role in controlling the foods their children eat or the media they consume [12]. Thus, it is important for parents to encourage or discourage certain products to help their children avoid potentially harmful foods and to help them eat healthier.

3.3. Impact of Product Labeling and Brands on Food Choice

The effects of product packaging and brands on consumer food choices are less studied than television food advertisements, but that doesn't mean it is less influential. Unlike television or other forms of digital advertising, the packaging of a product is crucial to the decision-making process at the time of sale. Both food advertisements and the use of cartoon characters on food packaging play an essential role in forming children's food choices by promoting specific food items. Substantial research has focused on the extent to which television advertising messages and mass marketing campaigns can affect children's diets. However, limited research has been done on the messages wrapped around the product or inscribed within it. Studies done on the nutritional quality of packaged foods at supermarkets have classified 97% of the products directed toward children as ultra-processed and 89% as unhealthy [30]. Many food products display cartoon characters on the packaging or the product itself through the character's shape, color, or design. Any "common" food item can be marketed as fun and interesting to children through popular cartoons, bright colors, fun shapes, and interactive packaging. By intertwining the use of cartoon images and fun fonts, food companies can attract children to purchase their products despite how detrimental the product may be [3]. Given the harmful impacts of attractive food packaging, extensive research has been conducted to prove that product packaging strongly impacts how consumers evaluate products. The tiniest of details, such as the colors used on the packaging or even the size or shape of the package that the product is contained, can influence someone's preferences and perceptions [24].

Children can discover brands from their parents, peers, and through their media. An essential factor that influences how someone perceives a food is the existence of a familiar or popular brand on the food packaging. A 2007 study examined children's food preferences when certain food items were either placed in a McDonald's wrapper or wrapper without a brand logo. The outcomes of the study found that children ages 3 to 5 rated foods as tastier when they were contained in a McDonald's wrapper even if the food was the same. This finding held for both unhealthy foods like chicken nuggets and healthy foods such as carrots [24]. This shows that children unconsciously associate brands that they like as more appealing and will be more willing to eat the foods promoted by that brand. Children have been found to be able to memorize brand names and mascots. However, they often get confused about the nutritional value of promoted foods because they either are unaware of how nutritious the food is or are deceived into believing the foods are healthy or appetizing by the packaging [23]. Due to this reason, food companies have successfully marketed various unhealthy products to children by associating them with familiar licensed brands or their mascots. Brand mascots are often cartoon characters created exclusively to promote a certain brand (e.g. Tony the Tiger for Kellogg's Frosties, the Kool-Aid Man for Kool-Aid). As part of the brand's visual identity, its mascots are often featured in advertising and on packaging to make people instantly recognize the brand and associate the product with that brand. Due to their visual format, this use of cartoon characters enhances children's brand awareness and thus their familiarity with the product [17].

Food packaging targeted towards children in itself is a form of food advertisement. Popular characters and brand mascots are often used to promote food products presented to children because they can increase consumer preference when they are depicted on food packaging [23]. A 2015 study conducted by Baldassarre and Campo examined the extent cartoon characters packaged directly on fruit and vegetables can make the foods more appealing to younger children. They sampled kindergarteners from 5 to 6 years old and

investigated their current food habits and their preferences towards certain cartoon characters. The participants were asked to select the foods they thought were the tastiest. The foods included various fruits and vegetables with a sticker displaying an image of their favorite characters and common brands of salty and sweet snacks without cartoon pictures on their packaging. The results of the experiment indicated that cartoon characters can deeply influence children's choices when selecting what foods they want to eat as the participants chose much more healthy foods when the sticker was included. This research finding suggests that cartoon characters can be a promising marketing tool to encourage children to consume fruits and vegetables [31]. Health campaigns, programs, and parents can incorporate various techniques such as packaging or displaying healthy foods with their favorite cartoon characters to boost children's fruit and vegetable intake. However, this method may only help solve short-term goals of making children eat their daily fruits and vegetables, but it may not help them develop long-term healthy eating habits. This technique may help familiarize children with foods that they may previously have not wanted to try, but other methods may be necessary to develop long-lasting healthy food choices.

4. The Influences of Media on Brain Development

4.1 The Effects of External Stimuli on Children's Brain Development

Throughout someone's life, their brain forms countless connections. These connections create memories, habits, ways of thinking, and mind. By the age of three, a child's brain would have created more than a thousand trillion synapses, almost twice as much as what they would have when they become an adult. The connections built by a child's brain can be either strengthened through repeated experiences or weakened if not used. After they are ten years old, the connections that are enforced through repeated exposures begin to affect a child's brain structure and shape their habits and way of thinking. Any less frequent experiences still affect their brain structure but to a lesser extent. More importantly, repeatedly formed connections by the age of 12 are so effective that they can leave a lifetime effect on a person's behaviors and thoughts [32]. Therefore, it is important to leave positive imprints on a child's mind to help them create more successful habits throughout their life. Thus, exposing people to healthy eating messages and providing them with positive impressions of healthy foods early in life can help them develop better eating habits throughout their lives.

Cartoons are one of the most common elements that sculpt children's brains, influencing their way of thinking and behavior when encountering new environments [32] (Figure 2). However, digital media can positively and negatively impact children's brains both structurally and functionally. Early experiences with digital media cause ambivalent impacts on children's brain structure. From a scientific perspective, digital experiences could create transformations in children's frontal, parietal, occipital, and temporal lobes and affect their brain connectivity and networks. It can also affect vulnerable areas like the prefrontal cortex—which controls attention, emotion, complex learning, and various processing mechanisms—and impacts the brain's executive function [33]. From a sociocultural perspective, cartoons can help educate children about the world, which can have both encouraging and dangerous consequences. On one hand, cartoons can improve children's verbal and cognitive abilities, encouraging them to think critically, creatively, and form connections. The influences displayed by cartoon characters encourage children to imitate virtues like

kindness, courage, honesty, and compassion. Cartoons can also aid children in developing their vocabulary and help them fit into the world they live in by teaching them social norms, teamwork, and much more. Additionally, they enable children to learn about appropriate behaviors under various circumstances and the importance of controlling their emotions. However, cartoons can also have many harmful effects that lead to unintended consequences and dangerous behaviors. Children who watch too many cartoons may become isolated from their friends and family as they lose their ability to socially interact with real people. Children exposed to violent cartoons can become more aggressive, violent, or hot-tempered [34]. Since the connections formed by the brain during childhood can leave lasting effects on someone's life, an aggressive child tends to become an aggressive adult. Furthermore, cartoons

can also cause unintended dangerous behaviors in children. In 2000 for example, Seda Aykanat, a 7-year-old girl in Turkey leapt off a fifth-floor balcony and was seriously injured. When asked why she did something so dangerous, the girl admitted that she believed she was a Pokémon character with superpowers and wanted to imitate their abilities. Not too long ago, a similar accident occurred with a 4-year-old boy who also suffered tragic injuries due to the same reason. According to ABC News, these events caused Turkish officials to issue Pokémon warnings to prevent further harmful events and compelled TV stations to replace Pokémon cartoons with other children's programs [35]. Numerous other similar instances of children committing dangerous actions under the influence of cartoons show the possible detrimental side effects of watching cartoons or consuming media in general.

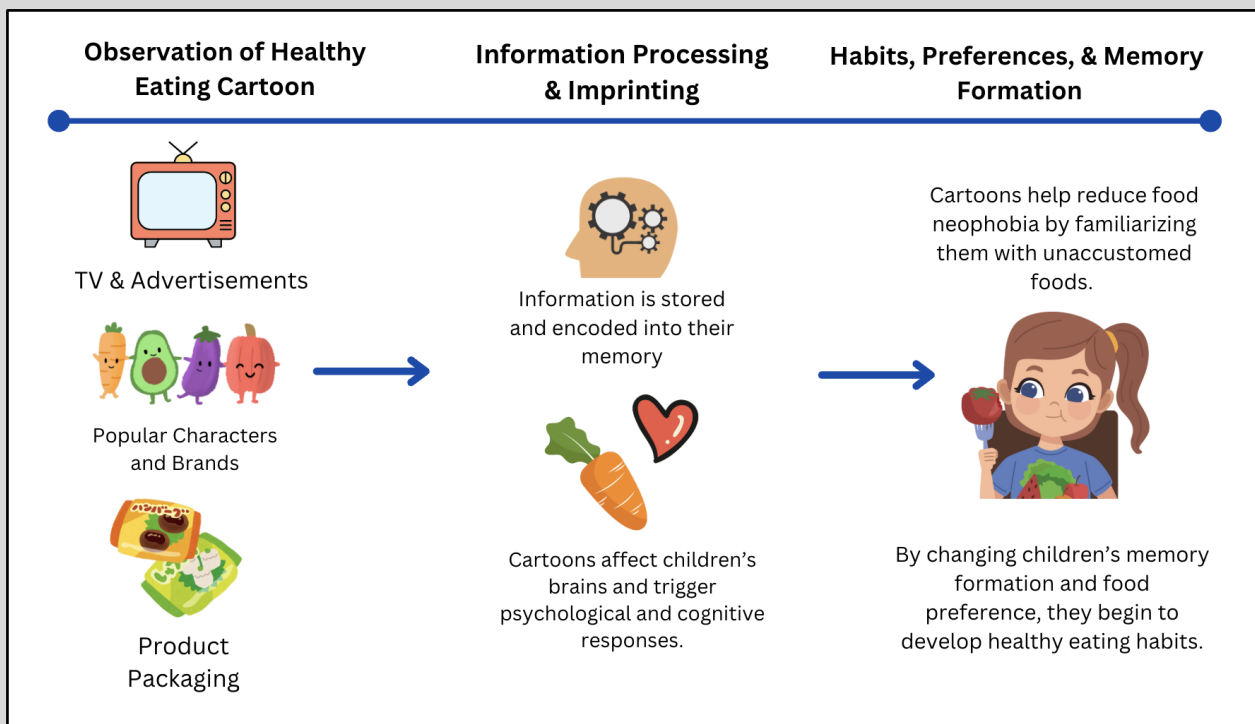


Figure 2: Cartoons on television, in advertisements, and in product packaging trigger cognitive and psychological responses in children to promote healthier eating habits [32].

4.2 The Effects of Media on Memory Formation and Retention

Many cognitive psychologists and neuroscientists posit that the human mind is like an associative network where ideas are activated, or primed, by associated stimuli. As follows, encountering an event or object can prime similar concepts, ideas, and emotions in someone's memory, even without them being aware of it. For example, the mere presence of a weapon within someone's visual field can cause them to have aggressive thoughts or behave aggressively [36]. In the new electronic generation, children's everyday lives revolve around auditory and visual communication through their screens. A 2017 study examined the effects of animations on students' memory retention. It surveyed 393 students and compared how much information they remembered 21 days after learning it through an animation or a static graphic. The conclusions of the study indicated that students exposed to the animation performed around 40% better than those who viewed the graphic on a test covering what they'd learned. This experiment shows the positive effect animated images can have on a child's memory retention [37].

Memory can be divided into two types: short-term memory, which retains information for around 5 to 6 hours, and long-term memory, which stores information for the rest of someone's life. The formation of memories, or the learning process, involves

information being transferred from the short-term memory system to the long-term memory system. This process occurs in the hippocampus, which helps retain short-term memories and enables the brain to organize, store, and receive memories. The transfer of memories from short-term to long-term storage involves billions of neurons in the brain. Neurons perform complicated electrical and chemical processes that collectively create our sensations, perceptions, and memories. Each neuron is connected to thousands of others through gaps between them called the synapse [38]. Neuronal synapses create our memories by strengthening or weakening the connections between neurons through repeated activity. When these synapses are activated again, neural circuits are formed that represent specific experiences and allow memories to be retrieved. The process of strengthening neural synapses is called long-term potentiation (LTP), which is a key mechanism for memory formation [39]. Our ability to learn involves three different mechanisms: changing the sensitivity of an existing neural synapse, forming new synapses, and creating completely new nerve cells. Thus, encouraging children to consume new foods involves creating new synapses through advertising and experience while the consumption of familiar foods can be increased by refreshing the existing synapses [38]. Experiments done by Ambler et al used brain imaging techniques to examine the parts of the brain affected by

emotionally and reasonably engaging advertising stimuli. By comparing differences in brain activation after watching promotional advertisements, they found increased activity in the parietal and frontal lobes, which occurs as the participant's brain performs executive functions and processes and stores memories [38]. The frontal lobe of the brain located just behind the forehead is commonly recognized to control executive functions, problem-solving, planning, and voluntary movement [40]. More importantly, it plays a crucial role in decision-making. Stimulating this part of the brain using emotionally or cognitively arousing information or images can significantly impact someone's decision to purchase or consume a certain product. Marketers often rely on this fact to promote their goods and services. As a result, exposing children to appealing cartoon images may have a similar effect on their decision-making processes, encouraging them to consume more nutritious products.

4.3 The Impact of Media on Behavioral Development in Children

The term, neuroplasticity, has been increasingly used in arguments for both the benefits and consequences of the pervasiveness of digital media given its ability to characterize children's lives [41]. At a young age, when the brain is at its peak in its neural plasticity and is rapidly developing, environmental influences and personal experiences are particularly important in developing habits and ways of thinking [42]. Examining brain imaging data, scientists have indicated clear structural changes in the brains of children and adolescents with intensive digital media use. According to Braun-LaTour and LaTour, the use of media technology affects various brain functions, including visual perception, language, cognition, and much more. Using psychological, psychiatric, and neuroimaging techniques, researchers found that media can cause structural and functional changes in the brain, creating changes in specific areas of cognition and perception. Someone exposed to media promoting a certain item may therefore cognitively view that item as more familiar and will gravitate towards that specific item compared to other items that weren't promoted. Additionally, the persuasiveness of media and promotional advertisements is in part caused by their ability to impact someone's memory. Researchers used to believe that memory for an advertisement created a new distinct memory trace that deteriorates over time and the inability to remember the advertisement is because the brain can't obtain the cue to access its content [28]. However, the newer belief is that the memory of the advertisement interacts with other information stored in the brain, such as other remembered advertisements, personal experience with the endorsed product, or what you've heard about the product from others. Past studies have discovered small differences in the number of cognitive responses or attitudes when an advertisement was viewed once or twice, but they found changes in people's memory structure. An advertisement viewed numerous times can leave a lasting imprint on someone's memory and can influence their behaviors and attitudes when they see the advertised product [28].

Observational learning is a form of imitation where complex representations are learned through inductive reasoning and abstraction. The more the child feels like they belong with the people being observed, the more that the observed behavioral scripts are learned as they are portrayed as appropriate. If children believe these observed behaviors are what should be done during a novel situation, the more firmly these beliefs will be extracted and encoded within their memory [36]. By the late 1900s, child development researchers had confirmed that exposure to media during a child's early developmental years increases their likelihood of following the behaviors and attitudes presented to them in the media they

consume. Specific behaviors in children increase following the observation of that behavior in the media due to several psychological processes. First, cartoon media can encourage or familiarize children with behavioral scripts, and emotional cognition or reactions that promote certain behaviors over others. Second, the social learning theory predicts that children tend to mimic the behaviors they see in their environment, which can be risky as children may not be cognitively aware of the right or wrong of their actions. Lastly, changes in emotional arousal caused by the observations of specific behaviors or attitudes in children's media encourage children to participate in those actions themselves. These processes can promote both positive and harmful behaviors in children, ranging from compassion and generosity to violence and aggression. Many believe that the excessive use of digital technology at a young age can cause potentially harmful effects, such as its ability to damage the developing brain and lead to mental health problems [41]. Although the negative consequences of cartoon media are a serious concern, most approved children's cartoons do not exhibit any harmful influences. Even more, a large majority of food-promoting cartoons show characters consuming or discussing safe foods and do not encourage dangerous behaviors of any kind. Numerous strict regulations around children's media unfortunately are not present in other sources of media created for teens or adults. Therefore, parents play an essential role in controlling the media their child consumes to prevent them from receiving negative influences.

5. The Effects of Cartoons on Children's Behaviors and Responses

5.1 The Role of Cartoons in Shaping Children's Eating Habits and Reducing Food Neophobia

Media can significantly impact people's behavioral and emotional responses toward certain people, objects, or ideas. This impact is especially prevalent throughout children's cartoons. Children's developing minds with minimal encoded cognitive connections can effortlessly encode new ideas, scripts, and beliefs with less interference than adults. This mainly occurs through observational learning and behavioral mimicry, which are the most prevalent ways children learn how to behave and act [36]. According to Hémar-Nicolas et al, cartoons stimulate emotional responses directly to children through a constructive persuasion process, enabling them to observe new ideas and behaviors that will impact their actions and way of thinking. Cartoon media promoting food products transfer the product directly into the minds of children and allow them to form connections with the food. When repeatedly exposed to cartoon characters in the media, children begin to consider them as friends. Additionally, they may also imaginatively interact with these characters and construct parasocial relationships. Over time, cartoon characters could act as role models and influence children's preference for certain ideas or products [17]. When these characters are used in advertisements, television, or product packaging, children may favor the food items with which they are associated. Thus, cartoon characters can play a major role in weaving together the habits and attitudes of children. Using this idea, nutritional cartoons can be a promising way to encourage children and adolescents globally to eat healthier.

Food neophobia is a constantly changing trait most common in children between the ages of two to five years old. Since this fear often decreases people's consumption of fruits, vegetables, and meats, it is important to familiarize children with these foods to make them more willing to try them. Visual exposure to a specific food that places it in a positive light is found to be exceptionally

effective in convincing children to try new foods. Visually exposing someone to an unfamiliar food before consumption can reduce their food neophobia and familiarize them with the food. Past research has indicated that children visually presented with new foods through pictures or in real life showed a greater willingness to try those foods than those who were not exposed [43]. To study the impacts of food neophobia in children, Dovey *et al.* exposed children to a visually similar and familiar fruit before showing them a new fruit. The findings of the study indicated that the children exposed to the familiar fruit displayed greater acceptance of the new fruit than those who were only presented with the new fruit [44]. One 2012 study conducted by Hausner *et al.* repeatedly exposed children to artichoke purée more than 10 times using the concepts of the mere exposure effect, which is a psychological phenomenon that describes the tendency for people to prefer things they are familiar with. The results of the study found that the children continuously exposed to artichoke purée showed increased acceptance of the new food [45]. The experiment also found that the increase in fruit intake was maintained after 3 and 6 months during follow-up studies, where the participants were given the same artichoke purée, showing the long-term changes to children's diets caused by food familiarity. The conclusions of this study suggest that visual exposure to a novel food item before consumption can promote a greater willingness to try that food. To encourage healthier eating and to lower the prevalence of food neophobia, the use of cartoons through the mere exposure effect can be used to familiarize children with nutritious foods.

5.2 The Impact of Cartoon Characters on Promoting Nutritional Choices in Children

Although many cartoon characters have been used negatively to promote low-nutritional products to children, the same could be done to encourage children to consume healthier products. Several studies using experimental design found that exposure to both pro-nutrition and low-nutrition commercials affects verbalized food preference. Participants who viewed commercials for junk foods displayed a preference for more highly sugared foods, while those who were shown commercials promoting nutritious products selected more fruits and vegetables [12]. The results from the experiment propose that people tend to prefer information provided by familiar objects or characters and that their social-cognitive abilities play a role in influencing their decisions [46]. Moreover, Drew Hanks and his research team created a team of superhero vegetable characters called Super Sprowtz to promote healthy eating in elementary schools. Using this team of cartoon vegetables as a marketing strategy, Super Sprowtz was found to almost triple the number of elementary students eating from the school's salad bar. Using various methods throughout 10 New York elementary schools, Hanks' team tested the effectiveness of the superhero characters by installing banners displaying Super Sprowtz or by playing Super Sprowtz videos in the lunchrooms. The experiment results indicated that around 25% of the students took vegetables from the salad bars with the promotion, which was nearly double what researchers observed before the addition. Schools displaying both the banner and the video saw the number of students eating vegetables rise from around 10% to up to 35% [47]. Cartoons are most effective when supported with text and other important structures and reinforced continuously [37]. Simple and easy processes such as installing cartoon characters on banners inside school cafeterias have shown spectacular results. Applying these designs elsewhere can help reduce the prevalence of childhood obesity as significantly more children began to eat their fruits and vegetables with the addition of cartoon characters. However, more research needs to be conducted to investigate the effects of these superhero characters in

other areas globally before this method can be widely applied throughout schools as regional preferences and tastes may vary. Nevertheless, this shows the promising results of using cartoon characters to promote healthy eating habits in children.

Additionally, it is also important to investigate the role of age when studying the effects of food messages in children's entertainment media as age can significantly impact their ability to be persuaded [18]. As people age and encounter more experiences, they may become more aware of the messages they see in the media and are more able to cognitively decide between swaying to the messages or sticking to their own beliefs. Researchers have found that the ability of children to process information revolves around their cognitive skills. These skills develop as they age at varying rates between individuals. According to Binder *et al.*, before the age of 5, children begin to develop their ability to process sensory information, but they may struggle to recall or verbalize specific information from their memory. By around 6 to 9 years old, children begin to accurately process and remember information and the content of messages. Finally, when they are 10 to 12 years old, they start to think for themselves and reason abstractly. It is easy to believe that younger children's lack of self-thinking or older children's greater awareness and enhanced information processing skills can make nutritional messages with the media more effective. Yet inclusive data on the effects of food messages between various age groups and the lack of research make the topic poorly understood [18]. In a study conducted by Ogle *et al.*, participants 6 to 9 years of age were shown pairs of food and beverages that were either more healthy or less healthy than similar versions of the products. These products were also presented with and without a licensed cartoon character on the packaging. To monitor the participant's interest in the different products, researchers used an eye-tracking camera to observe the amount of time children focused on each product. After choosing which products they preferred from each of the 60 pairs of unhealthy and healthy foods, they discovered that children showed greater attention toward products with characters and selected less nutritious products overall. The participant's choices significantly varied depending on their age, sex, and the cartoon character that was displayed on the packaging. The study's findings found that inserting images of licensed cartoon characters on more nutritious foods and beverages can encourage some children to make healthier decisions, especially if they are younger, male, or like the specific character presented on the product [48]. Overall, children are much more attracted to cartoon and fun visual content compared to traditional academic learning methods, largely due to the bright colors, enjoyable audio and visual effects, and pleasurable structures. These factors of children's media encourage them to better absorb and recall information than that presented by a teacher in a classroom [32]. Thus, cartoon characters should be used to their greatest extent to promote healthier eating behaviors to children to help them develop better eating habits throughout their lives.

5.3 The Role of Parents in Shaping Children's Diets and Food Consumption

In addition to cartoons, parents can significantly influence the food preferences of their children and contribute to what children learn to like or dislike. Many studies have shown that while cartoon characters can help encourage healthy food choices in children and adolescents, diligent parents and other trusted adults can do even more. For example, parental influence plays a key role in children's eating habits, acting as role models or supporters for their children. Researchers analyzing children's dietary trends found that parental figures can play a special role due to their almost unprecedented influence over their children's diets, such as through preparing meals

or the enforcement of eating rules [18]. Most parents may be familiar with their children's preference for unhealthy foods over more nutritious options. Research on a psychological phenomenon called the nag factor shows that parents often end up purchasing unhealthy products for their children upon being repeatedly "nagged" to buy them. This can occur as parents become increasingly irritated and hope to alleviate some frustration by satisfying the demands of their children, despite the consequences that may ensue. Ideal parents should encourage their children to consume healthy snacks, but they often concede to their children's desire for unhealthy products. Food companies often rely on this factor to sway children and influence their parents' purchasing decisions [24]. Thus, parents need to encourage their children to view healthier products positively and protect them from the swaying messages from junk food companies. One unique approach parents can visually familiarize their children with novel foods is through play settings. Through play-based settings, children can gain increased familiarity with fruits or vegetables and thus show greater willingness to consume these foods at the dinner table. Furthermore, children could also pretend to cook and eat nutritious foods in socio-dramatic settings like toy kitchens or restaurants. Parents can play with their children in these nutrition-based settings to create healthy eating behaviors by encouraging them to interact with various counterfeit healthy foods. Using these fun activities, children may begin to see unfamiliar foods in a positive light and make healthier decisions when asked to choose which foods they want to eat [22]. However, a 2012 study on the effects of food advertisements on children's food choices found that the strength of these influences could be not relatively easily undone by parental input. The participants in the study were more likely to select the promoted product and parental influences only slightly affected the persuasiveness of the advertisement [49]. The results of this study suggest that parents alone may not be able to change children's dietary habits. Thus, alternative approaches such as the promotion of healthy eating in children's media should also be included to encourage more nutritious diets in children.

Conclusions and Implications

By changing the typical junk food advertisements throughout children's media to ones that promote nutritious foods, more and more children can start to normalize healthy eating [27]. Current research has shown that television commercials contribute to the development and maintenance of poor eating habits by promoting and advertising unhealthy products like highly processed [12]. However, television programs and cartoons can also be used to encourage children to consume their fruits and vegetables by familiarizing them with the foods that they may have previously been uncomfortable trying. Since the habits and ways of thinking developed during someone's youth often last throughout their life, childhood is the ideal time to create healthy eating habits. Numerous studies have found crucial insights into how children's audio-visual entertainment media should present nutritious foods to increase children's fruit and vegetable consumption. Health programs should utilize cartoons and other forms of entertainment media as an effective approach and the importance of healthy eating and encourage pro-nutritious behaviors [18]. However, efforts to improve children's dietary habits are challenged by highly profitable industries and food companies that actively promote unhealthy food through children's media [1]. Thus, regulations need to be set to restrict the amount of unhealthy products advertised to children. Cartoons and other forms of children's entertainment media can play a huge role in promoting positive dietary habits, but it is important to note that not everyone can access online networks. Thus, it is essential to educate parents to aid their children in eating healthier

as they often are the major contributors to a child's diet. Parents can help children create healthy eating habits, especially if they know not to focus on the short-term goal of fruit and vegetable consumption and more on the establishment of a long-term healthy diet. By embracing alternative methods for expanding children's food familiarity, they will be more likely to develop long-term healthy food preferences and improve their overall health [22].

List of Abbreviations

BMI: Body mass index
CDC: Centers for Disease Control and Prevention
LTP: Long-term potentiation
NIH: National Institute of Medicine
TV: Television
WHO: World Health Organization

Ethics Approval

Not applicable. This is a literature review of already published data. We have not performed any experiments or directly collected any data from a patient.

Consent to participate

Not applicable. This is a literature review of already published data. We have not performed any experiments or directly collected any data from a patient.

Data Availability

We do not have any additional data to share. All the data is collected from published research and cited appropriately.

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Conflicts of Interest

The authors declare no conflict of interest.

Authors' Contributions

J.L. and F.F. conceived the idea, J.L. performed the literature search, J.L. and F.F. organized the data, J.L. wrote the manuscript, and J.L. and F.F. revised and approved the manuscript.

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