

TV exposure, attitudes about targeted food ads and brands, and unhealthy consumption by adolescents: Modeling a hierarchical relationship

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ABSTRACT

Public health experts raise concerns that extensive exposure to advertising for calorie-dense nutrient-poor food negatively influences adolescents' diets, but few studies have explored how food advertising affects children over age 12. This study examines adolescents' attitudes about highly targeted unhealthy food brands and assesses the hierarchical relationship between TV exposure, intermediary measures of advertising effects, and healthy and unhealthy food consumption. A cross-sectional online survey of 1566 adolescents (13–17 years) measured TV exposure, attitudes about eight highly advertised teen-targeted food brands and their advertising, and unhealthy and healthy food consumption. A theory-based structural equation model (SEM) tested hypothesized paths from TV exposure to unhealthy food consumption, with attitudes about teen-targeted TV ads and brands as intermediary variables, controlling for healthy food consumption and demographic characteristics. Participants reported high liking of targeted-brand advertising ($M = 4.05/5.0$, $SD = 0.65$), strong perceptions that the ads were targeted to someone like them ($M = 4.07/5.0$, $SD = 0.66$), positive brand attitudes ($M = 4.07/5.0$, $SD = 0.56$), brand popularity ($M = 4.01/5.0$, $SD = 0.63$), and consuming the brands a few times in the past month on average. As hypothesized, the SEM supported significant positive paths from TV exposure to ad attitudes ($\beta = 0.50$, 95% CI = 0.40–0.60) to brand attitudes ($\beta = 0.90$, 95% CI = 0.87–0.92) to unhealthy food consumption ($\beta = 0.41$, 95% CI = 0.32–0.50). Contrary to expectations, healthy consumption was positively associated with both brand attitudes ($\beta = 0.11$, 95% CI = 0.04–0.18) and unhealthy consumption ($\beta = 0.42$, 95% CI = 0.33–0.51). These results further public health concerns about the potential impact of adolescents' exposure to unhealthy food advertising on brand consumption and unhealthy food consumption more broadly. They also support marketing theories that ad liking and perceived targeting may increase the influence of ad exposure on brand attitudes and unhealthy consumption.

1. Introduction

U.S. companies spend more than \$14 billion annually to advertise foods high in sugar, fat, salt, and calories, primarily fast-food restaurants, sugary drinks, candy, and unhealthy snacks (Harris, Frazier, Kumanyika, & Ramirez, 2019). Much of this advertising is targeted to adolescents, including on TV (Harris, Frazier, Fleming-Milici, et al., 2019) and through techniques with special appeal to youth (e.g., social media, mobile apps, celebrity endorsements, product placements) (Dunlop et al., 2016; Fleming-Milici & Harris, 2020; Tatlow-Golden et al., 2016). In the United States and worldwide, youth-targeted advertising has fueled an epidemic of unhealthy diet among young

people that contributes to long-term health risks (Cairns et al., 2013; Kelly et al., 2013; World Health Organization, 2010). The World Health Organization has called for regulations that limit exposure to unhealthy food marketing for all children up to age 18, as well as the use of marketing techniques that effectively target children (World Health Organization, 2010). However, existing regulations to limit unhealthy food marketing, including both government and industry voluntary efforts, only address advertising to children up to age 11 or 12 (Patiño et al., 2020; Taillie et al., 2019). Moreover, most regulations focus on reducing exposure to unhealthy food advertising; few attempt to limit the power of that marketing by regulating techniques that appeal to and/or are specifically targeted to children (Patiño et al., 2020; Taillie et al., 2019).

Abbreviations: SEM, Structural Equations Model.

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In addition, relatively little research has examined how food marketing affects older children and adolescents (Harris et al., 2020; Qutteina et al., 2019). Early studies on the effects of food marketing to children were conducted with children 12 years and younger (Cairns et al., 2013; Institute of Medicine Committee on Food Marketing and the Diets of Children, 2006). More recent studies have included children up to age 14, but few studies have been conducted with older adolescents (ages 15 and older) (Norman et al., 2016; Qutteina et al., 2019; Smith et al., 2019). The relationship between amount of marketing (i.e., exposure) and unhealthy diet in children has been demonstrated in many countries (Norman et al., 2016; Smith et al., 2019), but only one study included adolescents (Scully et al., 2012). Furthermore, existing studies conclude that food marketing directed to young children (under age 11) is unfair and deceptive because they do not have the cognitive ability to understand its persuasive intent and effectively defend against primarily unhealthy messages (Institute of Medicine Committee on Food Marketing and the Diets of Children, 2006; John, 1999). These findings imply that older children and adolescents may be less vulnerable to influence since they have the cognitive ability to critically evaluate marketing messages (Buijzen et al., 2010; Children, 2006; Harris et al., 2009; Institute of Medicine Committee on Food Marketing and the Diets of Children, 2006; John, 1999).

However, more recent theoretical models to explain how food marketing affects food preferences and eating behaviors propose that effectively defending against negative food marketing effects requires much more than cognitive ability to recognize persuasive intent (Buijzen et al., 2010; Harris et al., 2009). Individuals (including adolescents and adults) must also be consciously aware of marketing attempts, recognize them as marketing, understand how to effectively counteract these messages, and possess the cognitive resources to do so at the time of exposure (Harris et al., 2009). Furthermore, they must be motivated to resist (Harris et al., 2009). However, adolescent-targeted food marketing is often specifically designed to deactivate skeptical responses by creating positive emotional associations that appeal to adolescents (e.g., cool, exciting, fun) with brands (Buchanan et al., 2017; Pechmann et al., 2005). It also encourages viral sharing of advertising messages through social and other digital media to take advantage of the importance of peers among this age group (Fleming-Milici & Harris, 2020; Tatlow-Golden et al., 2016). Therefore, the power of teen-targeted unhealthy food marketing reduces adolescents' ability to effectively defend against its effects. Recent studies of food marketing with adolescents have found high trust in food advertising and desire to try advertised foods (Thai et al., 2017), high levels of engagement with food and beverage brands on social media (primarily fast food, candy, sugary drinks, and snacks) (Fleming-Milici & Harris, 2020), and associations between higher exposure to junk food marketing and consumption of junk food categories (Critchlow et al., 2020).

1.1. A hierarchical approach to assess food marketing to adolescents

Another challenge to demonstrating that unhealthy food marketing negatively affects adolescents is that food marketing exposure does not directly and immediately lead to unhealthy diet and high weight status. These effects occur over a period of many years and result from repeated continuous exposure to all types of marketing messages and experiences with marketed brands (Harris et al., 2009). Existing research on food marketing to younger children supports a "hierarchy of effects" from marketing exposure to 1) brand awareness; 2) attitudes and preferences (including both brand and product category); 3) requests to parents (younger children) or purchase intent and purchases (older children); and 4) short-term consumption; which ultimately leads to unhealthy diet and weight gain (Boyland et al., 2021; Kelly et al., 2015). As with other food marketing research, few studies have examined potential intermediary outcomes of exposure with adolescent participants.

However, the marketing literature provides insights into potential measures of advertising impact that may apply to adolescents and food

marketing. Positive response to advertising is one of the strongest predictors of brand liking in both children and adults (Moore & Lutz, 2000). Enjoyment, or a positive emotional response to an ad, is a strong predictor of advertising effectiveness, measured by increased brand preferences and effects on sales (Binet & Field, 2009). In addition, targeted advertising (i.e., ads aimed at a specific customer, such as adolescents) signals that a product is a good match for the consumer group being targeted (Anand & Shachar, 2009; Harris, Frazier, Fleming-Milici, et al., 2019). Thus, liking an ad and believing the ad is meant for someone like them provide potential intermediary measures of advertising effectiveness that could be used with studies of adolescents.

1.2. The present study

In this study, we test potential intermediary measures with adolescents to assess a hierarchical path from TV food advertising exposure to unhealthy consumption. In addition to a direct positive relationship between TV exposure and unhealthy consumption, we also hypothesized a positive linear relationship from 1) TV exposure to, 2) attitudes about TV ads for teen-targeted brands (ad attitudes) to, 3) attitudes about those same brands (brand attitudes) leading to, 4) unhealthy food consumption. Lastly, we hypothesized that healthy food consumption would be negatively related to attitudes about unhealthy brands and unhealthy food consumption.

2. Methods

This cross-sectional study utilized an online survey with a large non-probability sample of 1566 U.S. adolescents (age 13–17) collected during March–May 2017. The survey included questions about TV viewing, attitudes about advertising and unhealthy brands highly targeted to teens, and consumption of those brands, as well as consumption of categories of unhealthy and healthy foods. The survey also assessed adolescents' engagement with brands on social media. These data have been previously reported (Fleming-Milici & Harris, 2020).

2.1. Participants

Participants were recruited through two U.S. online survey panels, including one large national panel (Innovate) (Innovate, 2018) and one panel of Hispanic households (Offerwise) (Offerwise, 2018). Parents provide consent for their children to join the panels and participate in surveys; consent for their child to participate in individual surveys is not required. Both panels recruit adolescent panelists to participate in individual surveys by sending email invitations that describe the length of the survey and the number of points they will receive for participating. Participation in individual surveys is voluntary and panel members do not receive direct compensation for each survey, but they can redeem their accumulated points for various incentives such as gift cards and charitable donations. Quota sampling was established to approximate equal proportions of respondents by gender and age. Additional quotas were established to ensure at least 300 Black participants and 600 Hispanic participants with varying levels of acculturation. The survey was administered using Qualtrics online software (Qualtrics, 2018). Participants read information about the study, described as a study on teen attitudes about food, and indicated whether they agreed or declined to participate. Participants in the Hispanic sample could answer each question in either English or Spanish. The survey took approximately 15 min to complete. The study was determined to be exempt by the University of Connecticut Institutional Review Board (X17-012), which waived written consent.

2.2. Measures

Cognitive testing with a convenience sample of 10 adolescents (ages 14–17) prior to data collection ensured understanding of all questions by

individuals in this age group. No changes were required. Participants first reported their age (13–17 years) to screen for eligibility. They then reported their screen usage, including two items that measured TV exposure. Hours of TV viewing on an average school day was assessed using a question from the Youth Risk Behavior Surveillance System (Centers for Disease Control and Prevention, 2018). Responses were coded as never (0), <1 h (0.5), 1 to <2 h (1.5), 2 to <3 h (2.5), 3 to <4 h (3.5), 4 to <5 h (4.5), and 5 or more hours (5.5). Participants also indicated if they had a TV in their bedroom (yes, no). This measure has been used in previous research as an indicator of TV advertising exposure (Harris & Bargh, 2009).

2.2.1. Ad and brand attitudes

Questions to assess ad and brand attitudes asked participants to rate eight highly advertised brands with advertising targeted to adolescents. These eight brands (Wendy's, Taco Bell, Pop-Tarts, Doritos, Pepsi, Gatorade, Starburst and Twix) represented a range of different types of products within the four food categories with the most advertising to teens (12–17 years) (fast food, snack foods, sugary drinks, and candy) (Harris, Frazier, Fleming-Milici, et al., 2019; U.S. Federal Trade Commission, 2013) and were selected using Nielsen advertising data. Within each category, two brands that averaged at least 15 ads viewed by teens in 2016 and that had higher-than-average ratios of TV ads viewed by adolescents versus adults (a measure to identify targeted ads) (Harris, Frazier, Fleming-Milici, et al., 2019) were selected (Appendix Table 1).

Ad attitudes were assessed using two questions for each brand: "I like the ads for this brand" and "Advertising for this brand is aimed at someone like me." Participants indicated agreement on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). To assess brand attitudes, participants first answered questions to "describe what they think about" each brand, according to three brand attributes used in previous research (Kelly et al., 2016): "This brand is" "Very cool" to "Very uncool," "Very exciting" to "Very unexciting," and "Very fun to Very boring," presented as 5-point scales. The second brand attitudes measure assessed brand popularity using a 5-point scale ("The type of person who would eat or drink this brand is" "very popular" to "very unpopular"). Brand-specific responses to ad and brand attitude measures were averaged to create total scores for "like ads," "ads for me," "brand liking," and "brand popularity." All scales had acceptable internal consistency (Cronbach's $\alpha \geq 0.77$).

2.2.2. Consumption variables

Additional questions assessed consumption of the eight brands and unhealthy and healthy categories of foods. *Unhealthy consumption*

included two measures. First, participants selected one of six answers that "best fits about how often they consume" each of the eight brands ("I never had it or don't remember having it" [0], "I have had it, but not in the past month" [1], or "I had it" "Once in the past month, but not in the past week" [2], "A few times in the past month, but not in the past week" [3], "Once in the past week" [4], or "More than once in the past week" [5]). Responses for the eight brands were averaged to create a "brands consumed" scale (Cronbach's $\alpha = 0.79$).

Category consumption was measured with the Youth Risk Behavior Surveillance System questions that assess both unhealthy and healthy food consumption. Fast food consumption asked, "In the past week, how often did you eat something from a fast-food restaurant (like McDonald's, Burger King, Wendy's, etc.)?" with six options ranging from "Never" to "Five or more times." Soda consumption asked, "During the past 7 days, how many times did you drink a can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite?" with seven response options ranging from "I did not drink soda or pop during the past 7 days" to "4 or more times per day." *Healthy consumption* was measured using four items that asked, "During the past 7 days, how many times did you eat" "salad," "carrots," "other vegetables," and "fruit"? Seven response options ranged from "I did not eat [food] during the past 7 days" to "4 or more times per day."

2.2.3. Sociodemographic variables

Finally, participants provided demographic information. Sociodemographic variables included participants' gender, age, highest level of education of their parents/guardians, and race/ethnicity. Participants who self-identified as Latina/Latino were given the Short Acculturation Scale for Hispanics (SASH) that measures language choice in reading and speaking in different situations using 5-point Likert scales ranging from 1 (only Spanish) to 5 (only English) (Ellison et al., 2011). Responses to all questions were averaged and a median split classified Hispanic participants with a score ≤ 3.5 as less-accultured.

2.3. Statistical analysis

Descriptive information included frequency analyses and proportions for categorical variables and means and standard deviations for continuous variables. A structural equations model (SEM) tested the hypothesized paths from TV exposure to unhealthy consumption, using the *lavaan* package in R version 4.0.2 (R. Core Team, 2013). All underlying variables were entered into the model as ordinal variables. The five latent variables in the model included TV exposure, ad attitudes, brand attitudes, unhealthy consumption, and healthy consumption. The model tested the relationships between latent variables, including a direct linear path from TV exposure to unhealthy consumption and the hypothesized indirect path from TV exposure to ad liking to brand attitudes to unhealthy consumption. Associations between brand attitudes, healthy consumption, and unhealthy consumption were also assessed.

Maximum likelihood estimation with robust standard errors was utilized to help ensure model accuracy overall, and Satorra-Bentler correction was deployed to help specifically handle any violations to normality. Standardized estimates were extracted for each path of interest in the model. For each latent variable, the loadings of underlying items and their errors were also extracted. Internal consistency reliability for each latent variable was calculated via omega (ω), which accounted for unequal loading of items within SEM. The model included demographic variables (age, gender, race, ethnicity, and parent education) as covariates. Common indices were assessed to determine the fit of the model. Standardized path estimates, latent variable factor loadings, and errors are reported in a path diagram.

Lastly, adjusted R^2 was calculated to assess the degree to which the variance in unhealthy consumption was explained by the full model, including both the direct path from TV exposure and the path with intermediary variables (ad and brand attitudes). Adjusted R^2 's were also

Table 1
Participant demographic information.

	Freq	Percent
<i>Gender</i>		
Male	733	46.9%
Female	831	53.1%
<i>Age (years)</i>		
13	267	17.1%
14	285	18.2%
15	337	21.5%
16	333	21.3%
17	342	21.9%
<i>Parent education</i>		
High school or less	467	29.9%
Technical school, some college	365	23.3%
4-year college grad or more	670	42.8%
Not sure	64	4.0%
<i>Race/ethnicity</i>		
White, non-Hispanic	521	33.3%
Black, non-Hispanic	337	21.5%
Hispanic, less-accultured	339	21.7%
Hispanic, more-accultured	336	21.3%
Other/mixed race, non-Hispanic	33	2.2%

calculated for two separate models: the direct path between TV exposure and unhealthy consumption alone and the path with intermediary variables alone. The change in R^2 between the full model and the two partial models was compared using F -tests. Alpha for two-sided tests was $p = 0.05$.

3. Results

Of the 1963 participants who responded to the survey request, 20% did not meet the age requirements or complete the survey, including 15 respondents who were removed for providing nonsense responses to open-ended questions. The final sample of 1566 participants included slightly more females (53%) and somewhat fewer 13- to 14-year-olds than 15- to 17-year-olds (Table 1). Due to recruiting procedures, participants were highly diverse in race and ethnicity: 22% reported being non-Hispanic Black and 43% reported being Hispanic. Approximately one-half (53%) indicated that their parent had less than a 4-year college degree.

More than 80% of participants reported having a TV in their bedroom, and they averaged approximately 3 h of TV viewing on an average school day (Table 2). As expected, participants reported liking

Table 2
Descriptive results for factors examined in the structural equations model.

	Freq	Percent	M	SD	Cronbach's α^a
TV viewing					
TV viewing time (average school day)			2.98	1.56	n/a
0 to <2 h	621	39.7%			
2 to <4 h	408	26.1%			
4+ hours	535	34.2%			
TV in the bedroom	1261	80.5%			
Ad liking					
Like ads ¹			4.04	0.65	0.77
Targeted to me ²			4.07	0.66	0.77
Brand attitudes					
Brand liking			4.07	0.56	0.91
Brand popularity			4.01	0.63	0.80
Unhealthy food consumption					
Brand consumption			2.79	0.98	0.79
Fast food in the past week (0–5)			2.03	1.26	n/a
Never	152	9.7%			
1–2 times	789	50.5%			
3+ times	544	34.9%			
Soda/pop in the past 7 days (0–6)			2.05	1.63	n/a
Never	231	14.8%			
1–3 times	533	34.1%			
4–7 times	495	31.6%			
>1 times per day	305	19.5%			
Healthy food consumption					
Fruits in the past 7 days (0–6)			2.31	1.60	n/a
Never	142	9.1%			
1–6 times per week	789	50.5%			
1+ times per day	633	40.4%			
Other vegetables in the past 7 days (0–6)			1.97	1.46	n/a
Never	188	12.0%			
1–6 times	877	56.1%			
1–4+ times per day	499	31.9%			
Green salad in the past 7 days (0–6)			1.48	1.49	n/a
Never	458	29.3%			
1–6 times per week	736	47.1%			
1+ times per day	370	23.6%			
Carrots in the past 7 days (0–6)			1.08	1.41	n/a
Never	722	46.2%			
1–6 times per week	588	37.6%			
1+ times per day	254	16.2%			

^a Reliability for scale questions. Brand liking includes three ratings for each brand (cool, fun, exciting, $N = 24$ items). All other scales include one rating for each brand ($N = 8$ items).

the ads for all eight brands, agreeing the ads were for someone like them, liking the brands, and agreeing that people who consume the brands are popular (all $M > 3.8$ out of 5.0) (Table 3). Mean scores for all scales (eight brands combined) exceeded 4.0. More than 90% of participants had previously consumed each of the brands, and average reported consumption of each brand was more than once in the past month ($M = 2.8$). Reported consumption of individual brands in the past week ranged from 25% of participants (Wendy's) to 57% (Doritos). For unhealthy categories, nearly all participants reported consuming fast food at least once in the past week and approximately one-half reported drinking soda four or more times (Table 2). The majority also reported consuming healthy food categories less than daily, and approximately 10% or more reported never consuming fruit, green salad, or other vegetables.

3.1. Structural equations model (SEM)

Fig. 1 provides standardized coefficients for all significant variables in the model. Model fit indices were generally excellent, including Root Mean Square Error of Approximation (RMSEA) (0.05, $p_{Close} = 0.99$), Comparative Index (0.96), Tucker-Lewis Index (0.94), and Standardized Root Mean Square Residual (SRMR) (0.05). Factor loadings for all latent variables were significant in the expected directions (all p 's ≤ 0.005). Most items loaded on their respective factors above acceptable levels ($\lambda > 0.50$). Composite reliabilities were excellent for healthy consumption and unhealthy consumption (ω 's = 0.94), good for ad attitudes and brand attitudes (ω 's = 0.89), and acceptable for TV exposure ($\omega = 0.60$). All relationships between latent variables in the model were significant (all p 's ≤ 0.005). Relationships with demographic covariates in the model are detailed in Supplemental Table 2.

As expected, greater TV exposure directly predicted unhealthy consumption. In addition, greater TV exposure significantly predicted ad liking, which in turn predicted more positive brand attitudes, and brand attitudes positively predicted unhealthy consumption. Contrary to our hypothesis, healthy consumption was also positively related to brand attitudes (although covariance was low) and to unhealthy consumption.

Approximately 60% of the variance in unhealthy consumption (61.6%) was explained by the hypothesized model. In addition, the model with both paths explained substantially more variance than either the direct path from TV exposure to unhealthy consumption (50.0%, $F [2, 1555] = 1012.4$, $p < 0.001$) or the indirect path (including ad attitudes and brand attitudes) alone (42.9%, $F [1, 1555] = 1737.2$, $p < 0.001$).

4. Discussion

As predicted, participants in this large, diverse panel of U.S. adolescents demonstrated high levels of liking for targeted advertising and advertised brands, as well as frequent consumption of advertised brands. These results provide further evidence that adolescents may be highly susceptible to advertising influence, despite their cognitive ability to recognize and defend against unwanted persuasive attempts, as previously shown in a small number of studies (Qutteina et al., 2019; Scully et al., 2012; Thai et al., 2017). Although adolescents have the cognitive ability to critically process advertising messages (Institute of Medicine Committee on Food Marketing and the Diets of Children, 2006; John, 1999), marketing for the eight fast-food, sugary drink, candy, and snack brands appears to be highly successful in appealing to this age group. These results suggest that the amount and power of advertising for these brands, which was designed to appeal to this target consumer group, likely contribute to brand preferences and consumption among U.S. adolescents.

Further, these results support public health concerns that high levels of advertising for nutritionally poor food and drinks also contribute to poor diet among adolescents more broadly. The SEM showed that exposure to TV (with its large amounts of TV advertising for unhealthy

Table 3
Ratings of teen-targeted brands.

	Wendy's	Taco Bell	Pop-Tarts	Doritos	Pepsi	Gatorade	Starburst	Twix
<i>Ad liking</i>								
Like ads ^a	3.78 (1.10)	4.02 (1.10)	3.94 (1.09)	4.37 (0.88)	3.96 (1.11)	4.11 (1.04)	4.10 (0.99)	4.02 (1.03)
Ads for me ^b	3.87 (1.10)	4.07 (1.10)	3.99 (1.11)	4.39 (0.88)	3.94 (1.18)	4.07 (1.13)	4.15 (0.99)	4.08 (1.02)
<i>Brand attitudes</i>								
Brand liking ^c	3.85 (0.97)	4.01 (1.03)	3.96 (0.96)	4.40 (0.77)	3.91 (1.03)	4.20 (0.85)	4.14 (0.88)	4.08 (0.88)
Brand popularity ^d	3.80 (1.00)	3.97 (1.03)	3.86 (1.04)	4.29 (0.88)	3.95 (1.05)	4.21 (0.89)	4.01 (0.97)	3.95 (0.97)
<i>Brand consumption^e</i>								
Never	6.8%	6.3%	6.3%	2.0%	6.1%	4.5%	4.3%	5.2%
Not in the past month	32.7%	29.1%	30.3%	13.2%	24.4%	20.6%	26.3%	27.2%
In the past month, but not the past week	35.4%	35.8%	29.6%	27.6%	22.3%	25.2%	33.4%	33.2%
In the past week	25.1%	28.8%	33.8%	57.2%	47.2%	49.7%	36.0%	34.4%

^a "I like the ads for this brand" (1 "strongly disagree" to 5 "strongly agree").

^b "Advertising for this brand is aimed at someone like me" (1 "strongly disagree" to 5 "strongly agree").

^c Average of three questions for each brand: "This brand is" (1 "very cool," "very exciting," "very fun" to 5 "very uncool," "very unexciting," "very boring").

^d "The type of person who would eat or drink this brand would be" (1 "very popular" to 5 "very unpopular").

^e "Please mark the answer that best fits about how often you consume these foods or drinks" (0 "I never had it or don't remember having it", 1 "I have had it, but not in the past month", 2 "I had it once in the past month, but not in the past week", 3 "I had it a few times in the past month, but not in the past week", 4 "I had it once in the past week", 5 "I had it more than once in the past week").

products) was associated with consumption of unhealthy food and drink categories, as well as advertised brands. As previously shown in many studies conducted with younger children in different countries (Norman et al., 2016; Smith et al., 2019), greater TV exposure by adolescents was highly correlated with consumption of unhealthy food categories, as well as the specific targeted brands.

In addition, the SEM found that the hierarchical path, including attitudes about ads and brands as intermediary variables, increased the predictive value of the model over the direct path from TV exposure to unhealthy consumption alone. A previous study conducted with children found a hierarchical relationship between TV exposure and unhealthy consumption that was mediated by requests to parents for unhealthy foods (Boyland et al., 2021). However, this study tested for potential intermediary variables that would be appropriate indicators of advertising power for adolescents. The model also supported the two hypothesized dimensions of ad and brand attitudes. Based on the

marketing literature, liking ads for a brand and agreeing that the ads were aimed at "someone like me" would indicate positive attitudes about the ads (Anand & Shachar, 2009; Binet & Field, 2009; Moore & Lutz, 2000). Further, the adolescent development literature suggests that brand popularity and agreement that the brands are cool, fun, and exciting would indicate positive brand attitudes (Harris et al., 2020; Pechmann et al., 2005; Tatlow-Golden et al., 2016). These findings indicate that, in addition to assessing exposure, measures of advertising power should be included in future research to assess effects of advertising to adolescents.

The positive relationship between healthy consumption and both brand attitudes and unhealthy consumption was unexpected. The correlation with brand attitudes was low ($\beta = 0.11$), but the correlation with unhealthy consumption was high ($\beta = 0.41$). These findings require further research. A few experimental studies have shown that children consume more healthy food, as well as unhealthy food, immediately

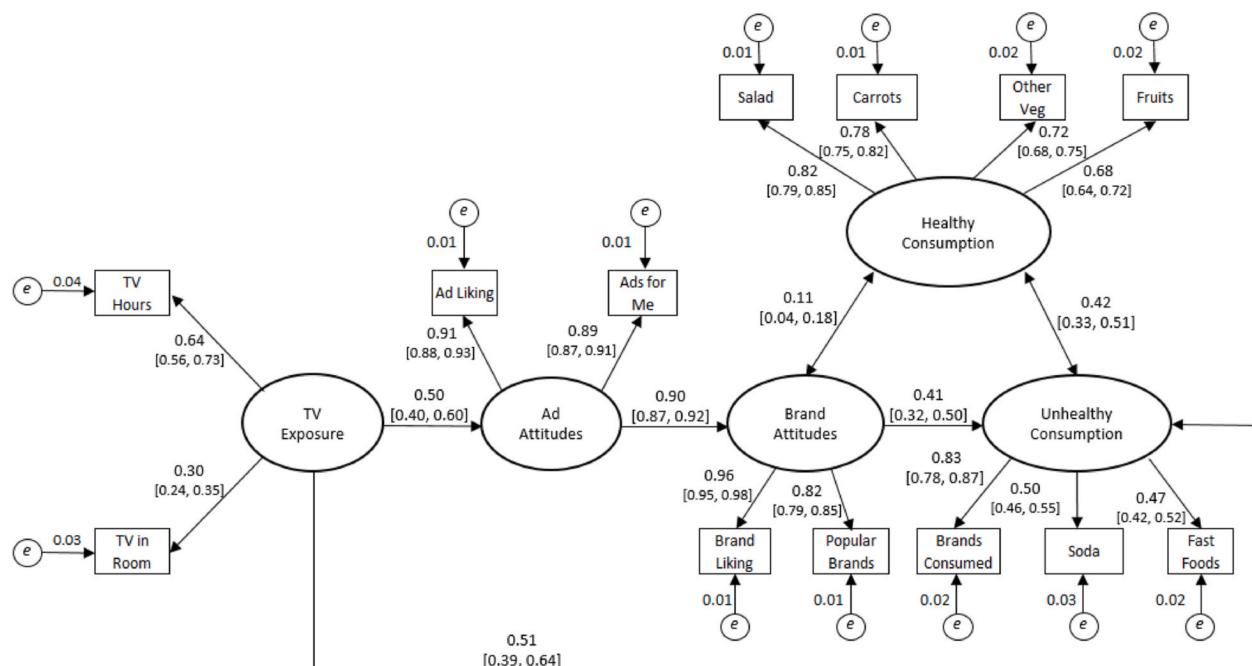


Fig. 1. Structural Equations Model testing direct and hierarchical paths from TV exposure to unhealthy consumption.

Notes: Includes standardized coefficients and 95% confidence intervals for paths between latent variables. All paths are statistically significant ($p \leq 0.005$). Demographic covariates include age, gender, race, Hispanic ethnicity and parent education.

after exposure to unhealthy food marketing (Boyland, Nolan, Kelly et al., 2016), but we are not aware of any studies showing a relationship between TV exposure and children's overall consumption of healthy food over the long-term. However, these findings do indicate that public health initiatives to increase fruit and vegetable consumption among adolescents, such as the FNV marketing campaign (Partnership for a Healthier America, 2019), may not effectively counteract the impact of unhealthy food advertising to reduce unhealthy consumption.

4.1. Strengths and limitations

This study contributes to the literature by testing a hierarchical model to link TV exposure and unhealthy food consumption in adolescents, including potential intermediary variables, but it does have limitations. The cross-sectional design cannot show causation. Although SEM tests for directional relationships between variables, it cannot rule out potential extraneous variables that could explain these findings. All measures were self-reported and subject to self-presentation and memory bias. The Youth Risk Behavior Surveillance System category consumption and TV viewing measures have been validated and used to indicate health risk behaviors in national and local surveillance systems (Underwood et al., 2020). However, the questions do not cover the full range of related behaviors, such as weekend TV viewing or consumption of other food categories, beyond soda and fast food for unhealthy consumption and four types of fruits and vegetables for healthy consumption. The brand and ad liking questions and brand popularity measures have also been used in previous research with children, but the ads for someone like me measure was developed for this study, based on the adolescent marketing literature. Further, the advertising and brand attitude questions have some limitations. We only assessed eight brands and did not ask participants if they had seen advertising for these brands. However, it is likely that most of our participants had seen TV ads for these brands. The brands were selected from those that were highly targeted to adolescents according to Nielsen data, which showed that all adolescents in the United States viewed, on average, 14 or more TV ads for each of the brands in 2016 (Harris, Frazier, Fleming-Milici, et al., 2019). Moreover, reported consumption of these brands was highly correlated with consumption of soda and fast food in total. Finally, we did not account for marketing that may have been seen on digital platforms, such as social media or YouTube channels. However, previously reported results from the same survey shows that engagement with brands on social media is associated with moderate to high amounts of TV viewing (Fleming-Milici & Harris, 2020).

5. Conclusions

Corporations have indicated that regulation of marketing to children over age 12 would negatively impact their business and they strongly oppose such policies (Pfister, 2016). However, relatively few research studies have assessed how TV advertising exposure and adolescent-targeted advertising influences adolescents' diets. This lack of research has limited the ability of public health advocates and policymakers to advocate for actions to reduce unhealthy food marketing to adolescents. Results of this study reinforce public health concerns about the negative influence of extensive exposure to unhealthy food advertising on adolescents and the need to examine advertising power (including ad liking and perceived targeting) as intermediary measures of advertising effectiveness. They also support calls to regulate food advertising to children up to age 17.

Author contributions

JH obtained funding for the study, conceptualized the hierarchical model, and drafted the article. SS conducted statistical analyses and designed the SEM. FFM designed the survey and collected the data. All authors provided input on the model and critically revised the article.

All authors have approved the final article.

Data availability

All authors have full access to the data reported in the manuscript. Data used in the study are available upon request.

Ethical statement

This study was determined to be exempt by the University of Connecticut Institutional Review Board (X17-012), which waived written consent. Before completing the online survey, participants read information about the study and indicated their agreement to participate.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2021.105804>.

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