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Youth Perspectives on the Effects of a Family-centered Media Literacy Intervention to Encourage Healthier Eating

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ABSTRACT

A pretest-posttest field test with control group (N = 189 parent-child dyads) tested a structural model representing youths' (ages 9–14) perspectives to examine the efficacy of a family-centered, media literacy-oriented intervention promoting fruit and vegetable consumption. The intervention facilitated critical discussion about nutrition and media, mentored by the parent. Results showed that youths' increases in fruit and vegetable consumption flowed from parent-child discussion of nutrition labels, which was predicted by child-initiated discussion, critical thinking about media sources, and critical thinking about media content. Multivariate analyses revealed that the intervention was productive for all participating age groups and for all dependent variables. The results suggest that a developmental progression from critical thinking about source to critical thinking about content affects behavior change and can be catalyzed through media literacy education and encouragement to discuss media messages (i.e. practice) with parents.

Introduction

A dose-dependent response exists between media screen time in childhood and lifetime obesity risk (Crespo et al., 2001; Tahir et al., 2018). In addition to displacement of physical activity and mindless eating (Marsh et al., 2013), explanations often focus on the effects of food marketing on youth (Boyland & Halford, 2013; Powell et al., 2013; Wootan et al., 2019; Zimmerman & Bell, 2010). Many of these effects are manifested within the family environment, making it important for prevention efforts to address them in the context of family communication dynamics and a developmentally based sensitivity to youths' perspectives about food marketing and family discussions.

This study reports on results from an intervention designed to reflect an understanding that the family's management of the media environment must be responsive to the child's developmental level and increasing independence. A curriculum was designed to address this issue by cultivating a positive environment for family interactions regarding the media and nutrition, focusing particularly on marketing. The curriculum aimed to help families cultivate an open and supportive communication environment that fostered critical thinking and shared decision making. By recognizing that children have agency for discussion and decision making, parents can help youth to cultivate effective skills as their children develop increasing autonomy. By encouraging youth to ask questions and by providing a mutually supportive environment for practicing parent-youth interaction skills, youth can gain confidence in their parents as expert information sources for nutrition and media information. This can prevent marketing pressures from creating a negative communication context for families. In this report we report results from the youths' perspective.

Food marketing effects take place in the family context

Home and parenting characteristics predict children's early BMI levels and later risk for obesity-related health problems (Boonpleng et al., 2013; East et al., 2019), motivating family-based interventions to improve modifiable child, parent and household factors (Shier et al., 2016). Yet most obesity-prevention interventions addressing media influences have focused on reducing youths' screen time rather than on promoting critical discussion of food marketing and strategic use of credible information sources (Harris et al., 2009). Screen-reduction effects have been modest (Maniccia et al., 2011) and may be impractical or unacceptable to parents (Minges et al., 2015). This strategy also overlooks the influence of marketing that reaches far beyond the home television screen.

Food marketing promoting calorie dense, nutrient poor foods are ubiquitous (Harris et al., 2009), reaching children via radio, movies, billboards, print media (including food packaging and in-store promotions), and digital media (Olson et al., 2013). In the U.S., industry self-regulation has been ineffective (Olson et al., 2013), and the nutrition criteria established by the Children's Food and Beverage Advertising

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Initiative has been criticized as inadequate (Wootan et al., 2019).

Youth awash in this environment tend to consider media messages as authoritative and persuasive information sources, including for food choices (Folta et al., 2006; Goris et al., 2010; Zimmerman & Bell, 2010). Children's resulting lobbying of parents about food choices frequently succeeds, can create family conflict, and increases in effectiveness with age (Henry & Borzekowski, 2011; Hingle et al., 2010; Linn & Novosat, 2008). Youth also attain the ability to make independent food choices as they age and must learn how to navigate the media environment successfully on their own.

Although adolescence is a period of increased autonomy from parents (e.g., Eccles et al., 1991; Erikson, 1959; Koepke & Denissen, 2012; Steinberg & Silk, 2002), parents continue to influence healthy food consumption during this time period by providing access to healthy foods in the home and by modeling their consumption (Yee et al., 2017). However, as children transition into adolescence, they spend more time eating in their parents' absence (Lachat et al., 2012) and spend increased time with peers (Lam et al., 2014). Compared to younger children, adolescents make many more food choices on their own—e.g., eating fast food with friends, buying snacks at the local convenience store, drinking coffee at the local coffee shop, or eating at a friend's house. In an analysis of the 2003–2006 National Health and Nutrition Examination Surveys, Poti and Popkin (2011) found that adolescents consumed 36.8% of their calories outside of the home. Studies also have shown that adolescents who frequently eat alone consume greater quantities of fast food, sweets, and sugar-sweetened drinks (Reicks et al., 2019), and that eating with peers is associated with higher levels of consumption of energy-dense and low-nutrient foods (Ragelienė & Grønhøj, 2020). The adolescent's developing autonomy is reflected in how adolescents and parents view adolescent food choices. Parents typically view these decisions as *prudential* issues (i.e., relevant to the child's health or well-being) and therefore feel justified in enforcing rules regulating the child's consumption; adolescents, in contrast, typically view this as a *personal* issue—i.e., an area under their own personal jurisdiction (Smetana & Asquith, 1994). Therefore, it is critical, especially during adolescence, to directly target adolescents' attitudes toward eating rather than assuming that educating parents will necessarily lead to the desired changes in adolescent attitudes and behavior.

Involving parents in childhood nutrition promotion that addresses children's decision making and the media has had promising but limited results. For example, Hindin et al. (2004) successfully taught Head Start parents how to discuss food advertising with their children, critically analyze commercials and prepared them to manage requests for advertised food but did not assess effects on children. (Evans et al., 2006) efforts to change both parent and child media awareness and eating behaviors found that parents provided more fruits and vegetables but providing them did not increase child consumption. Similarly, a media literacy-based program provided by the National Institute of Child Health and Human Development (NICHD) for 11 to 13-year-old adolescents achieved some attitudinal changes but no behavioral ones (Eunice Kennedy Shriver NICHH, 2013). These results suggest that programs need to account more effectively for the fact that parents are influenced by youth requests and that youth food consumption depends considerably on what foods parents choose to provide. Family communication dynamics around sources of information about food may represent a promising intervention target.

In response to this need, we field tested a media literacy-based intervention for families with 9–14 year olds to promote *Child Initiated Discussions* about persuasive messages (food marketing) and more credible sources of information (food labels). The strategy acknowledged that parent-initiated conversations in a domain in which many children believe they have legitimate decision-making authority can yield youth resistance (Lagattuta et al., 2010). A more beneficial approach might encourage child interest in media literacy issues and thereby increase the frequency of child-originated conversations that are likely to have a greater impact on child learning because they build on the child's interest (Brown, 1997; Kaiser et al., 2018). Moreover, in response to child initiations, parents can scaffold the development of further understanding (Wood et al., 1976).

Evidence suggests media literacy can be learned and can improve decision making

The theoretical model guiding our intervention holds that critical thinking about media messages begins by understanding that every message is created by someone pursuing a goal. Marketing messages, for example, are designed to promote products rather than to provide a balanced presentation of product benefits and drawbacks. Thus, while marketing messages can entertain and inform, consumers must treat them skeptically with respect to accuracy and completeness. Promoting *Critical Thinking about Sources* therefore can motivate *Critical Thinking about Content*. Critical thinking is consideration of a variety of solutions to a question and analysis of potential outcomes for alternative strategies (National Center for Education Statistics, 2000). Critical thinking about sources provides the foundation for critical thinking about message content, encompassing an understanding that messages are created, that creators of messages have purposes for doing so, that they have areas of expertise, and that they have a viewpoint (Austin et al.,2016; Jacks & Devine, 2000; Sagarin et al., 2002). Skills for critically assessing content, which include elements such as currency, completeness, accuracy, perspective, and techniques used to create the message, then can reduce the influence of affect on decisions. (Austin et al., 2007; Kupersmidt et al., 2010). Rigorously designed media literacy programs have been recommended by the American Academy of Pediatrics (Strasburger, 2011) and can affect health outcomes with effect sizes generally in the range of 0.32 to 0.41 (Jeong et al., 2012; Xie et al., 2019). Our theoretical model therefore incorporates consideration of the roles of *Critical Thinking about Sources* and *Critical thinking about Content* in the development of critical thinking about media and decision making about food choices.

How the curriculum was designed to be responsive to youth development

The *FoodMania* curriculum was designed to maximize success across age groups while acknowledging that developmental differences would exist that could affect cognitive responses, understanding and recall of information along with affective responses to the media, marketing and family dynamics. The curriculum was modified from a format employed previously for 11–13 year olds regarding media influences on food purchases but retired in 2017 (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2013). It was developed in a family-centered collaboration among Washington State University and University of Washington faculty (Austin et al. 2017), based on the Message Interpretation Processing Model (MIP; Austin et al. 2000; Austin et al., 2007; Pinkleton et al. 2013) and following the Strengthening Families program design (Molgaard & Spoth, 2001; Nathanson, 2004). The intervention model and structural model operationalizing the intervention applied social, cognitive, and dual-processing theories along with the MIP model to demonstrate how family members' communication and interactions regarding food marketing, food labels and food consumption reflected the results of the curriculum as experienced by youth.

The final six-week program employed a two-hour unit each week during which parents and youth met separately for one hour and jointly for one hour. Units convened at a community location (e.g., school, community center), led by university extension faculty. Lessons included information about food marketing techniques, specific practice to discuss and compare nutrition facts labels, expectancies related to mediating advertising influences and eating fruits and vegetables, and how to apply critical thinking toward food advertising. The curriculum (see supplementary materials) incorporated activities such as deconstructing food ads, reading and comparing food labels, tasting foods and drinks, designing a media campaign, and discussion strategies. The program was delivered by Cooperative Extension educators who are accustomed to delivering programming to mixed age groups.

Regarding developmental issues, Rozendaal et al. (2011) have suggested that advertising literacy requires mastery of 1) *cognitive advertising literacy*, which refers to recognition of advertising, knowledge of selling and persuasive intent, tactics used, and information about the industry; 2) *affective/attitudinal advertising literacy*, which refers to individuals' abilities to reduce their susceptibility based on skepticism and the cultivation of negative attitudes; and 3) *advertising literacy performance*, which refers to individuals' abilities to retrieve relevant information apply it as needed. Consistent with their recommendation, the *FoodMania* curriculum incorporated the practice of advertising literacy performance to assist those children whose less mature cognitive abilities might otherwise limit their independent use of the conceptual or cognitive advertising literacy elements present in the curriculum.

As well, Hwang et al. (2018) have recommended that advertising literacy curricula might include components of content (themes and ideas), grammar (tactics) and structure (social and economic structure of the advertising industry), They found, however, that while structure literacy enhanced knowledge gain for older youth it appeared to confuse younger youth. *FoodMania* did not focus on structure literacy other than to make sure the youth understand that marketers hire experts who help them to target youth specifically and to the extent it came up in discussions with parents regarding marketing research. Parents of course could bring this up with their older youth as they thought appropriate. Youth also could ask questions suited to their developmental level (child-initiated discussion).

In addition, the curriculum included tactile activities and rehearsal with parents to help youth who might still be developing their understanding of and ability to manage their responses to abstractions such as marketers' intentions to persuade people to believe things, which is more sophisticated than understanding the intent to get people to buy things (Lapierre, 2015, 2019). These require increasingly sophisticated understandings of how the mind works. A less developed theory of mind can lead to difficulties understanding concepts such as advertisers, audiences, and profit (Moses & Baldwin, 2005). Youth in focus groups had indicated a desire to do activities with parents, so their involvement also was expected to foster positive reinforcement of curriculum content.

Although the curriculum included components to boost affective/attitudinal literacy, it specifically did not cultivate a dislike of media or marketers. Austin et al. (2015) found that "demonizing media messages teens find desirable" is unnecessary and potentially counterproductive. Given that this could present a problematic issue particularly for older youth more reliant on media for social purposes, the curriculum was designed to cultivate self-discovery and collaborative exploration. For example, youth participated in taste tests and practiced deconstructing advertising. They then tried using marketing techniques to create their own cereal package, fruit and vegetable company, taglines and nutrition promotion campaigns.

Despite these accommodations, it was possible that the increased base of existing knowledge and experience present among older youth would lead to some age differences in intervention results. Xie et al. (2019) have found that media literacy interventions are largely consistent across age groups, but older youth might have less to learn. They may have learned about these topics previously in school, for example. Including primary caregivers in the program provided an important benefit because they are accustomed to adapting information to the unique needs and interests of their children.

A family-centered program provides an optimum context for media literacy-related effects

The theoretical basis for our intervention posits that a family-centered media literacy program will facilitate opportunities for youth to develop and practice critical thinking skills applied to food marketing and use of nutrition food labels. This is important for both parents and youth because acquisition of media literacy skills may not necessarily result in the application of them (Austin et al., 2002; Duran et al., 2008). In addition, the family provides an ideal context for providing the

practical experience and developmentally appropriate interaction through family discussion and parental reinforcement of critical thinking skills and skepticism related to media messages (Buijzen, 2009; Calvert, 2008). As youth grow older, critical discussion of media also is likely to be more effective than restricting media usage (Buijzen, 2009). Some evidence to support a family-centered strategy exists, such as from a program for 4th and 5th grade students that incorporated a child-to-parent component, improving parent social support, availability and accessibility of fruits and vegetables in the home (Evans et al., 2006). Our theoretical model therefore incorporates the opportunity for rehearsal of these skills through discussion: in this case *Talk about Nutrition Labels*, which were a focus of the intervention curriculum. Most importantly, the model focuses on the moderating role of *Child Initiated Discussion* because of its potential for magnifying the impact of family discussion about food marketing and food selections (Brown, 1997; Kaiser et al., 2018; Wood et al., 1976).

Discussion is vital because children progress from understanding that a source may try to sell something to a more abstract understanding that a source intends to change how someone thinks (Carter et al., 2011; Rozendaal et al., 2010). Even a rudimentary level of understanding of selling intent can associate with parents' reported purchasing behaviors (Lapierre, 2019). Youth who can achieve this first step, however, still need help to master a "stop and think" response, which develops with executive function (Rozendaal et al., 2011) but can be assisted by others such as through media literacy education Kupersmidt et al. (2010). As they enter adolescence, youths' reasoning, abstract thinking and metacognitive skills continue to develop (Dumontheil, 2014; Gauffroy & Barrouillet, 2011; Mills & Keil, 2004; Weil et al., 2013). They also increasingly make independent food choices, such as from a store on their route home after school (Carter et al., 2011). Parental influence throughout this developmental process is important, even while it may increasingly be manifested indirectly, through youths' use of decision-making skills learned and practiced through family interactions. This makes it important for primary caregivers to develop skills for effective interactions regarding food marketing, nutrition and food selection, and to do so before children reach adolescence.

In sum, an intervention that engages parents with children around interpretation of food marketing and nutrition labels to make choices about foods to consume provides a natural way to build on a parent's responsibility to create and manage a nurturing home environment. Parent-child interactions around eating behaviors and physical activity are instrumental to the success of family-based obesity prevention (Kitzman-Ulrich et al., 2010) through the cultivation of certain behaviors, expectations, beliefs and norms (Rhee, 2008). Studies tracking intervention outcomes related to general family management skills have found an indirect effect on pediatric weight gain from toddlerhood to middle childhood (Smith et al., 2015). Parental influence manifested through the practice of media literacy skills for food marketing and discussion of nutrition labels therefore has the potential to provide long-lasting effects.

Value of youth reports

Reflecting the importance of the child's perspective and agency, our test of this theoretical model focused on youth self-reports. Both Daly (2009) and Hill (2006) have asserted that concerns about the potential for children to adversely affect research quality (Campbell, 2008; Moules & O'Brien, 2012); youths' abilities to participate (Clarke, 2015); and that children might suffer adverse effects from research participation (Moules & O'Brien, 2012; Powell & Smith, 2009) have led to research in which youth are used as subjects, but rarely as active research partners. The Convention on the Rights of Children in 1989 (Unicef, 1989), however, has emphasized that children are social actors who should be seen as essential for the planning, implementation and evaluation of health research (Salsberg et al., 2015). (Boaz, Robert, et al., 2016) suggest that properly integrating and assessing youth participation in research requires health researchers to reimagine how their research is designed, conducted and communicated. Similarly, a recent systematic review of health promotion research involving youth (Larsson et al., 2018) found that while many studies wanted to increase youth participation in the research process, few studies included participation beyond that of research subjects.

Accordingly, this analysis focused on the child's perspective to assess the results of the family-centered media literacy intervention. Previous research comparing youth and parental reports on parental mediation of television influences has found unique value to the use of youth reports. Fujioka and Austin (2003), for example, found that the more youth noticed their parents' positive reinforcement of television messages, the more they accepted those messages into their attitudes and beliefs. In their study, focused on alcohol-related content, they also found that the child's perceptions predicted self-reported decision-making outcome variables more reliably than the parental reports did. Youths' interpretations therefore can provide unique and valuable information to guide an assessment of a family-based intervention, despite the methodological limitations of self-reports.

The theoretical model tested herein followed on previous tests of two complementary models that incorporated both parent and youth reports from one wave of these data (Austin et al., 2018) and from two waves (Austin et al., 2020a, 2020b). In one of the previous models tested (Austin et al., 2020a), several relationships among variables tested in this study were confirmed in a structural model which hypothesized that critical parental discussion of food marketing (*Negative Mediation*) would increase youths' *Critical Thinking about Content*, which would increase their *Child Initiated Discussion* and, in turn, their fruit and vegetable (*ns*) consumption. In this study, however, we wished to address two key issues not tested in that model: first, a more complete developmental model of media literacy learning that would incorporate the role of youths' *Critical Thinking about Media Sources*, which was not included in the previous model; and second, the role of the child's perspective and *Child Initiated Discussion* from that vantage point.

This project therefore focused on answering the following research questions:

- RQ1: To what extent will child's age interact with the intervention to affect results on the youth-reported dependent variables?
- RQ2: Will a family-centered media literacy intervention's effects on youth-reported outcomes of *Vegetables Eaten Yesterday* and *Fruit Eaten Yesterday* be manifested through progressive effects of the intervention on *Child Initiated Discussion*, which will affect *Critical Thinking about Sources, Critical Thinking about Content*, the effects of which are mediated through *Talk about Nutrition Labels* with parents?

Figure 1 illustrates the hypothesized process model. The latent constructs *Child Initiated Discussion* (CID), *Critical Thinking about Sources* (CTS), and *Critical Thinking about Content* (CTC) are represented by ovals (individual indicators not shown). The single outcome measures *Talk about Nutrition Labels* (TNL), *Fruit Eaten Yesterday* (FEY), and *Vegetables Eaten Yesterday* (VEY) are represented with boxes. We anticipated that, based the research literature on parental mediation processes and the value of child-initiated discussion, that, **relying on the youth's reports**:

- H1: *Child Initiated Discussion* about food advertising and nutrition will positively associate with *Critical Thinking about Sources* for food advertising;
- H2: *Child Initiated Discussion* will positively associate with *Critical Thinking about Content* of food advertising;
- H3: *Child Initiated Discussion* will positively associate with parent-child *Talk about Nutrition Labels*;
- H4: *Critical Thinking about Message Sources* will positively associate with *Parent-Child Talk about Nutrition Labels*;
- H5: *Critical Thinking about Message Content* will positively associate with *Parent-Child Talk about Nutrition Labels*;
- H6: *Parent-Child Talk about Nutrition Labels* will positively associate with child reports of *Fruit Eaten Yesterday*;
- H7: *Parent-Child Talk about Nutrition Labels* will positively associate with child reports of *Vegetables Eaten Yesterday*.

Methods

Following initial development, the *FoodMania* curriculum underwent an initial pilot test with 59 families followed by focus groups with parents, youth, and educators to further refine the curriculum and evaluation measures. Data collection procedures and the intervention were approved by the authors' institutional review board for the use of human subjects (#15012).

Following training to maximize fidelity, the research team collected pretest and posttest data from both parents and youth using a self-administered survey prior to the start of the intervention and following the final session. Families (N = 189 dyads) from three urban and two rural counties in Washington state participated through Extension programs. Treatment and control group families had sociocultural backgrounds typical for their respective 4-H and SNAP-Ed audiences. Initially, participants self-selected into either the intervention or control group. Because intervention groups filled first, recruitment continued to find comparable controls. Data were collected no more than 2 weeks prior to the first session and at the final session for the intervention group, or after six weeks for the control group. Attrition rates pretest to posttest were 16.93% for parents and 17.46% for youth. Missing data rates were 1.06% and 2.12% for parents and youth, respectively. Results based largely on the adult responses are reported elsewhere (Austin et al., 2020a, 2020b).

Nutrition items were selected from the National Collaborative on Childhood Obesity Research Measures Registry that aligned with the curriculum (McKinnon et al., 2012). Youth were asked about the number of fruits (M = 3.41, SD = 1.58) and vegetables (M = 3.32, SD = 1.55) eaten yesterday and reported on a variety of constructs (Hoelscher et al., 2003). This dietary assessment approach is used in the Coordinated Approached to Child Health program and community-based settings (Penkilo et al., 2008; Springer et al., 2013). Food frequency questionnaires not reliant on portion sizes, parent assistance or recall of previous days of food intake tend to have the best reliability and validity for youth (Kolodziejczyk et al., 2012). Vegetables were defined as salads, boiled, baked, mashed potatoes and all cooked and uncooked vegetables. Youth were instructed, "do not count French fries or chips" with a graphic visual of 14 commonly consumed

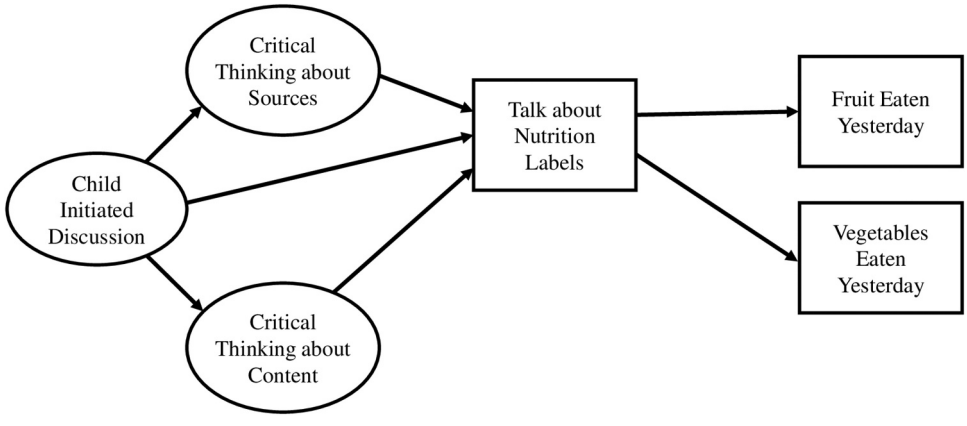

Figure 1. The basic hypothesized youth process model. Not shown, but included in the model, were age and pretest levels of each construct and measure.

fresh, whole vegetables provided. Youth were instructed to not count fruit juice and to refer to a graphic visual of 12 commonly consumed whole, fresh fruits.

Other measures were not time-based due to poor youth recall ability that tends to reflect a 24-hour period (Baxter et al., 2004) but instead were measured at pretest and posttest, with pretest measures controlled in the posttest analyses.

Child Initiated Discussion (M = 2.59, SD =.75, α = .78) was measured with "I start conversations with my parents about:" "selling techniques that food or drink advertisers use;" "what is real or not real in food advertising;" "nutritional content of foods;" "healthier food choices" (graphically presented as NO!; 2, No; 3, Yes; 4, YES!). This was included to enable a test of whether youth in the control and intervention groups differed in how frequently they talked about these topics with their family members.

Critical Thinking about Sources (M = 2.57, SD =.72, α = .77) was measured with I think about how someone created a food or drink ad that I see; I think about who made the food or drink ad; I think about what the creator of a food or drink ad wants me to think; I think about why someone created a food or drink ad I see. (graphically presented as NO!; 2, No; 3, Yes; 4, YES!) based on the strategy employed by Austin and Johnson (1997). This was intended to reflect discussions about food marketing.

Critical Thinking about Content (M = 2.78, SD =.74, α = .70) was measured with "I think twice about what I see in food or drink ads;" "I think about things I see in food or drink ads before I believe them;" "I ask somebody before I believe something I see in food or drink ads;" "I think about what a food ad is not showing me about the food." (graphically presented as NO!; 2, No; 3, Yes; 4, YES!). This also was intended to reflect discussions about food marketing.

Parent-child *Talk about Nutrition Labels* (M = 2.92, SD = 1.14) was measured with "How often do you and a parent (your mom or dad) talk about the nutrition information from the label of a packaged food? (Never, Rarely, Sometimes, Often, Very Often). This was intended to help families determine food selections, such as when in a store. This measure was included to test whether intervention and control groups differed in their application of specific lesson content focused on reading and comparing nutrition labels.

Intraclass correlations and design effects were first estimated to determine whether the clustered nature of the intervention administration affected the data in a meaningful way (Muthén & Satorra, 1995). As reported elsewhere (Austin et al., 2020a) and with selected results displayed in Table 1, multiple analysis of covariance (MANCOVA) was used to estimate mean differences between the Intervention and Control groups on the latent constructs and single measure outcomes with covariates controlling for *pretest levels* of each dependent variable. The age by condition interaction results were then used to inform the building of a structural equation process model. Both MANCOVAs were estimated in MPLUS 8.3 (Muthén & Muthén, 2017) using the Satorra and Bentler (1994) correction for non-normal data to ensure accurate standard errors.

The hypothesized model was based on theory and previously tested alternative models (Austin et al., 2020a). The conversations and thinking tested in the model were theorized to take place in an iterative fashion and are represented in a parsimonious manner to lead to the specific behavior of fruits and veggies eaten yesterday at the end of that process. The hypothesized model reversed the path of *Child Initiated Discussion* and *Critical Thinking about Content* from a previously tested model to test the role of the youth's perspective and agency, add the role of *Critical Thinking about Sources*, and test the potential for *Talk about Nutrition Labels* to act as a mediating variable on the outcome variables of *Fruit* and *Vegetables Eaten Yesterday*. To test the hypothesized model, a multigroup structural equation model (MGSEM) was fit to the data to estimate the process by which youth critical thinking and discussion about nutrition impact the consumption of healthy foods (Hoyle, 1995). The MGSEM groups were the Control ($n = 83$) and Intervention ($n = 106$) conditions. Age could then be incorporated as a control variable to account for any interaction effects detected in the MANCOVA. All elements in the MGSEM were controlled for *pretest levels* (not shown in Figure 1). Each indicator within a construct was correlated with itself across time (Little et al., 2007). The model was fit in MPLUS 8.3 (Muthén & Muthén, 2017). None of the 189 cases in the sample were excluded due to excessive missing data. Guidelines from Hu and Bentler (1999) were used to assess the fit of the model (e.g. CFI >.95, RMSEA <.06, SRMR <.08). Because we were sensitive to the impact of age on all outcomes in the model, we placed age as a control on all constructs and outcomes to provide accurate estimates of age's total effect on each element measured within the model and to align the SEM with our MANCOVA results.

The assumption of multivariate normality was found lacking for at least two of our outcomes, *Fruit* and *Vegetables* eaten yesterday, which tested as significantly ($p < .05$) platykurtic. It has been established that a lack of normality does not affect the accuracy of maximum likelihood estimates but can lead to Type I or Type II errors due to inaccurate standard errors (Finney & DiStefano, 2006). It was not possible in MPLUS to implement the Satorra and Bentler (1994) correction for nonnormal data because it is not available in the multigroup environment. We therefore chose to use the Bayes estimator.

Table 1. Standardized mean differences MANCOVA.

Dependent	Factor	Estimate	S.E.	1-Tailed P-Value	Sig
Child Initiated Discussion	Condition[1]	0.166	0.063	.009	*
Critical Thinking (Source)	Condition[1]	0.104	0.075	.165	
Critical Thinking (Content)	Condition[1]	0.213	0.074	.004	*
Talk About Nutrition Labels	Condition[1]	0.170	0.061	.005	*
Vegetables Eaten Yesterday	Condition[1]	0.239	0.061	<0.001	*
Fruit Eaten Yesterday	Condition[1]	0.288	0.060	<0.001	*

1. Condition was coded as 0 = Control, 1 = Intervention.

Bayesian estimation provides greater flexibility under small sample size conditions and does not require distributional assumptions, such as multivariate normality, required with standard frequentist approaches (Levy & Choi, 2013; van de Schoot et al., 2015). Estimates from our maximum likelihood analysis were used to specify prior distributions for the structural paths. Large prior distribution variances were specified, however, to indicate a moderate level of certainty about the specified estimates on the part of the authors. Large prior variances also allowed the data to drive the estimation process as opposed to prior beliefs given the exploratory nature of the research. Model fit was assessed using guidelines from Levy and Choi (2013) and van de Schoot et al. (2015).

A model building process was initiated by specifying a single group baseline model with no distinction made between the Control and Intervention groups using diffuse priors that allowed the data to drive the estimation process. The Baseline assumed no meaningful differences in structural paths between the Control and Intervention groups. A multigroup Bayesian model was then estimated using the diffuse default priors available in MPLUS under the assumption of no prior knowledge concerning the paths and allowing both groups to be estimated without constraints. Maximum likelihood (ML) was then employed on a multigroup model and the resulting estimates were used as our priors in the Bayesian model. The Bayesian model was estimated with both Intervention and Control group paths constrained to use the same set of priors. A final model was then estimated by eliminating the constraint and allowing the two groups to be estimated independently using our priors. This final model tested our hypothesis that the intervention model would produce larger and more significant path effects compared with the control model while also reducing the likelihood of Type I error experienced under ML estimation due to a lack of multivariate normality. We made use of the Deviance Information Criteria (DIC) and the Posterior Predictive P-value (PPP) to compare results during the model building process (Zyphur & Oswald, 2015). Specifically, the DIC was used as a comparative index (similar to AIC or BIC) in which lower DIC values indicate better relative model fit.

Results

Intraclass correlations and design effects showed that the average ICC was 1.6% across all 30 indicators and measures, and all were less than 5%. We therefore concluded that standard errors for paths and mean differences would not be noticeably affected by the clustered nature of the data.

MANCOVA age x interaction effects

The three significant age by condition interaction effects from Table 2 are presented in Figure 2. *Child Initiated Discussion* (Panel A), *Critical Thinking about Sources* (Panel B), and *Fruit Eaten Yesterday* (Panel C) are shown with the Intervention group (solid line) and Control group (dashed line) with youth age on the X axis. For each construct, the Intervention group shows a significant improvement over the Control for most ages. Youth in the Intervention group reported larger increases of *Child Initiated Discussion* and *Critical Thinking about Sources* as age increased with little or no differences for youth of ages 9 and 10 years. Youth in the Intervention group also reported eating more fruit the previous day compared with youth in the Control group. Interestingly, the slope of the Control group increases with age while the slope of the Intervention decreases even though there is an overall increase for the Intervention group compared to Control. While the interaction effects in Panels A and B reflect positive change with age in the Intervention group, the negative Intervention slope for *Fruit Eaten Yesterday* may reflect that for fruit consumption the intervention has a greater impact on younger children producing a greater increase in healthy consumption compared with older intervention youth.

MGSEM results

The results of the MANCOVA models indicated that *Youth Age* should be included as a covariate in the multigroup structural model for terms demonstrating the age by condition interaction. The MGSEM results showed that the intervention effects drove improvements in the home dietary environment as reflected by increased youth consumption of fruits and vegetables in the Intervention group compared to the control. Figure 3 shows results of the Bayes-estimated MGSEM in which Panel A displays significant paths for the Control group and Panel B displays significant paths for the Intervention group. Of the four MGSEM models examined, the hypothesized final model, estimated using the ML priors and no constraints between groups, produced the lowest DIC (11594.609) indicating the best fit to the data. The model PPP, however, was only .005 indicating underestimation of the

Table 2. Standardized mean differences MANCOVA controlling for youth age for dependent variables showing a significant age by condition interaction.

Dependent	Factor	Estimate	S.E.	1-Tailed *p*-Value	Sig
Child Initiated Discussion	Condition[1]	−1.022	0.480	.017	*
	Youth Age	−0.032	0.089	.360	
	Age by Condition	1.206	0.491	.007	*
Critical Thinking (Source)	Condition[1]	−1.476	0.525	.003	*
	Youth Age	−0.034	0.072	.319	
	Age by Condition	1.604	0.529	.001	*
Fruit Eaten Yesterday	Condition[1]	0.122	0.084	.073	
	Youth Age	1.270	0.486	.005	*
	Age by Condition	−0.990	0.475	.019	*

Condition was coded as 0 = Control, 1 = Intervention.

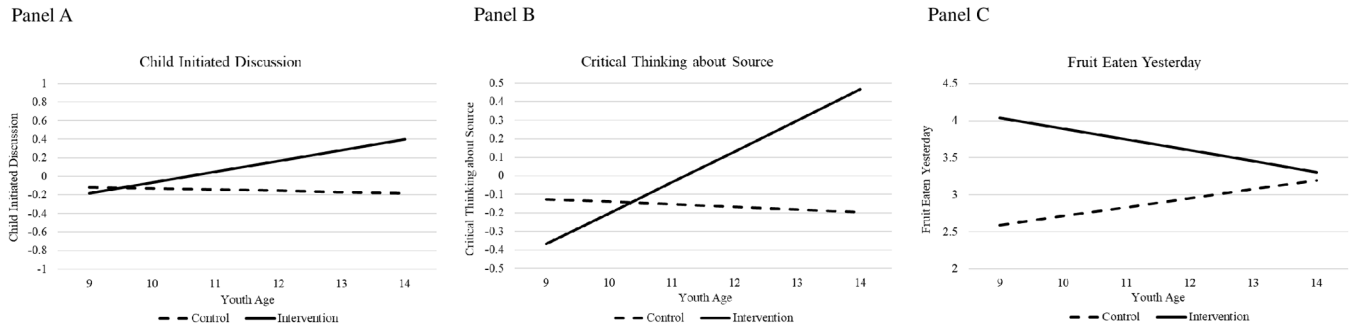

Figure 2. The age by condition interaction effects (N = 143) on *child initiated discussion* (Panel A), *critical thinking about source* (Panel B), and *fruit eaten yesterday* (Panel C). A version of the results presented in panels a and C have been reported previously in a multivariate analysis (N = 137) with a larger model (Austin et al., 2020b). Both versions controlled for pretest levels of the dependent variables.

observed data by the model, i.e. a conservative estimate of the likely population parameters.

The results in Figure 3 show that the intervention effects produced more significant paths ($p < .05$) and larger effect sizes compare to the control. The age of the intervention group youth also produced significant effects on three of the six outcomes. The effect of youth age on *Child Initiated Discussion* and *Critical Thinking about Sources* reflected the positive effects found in the MANCOVA, while the total effect of age on *Talk about Nutrition Labels* and *Vegetables Eaten Yesterday* were both non-significant (Table 3, $p > .05$). Finally, the total effect of age on Fruit Eaten Yesterday (TE = −0.130, $p < .01$) also reflects the interaction results from the MANCOVA in which the positive effect on fruit consumption in the intervention group was less for older youth compared to younger participants.

Main and total effects for *Youth Age* and *Child Initiated Discussion* were calculated for *Talk about Nutrition Labels, Vegetables Eaten Yesterday*, and *Fruit Eaten Yesterday* from the final MGSEM model as shown in Table 3 for both Control and Intervention (MacKinnon, 2012). Overall, effect sizes in the intervention group are larger and more are statistically significant ($p < .05$). The effects of *Child Initiated Discussion* to *Talk about Nutrition Labels* ($b^* = 0.661$) and to *Critical Thinking about Content* ($b^* = 0.451$) were considerably larger in the Intervention model compared with the Control. One path in the intervention model appeared smaller than in the control, from *Child Initiated Discussion* to *Critical Thinking about Sources* for which the control group exhibited a larger effect size ($b^* = 0.458$, $p < .001$) compared with the intervention ($b^* = 0.366$, $p < .001$). This seeming discrepancy is due to the significant effect of age on *Critical Thinking about Sources* in the intervention model and is another reflection of the interaction effect between youth age and condition observed in the MANCOVA and shown in Figure 2 Panel B. Despite the smaller effect size in the intervention group, there is an overall

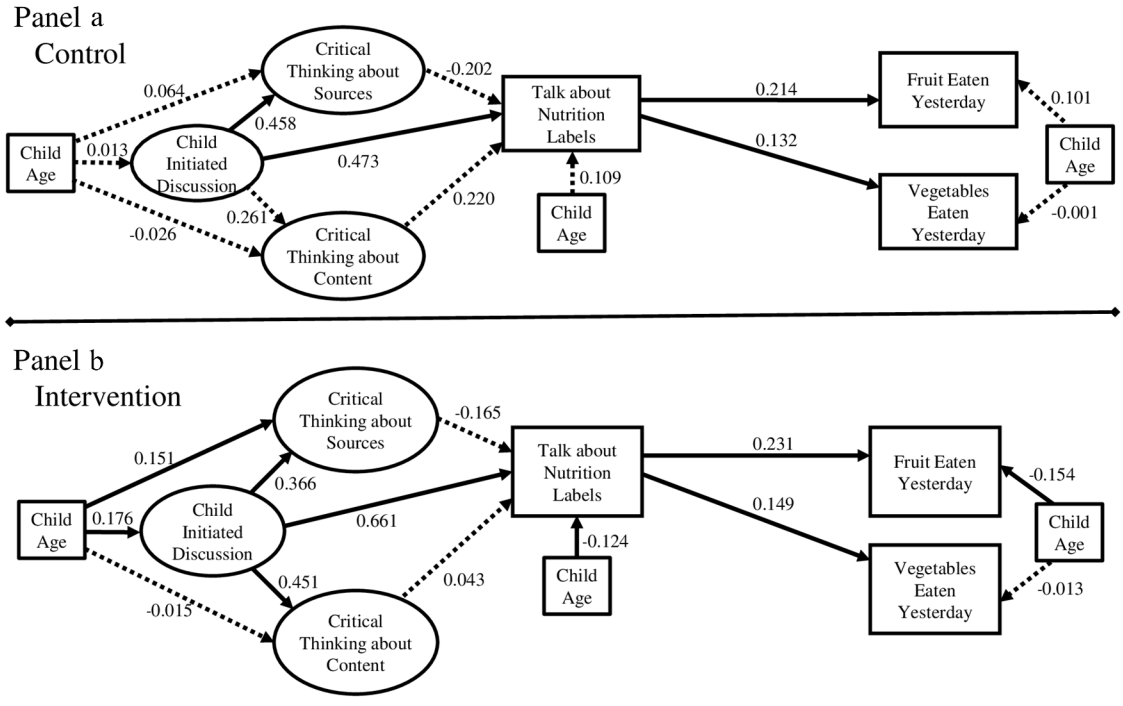

Figure 3. The final multigroup structural equation model showing differences between control group (Panel A) and intervention group (Panel B).

Table 3. Control and intervention group estimates from the MGSEM model.

		Control				Intervention			
				95% CI[3]				95% CI[3]	
Dependent	Predictor[1]	Estimate	S.D.	Lower	Upper	Estimate	S.D.	Lower	Upper
Child Init. Disc.	Youth Age	0.013	0.107	−0.194	0.235	0.176***	0.059	0.077	0.281
Critical Thinking (Content)	Child Init. Disc.	0.261	0.194	−0.149	0.611	0.451***	0.107	0.215	0.641
	Youth Age	−0.026	0.139	−0.318	0.230	−0.015	0.044	−0.096	0.066
Critical Thinking~ (Source)	Child Init. Disc.	0.458***	0.139	0.162	0.716	0.366***	0.076	0.218	0.512
	Youth Age	0.064	0.107	−0.150	0.272	0.151***	0.053	0.078	0.281
Talk about Nutrition Labels	Child Init. Disc.	0.473*	0.214	0.053	0.899	0.661***	0.087	0.481	0.821
	Crit. Th. Content	0.220	0.201	−0.181	0.609	0.043	0.035	−0.026	0.112
	Crit. Th. Source	−0.202	0.203	−0.630	0.178	−0.165	0.106	−0.373	0.048
	Youth Age	0.109	0.105	−0.109	0.313	−0.124*	0.057	−0.236	−0.012
	Youth Age TE[2]	0.068	0.072	−0.078	0.209	−0.034	0.051	−0.130	0.066
Vegetables Eaten Yesterday	Talk About Nutrition Labels	0.132*	0.067	−0.003	0.260	0.149*	0.075	−0.004	0.294
	Youth Age	−0.001	0.104	−0.205	0.205	−0.013	0.069	−0.152	0.121
	Child Init. Disc. TE[2]	0.056*	0.038	−0.003	0.149	0.091*	0.050	−0.003	0.193
	Youth Age TE[2]	0.008	0.075	−0.140	0.156	−0.015	0.054	−0.125	0.093
Fruit Eaten Yesterday	Talk About Nutrition Labels	0.214**	0.064	0.085	0.335	0.231**	0.069	0.093	0.367
	Youth Age	0.101	0.101	−0.106	0.283	−0.154*	0.064	−0.279	−0.024
	Child Init. Disc. TE[2]	.093**	0.044	0.022	0.194	0.150**	0.050	0.059	0.258
	Youth Age TE[2]	0.088	0.075	−0.065	0.230	−0.130**	0.053	−0.232	−0.027

* $p < .05$; ** $p < .01$; *** $p < .001$.
1. Results reflect variable's direct effect unless otherwise noted; interaction effects tested in the MANCOVA are not noted.
2. TE = Total Effect.
3. Bayesian 95% Credibility Interval.

greater increase in *Critical Thinking about Sources* in the intervention group compared with the control.

Finally, the Bayesian 95% credibility intervals shown in Table 3 for the Intervention group are considerably smaller, in most cases, compared to the Control indicating an increase in estimate precision as a result of the intervention. Credibility intervals are similar to frequentist confidence intervals with the important conceptual difference that the Bayesian 95% CI can be interpreted as a 95% probability that the true population parameter lies within the interval (Levy & Choi, 2013).

Discussion

This study tested a structural model representing the youths' perspective to examine the efficacy of a family-centered media literacy-oriented intervention to promote healthy food consumption. The intervention facilitated *Child Initiated Discussion* for improving 9–14 year olds' critical thinking about media messages and promoted parent-child discussion of factual nutrition content. The intervention involved both youth and parents in its design, implementation, and measurement of results. It did not focus on encouraging parents to reduce youths' screen time. As predicted, the program demonstrated improvements in youths' healthy eating behaviors by increasing productive interactions among family members, with food marketing and nutrition as the focus for discussion.

Multivariate analyses of the results revealed that the intervention was productive for all participating age groups. Older children improved more than younger children on *Child-Initiated Discussion* and *Critical Thinking about Sources*, while younger children benefitted more for *Fruit Eaten Yesterday*, perhaps reflecting younger children's greater dependence on parents for providing fruit at home. The findings that the intervention had greater effects on older than younger children for both *Child Initiated Discussion* and *Critical Thinking About Sources* are consistent with the increases in abstract thinking and complex reasoning that occur between middle childhood and early adolescence (e.g., Dumontheil, 2014; Gauffroy & Barrouillet, 2011; Inhelder & Piaget, 1958). These particular age differences may reflect that as children develop their ability to reason and think abstractly, they are better equipped to initiate conversations about the intentions and strategies of advertisers (Hwang et al., 2018).

The results highlighted the importance of the family-centered context for intervention. As expected, the intervention's effects on *Child Initiated Discussion* mentored by the parent were the catalyst for critical thinking and behavior change. The confirmed model, which accounted for changes from pretest to posttest, showed that youths' increases in fruit and vegetable consumption flowed from parent-child *Talk About Nutrition Labels*, which was predicted by *Child Initiated Discussion*. Particularly through *Child Initiated Discussion*, the intervention also improved youths' critical thinking about sources and message content, independent skills necessary for their longer-term decision making about food and nutrition.

Not surprisingly, study results also provide support for a developmental perspective to media literacy education. While child-initiated discussion had an influence on *Critical Thinking About Sources* for the control group and the intervention group, it had an effect on *Critical Thinking About Content* only for the intervention group. This suggests that children already had been developing skills for considering the persuasive intent of sources, which appears to progress from an understanding of a selling function to a deeper understanding of persuasive intent (Carter et al., 2011; Grohs et al., 2012; Lapierre, 2015; Rozendaal et al., 2010). Skills for considering message content features, such as techniques for making food and its consumers look especially attractive in marketing

messages, were better developed among the intervention group and especially so for the older youth. Moreover, *Child Initiated Discussion* predicted *Critical Thinking About Content* only for the intervention group, suggesting that these youth were practicing a new skill that did not exist in the control group. Meanwhile, older youth benefitted more from the intervention for *Critical Thinking About Sources*, with all ages benefitting equally for *Critical Thinking About Content*. These findings appear to indicate that older youth were developmentally primed to build critical thinking momentum on their previously existing knowledge base about sources. They are at the beginning stages, however, for their mastery of critical thinking skills about message content as their abilities for abstract thinking, critical reasoning and metacognition begin to develop and grow in sophistication (Brown & DeLoache, 1988; Gauffroy & Barrouillet, 2011; Mills & Keil, 2004; Weil et al., 2013). In other words, while some media literacy skills likely develop naturally through social interactions and cognitive maturation, the speed and depth of mastery can be increased through instruction and opportunities for practice.

The structural model tested in this study followed on a previous test of a family-based structural model showing that the program's effects on parents' critical discussion of food marketing (*Negative Mediation*) associated with increases in youths' critical thinking about food marketing content, which positively associated with their *Child-Initiated Discussion* and, in turn, with youths' consumption with fruit – although not with vegetables. In the model tested herein, we wanted to investigate how *Talk about Nutrition Labels* might serve as a mediating variable – discussion practice – to predict the behavioral outcomes of fruit and vegetable consumption. Using the youths' perspectives exclusively, we used *Child Initiated Discussion* as the predictor variable, and we incorporated *Critical Thinking about Sources* into the model along with *Critical Thinking about Content*. The total effect size for *Child Initiated Discussion* was almost identical in both analyses for vegetables (.091 in this study, $p = .027$; .101 in Austin et al., 2020a, *ns*) and for fruits (.150 in this study, $p = .001$; .195, $p < .05$), demonstrating good consistency in model fit. In addition, the correlation was virtually the same in both analyses between *Critical Thinking about Content* and *Child Initiated Discussion* despite the additional variables and the reversed relationship hypothesized in this model, which we had proposed from the child's vantage point rather than from the parent's.

The model was confirmed as parsimonious, with a good fit, documenting strengthened relationships among the variables in the model at posttest as hypothesized to occur from the intervention. It should be emphasized that structural models are theorized to be causal but actually test hypothesized associations that cannot be documented as causal without a highly controlled situation. Our study involved a field test in a community setting with self-reported measures. This study did not include 24-hour dietary recalls, BMI measures and other measures that could provide behavioral or longer-term documentation of behavioral change. Also, as noted in (Austin et al., 2020a), the limited cultural relevance and language accessibility of the program dampened its reach and effectiveness for Hispanic/Latinx and other groups: Too often, widely available programs lack community values, translations and culturally responsive recommendations, information sources and worldviews, and so it would be useful to produce and test more culturally relevant or modifiable versions of *FoodMania* given its promising results. Media literacy may play an important role in closing equity gaps in health and other socio-economic structures (Austin et al., 2021; Koonce, 2017; Media Literacy Now, 2020).

It is encouraging that the intervention demonstrated results across the age span of 9–14 years even while revealing some apparently developmentally related differences in study outcomes. The curriculum's focus on content (themes and ideas) and grammar (tactics) literacy but not on structure (social and economic structure of the advertising industry), literacy may have enhanced its overall success, consistent with the findings of Hwang et al. (2018). Although program developers had expressed concern about a lack of age-specific program content and delivery strategies, parents commonly teach and nurture youth of varied ages and sophistication. The curriculum also included specific opportunities for rehearsal and cooperative reinforcement of lesson content, consistent with the recommendation of Rozendaal et al. (2011), through hands-on activities that youth helped design through the program development process. This made our approach relevant for a family-centered context and family-based community activities that often must have relevance for youth across a wide age range.

Consistent with scholars' recommendations to include children as research partners rather than just as subjects, a strength of this study was that the intervention involved youth in program development and assessment. Although the study collected data from parents and some analyses have incorporated parental feedback (e.g. Austin et al., 2018), the models tested in this study focused on the youth perspective and the variables emerged from youth self-reports. Previous research has suggested that parents and youth can differ meaningfully on their interpretations of communicative acts such as parental mediation practices, making the analysis of youth perspectives valuable to consider independently despite limitations of reliability and recall (Fujioka & Austin, 2003). The results suggest that the family-centered intervention was empowering for the youth by promoting youth-initiated discussion, thereby producing beneficial effects for family decision making processes and youth behaviors.

It will be useful to extend tests of the study's hypotheses to other topics, more generalizable samples, and designs that facilitate the analysis of sustained effects and less intensive, flexible and modifiable delivery modalities. Meta-analyses of media literacy interventions (e.g. Xie et al., 2019) indicate that media literacy interventions can have lasting effects, yet few studies currently exist to verify this across topics and accounting for potential mechanisms of change, decay or strengthening of effects over time. The family-centered model also could make it possible to sensitively address topics with stigma such as substance use and mental health, to misinformation and disinformation more broadly, and to civic engagement more specifically. It also is possible that the model could be applied to media literacy education for science and health literacy, given that the principles for science literacy are so parallel to

those for media literacy, and much learning about science takes place through news, entertainment and social media. Science literacy similarly emphasizes critical thinking and consideration of evidence provided and missing, consideration of multiple sources for information, and how data are collected and interpreted (Baker, 2020; McClune & Jarman, 2010; Ryder, 2001).

Our reliance on self-reports, however valuable for their perspective, nevertheless can include self-report bias and may reflect limitations resulting from participants' abilities to understand and respond to survey questions. One limitation to the findings may be the readability of the questionnaire, which a Gunning-Fogg analysis indicated was approximately 8.2. Adults did help the youth answer the questionnaire but this questionnaire would still be generally above grade level for the youth participating the study. It will be important to continue to develop better tools for assessing youth perspectives.

Conclusion

Overall, the results of this family-centered test of a media literacy intervention for healthier food consumption suggest that a developmental progression exists from critical thinking about source to critical thinking about content that can be catalyzed through media literacy education, particularly to the extent that children are encouraged to discuss media messages (i.e. practice) with parents. Children who develop persuasion knowledge still need to practice it and be motivated to use it, and this can happen productively through family discussion and parental reinforcement that cultivates the child's agency.

Disclosure statement

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