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ORIGINAL ARTICLE

Predictors of fruit and vegetable intake in low-income and racially diverse preschoolers: does parental feeding style matter?

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Abstract

Aim Diets rich in fruit and vegetables (FV) are associated with favorable public health outcomes, including lower prevalence of cancer and obesity. However, children's FV consumption in many Western countries fails to meet the minimum recommendations. Because parental behaviors influence children's diet from birth, it is important to examine potential interactions between taste preferences and parental behaviors on FV consumption in early childhood. This study tested the moderating effect of an authoritative feeding style on the link between child's FV taste preferences and FV intake.

Subjects and methods Racially/ethnically diverse, low-income parents of 3–5-year-old children were recruited for the study. Parents completed an interviewer-assisted FV food frequency questionnaire and a survey on sociodemographic and other characteristics of the child/parent/family. Hierarchal linear regression models tested the main and interactive effects of taste preferences and authoritative feeding style on children's FV frequency intake, controlling for known covariates, including race/ethnicity and household availability.

Results A total of 281 parents participated in the study, with 16% being authoritative feeders. Authoritative feeding style did not interact with child taste preference to predict fruit intake ($\beta = 0.084$; $p = 0.98$) or vegetable intake ($\beta = -2.908$; $p = 0.24$). Child's taste preference, after controlling for home availability, was the strongest predictor of FV intake in the sample ($p < 0.05$).

Conclusion Nutrition education efforts targeting FV promotion in low-income families should focus on strategies that help parents increase children's FV taste preferences as early in life as possible.

Keywords Fruit and vegetable consumption · Children · Taste preferences · Feeding style · Disease prevention

Introduction

Diets rich in fruit and vegetables (FV) have been associated with a lower risk of chronic diseases, such as type II diabetes and obesity (Boeing et al. 2012; Liu 2013). Despite the importance of establishing healthy eating habits early in life, children in many European countries and the US fail to meet the minimum FV recommendations (Cooke 2007; Hansen et al. 2015; Kim et al. 2014; Lorson et al. 2009; Lynch et al. 2014). Furthermore, the FV intakes are even lower among children in socioeconomically disadvantaged families, which puts them at a greater risk for a variety of chronic diseases in the future (Di Noia and Byrd-Bredbenner 2014; Dubowitz et al. 2008; Guerrero and Chung 2016; Kamphuis et al. 2006; Kong et al. 2013; Rasmussen et al. 2006; Story et al. 2002).

Several personal-, family- and community-level correlates of children's FV consumption have been identified in previous research, including FV home availability, parental modeling and socioeconomic status (Amuta et al. 2015; Benton 2004; Birch 1999; Di Noia and Byrd-Bredbenner 2014; Gross et al. 2010; Rasmussen et al. 2006). Taste preference for FV, in particular, has been suggested as one of the important

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correlates of FV consumption across age groups (Kong et al. 2016; Neumark-Sztainer et al. 2003). Personal taste preferences for various foods develop early in life, with young children naturally preferring sweet and salty tastes over bitter and sour tastes (Birch 1999). Typically, aversions to bitter and sour tastes diminish over time and children develop a broader taste palate (Benton 2004; Birch 1999; Cooke 2007; Desor et al. 1975). In recent years, studies have pointed out the importance of increasing FV taste preferences and optimizing dietary intake in preschool years because food habits developed during childhood tend to track into later years (Fletcher et al. 2017; Hansen et al. 2015; Shriver and Buehler 2016).

Food-related behaviors of parents also significantly impact children's taste preferences, dietary intake and long-term food habits (Bante et al. 2008; Benton 2004; Blissett and Fogel 2013; Cooke et al. 2004). Because it is not only important what parents feed their children, but also how they approach feeding situations, the Caregiver's Feeding Style Questionnaire (CFSQ) is commonly used to gain a better understanding of parenting behaviors in the feeding context in nutrition research (Hughes et al. 2012). Parental feeding style is determined by two dimensions of parenting, demandingness and responsiveness, which refer to the amount of parental control, freedom and support in the feeding context (Hughes et al. 2005, 2012). From the four feeding styles that have been conceptualized in the literature, the authoritative feeding style has been consistently linked to the most favorable nutrition-related outcomes among children (Hoerr et al. 2009; Olvera and Power 2010; Patrick et al. 2005; Rhee et al. 2006; Vollmer and Mobley 2013). The authoritative feeding style is characterized by high demandingness and high responsiveness, which sets clear expectations for the child but also allows the child to be part of the feeding process and attends to children's needs (Baumrind 1971; Hughes et al. 2005; Maccoby and Martin 1983).

Compared with other feeding styles, the use of authoritative feeding has been associated with a variety of positive nutrition outcomes, including a lower risk of child overweight, a greater consumption of FV among children and more parental attempts to encourage children to eat FV (Olvera and Power 2010; Patrick et al. 2005). A number of studies have shown that the authoritarian, permissive and uninvolved feedings styles are correlated with much less desirable nutrition outcomes in children, including a greater consumption of energy-dense foods among children whose parents use a permissive feeding style, marked by high responsiveness but very limited demandingness (Blissett 2011; Hennessy et al. 2012).

To date, it has been well established that both children's taste preferences and feeding-related parental behaviors play an important role in the evolution of children's nutrition outcomes (Birch 1999; Cooke 2007; Cooke et al. 2004). While parents are encouraged to use the authoritative feeding style and set clear rules and expectations related to food, little is known about the influence of this feeding style when it comes to promoting foods that are generally less preferred by children, such as vegetables, compared with other foods. Thus, the main purpose of this study was to test the moderating effect of the authoritative feeding style on the link between children's FV taste preferences and FV frequency intake in a sample of socioeconomically disadvantaged and racially/ethnically diverse preschool-aged children.

Methods

Study design

Data for this correlational study were collected as part of a larger observational study of parents/legal guardians of 3- to 5-year-old children enrolled in 42 preschool childcare sites in the southern part of the US. Participant recruitment took place between March 2015 and May 2016. Trained research assistants recruited participants during drop-off and pick-up times and during parent meetings at the centers. Given the large Hispanic population in the participating childcare sites, recruitment flyers were available in both English and Spanish. The flyers were sent home in children's backpacks and also posted in the hallways at each site. Bilingual research assistants were available to recruit, contact and enroll interested participants, including English- and Spanish-speaking participants, into the study.

Prior to any data collection, participants (hereafter the term "parents" will be used to refer to all eligible participants) reviewed and signed written consent forms and provided written permission for researchers to obtain their child's birthdate, height, weight and date of measurement from recent childcare site records. The study protocol and procedures were reviewed and approved by the University Institutional Review Board at [blinded for review University of North Carolina Greensboro] prior to data collection.

Study participants and procedures

All parents were first screened for eligibility using the following inclusion criteria: (1) being a parent/legal guardian of a 3- to 5-year-old child enrolled in one of the participating childcare sites with low-income admission criteria; (2) being ≥18 years of age; (3) being the primary feeder of the child at home, referred as a parent from here after; (4) self-identifying as either a non-Hispanic White, Hispanic White or African American individual; (5) the child not having any medical conditions that required a special diet (e.g., diabetes). After the parent eligibility for the study had been established, a one-on-one visit with each parent was scheduled based on parental availability. Childcare and transportation services for the study visit were arranged upon request.

Once parents arrived for the scheduled visit, they were asked to complete a parent survey. The six-part survey was designed for the larger study, but data from only three sections were utilized for the purposes of the current study: section 1: socio-demographic, individual/family information; section 2: parent-reported child FV food frequency questionnaire (FFQ); section 6: FV household availability, parent-reported child taste preferences for FV and parent taste preferences for FV. The FFQ was completed in an interview format with a trained research assistant recording parents' responses to each item. Trained research assistants were available to provide assistance to parents while completing the survey. Parents were given a $25 gift card for their participation at the end of the visit.

Study measures and variables

Parental and family characteristics and household availability

Parental race/ethnicity was determined by parent's self-reports to two questions adapted from the US Census. For the regression models, the final variable was dummy coded as 0 = African American or Hispanic White; 1 = Non-Hispanic White. The highest level of education was assessed by one item that provided nine categories ranging from grade school (grades 1–8) to doctorate degree. Two education categories were created for the final regression analyses (0 = high school degree or less; 1 = some college, associate/baccalaureate/graduate degree). Parents also self-reported their height and weight, which was used to calculate their body mass index (kg/m^2) to determine their weight status.

The target population of the current study was low-income families whose 3- to 5-year-old children were enrolled in a specific childcare program. To participate in the program, families must meet specific low-income eligibility criteria. For instance, a parent of a family of four has to have an annual income < $24,250, according to the federal guidelines (USDHHS 2015). In addition to meeting these criteria, parents were also asked about their total household income in the past year with the following response options: < $10,000; $10,000–$24,999; $25,000–$34,999; $35,000–$49,999; $50,000–$74,999; > $75,000. The income categories were dummy coded for the final analyses as follows: 0 = under $10,000; 1 = ≥ $10,000.

FV availability was assessed using a modified version of a previously validated household FV availability measure (Marsh et al. 2003). Parents self-reported whether or not they had the specific F and V item (i.e., fresh, frozen or canned) in their home in the past 7 days using a "yes" or "no" format (0 = no; 1 = yes). Based on our own preliminary findings and previous studies with the target population, 10 F and 10 V items were included in the final measures related to FV (Linneman et al. 2004). The household availability scores were used as a continuous variable of F and V availability (i.e., possible score range of 0–10 for each).

Child measures and variables

Children's demographic and anthropometric characteristics were collected via the parent survey and from the official childcare center records. Body mass index-for-age (BMI-for-age) percentile and z-scores were calculated for each child using the Epi Info software (Epi Info, CDC, version 2007). For the purposes of describing the sample, children were categorized into four weight status categories: 1 = underweight (BMI-for-age < 5th percentile); 2 = healthy weight (BMI-for-age 5th to <85th percentile); 3 = overweight (BMI-for-age 85th to <95th percentile); 4 = obese (BMI-for-age > 95th percentile) (Kuczmarski 2002).

During the data collection visits, parents completed the Slu4Kids FFQ based on their child's FV consumption during the past 7 days. The measure was developed and validated with parents of preschool-aged children and included a total of 27 FV items (Haire-Joshu et al. 2008; Linneman et al. 2004). First, parents were asked if their child's food intake in the past 7 days was "typical," followed by questions about frequency of specific FV. Preliminary findings from our own research with the target population of racially/ethnically diverse parents of young children led to minor modifications of the Slu4Kids FFQ. For the purposes of the current study, the assessment of the child F and V frequency intake was based on parent report of child consumption of ten fruits (e.g., bananas, grapes, apples, strawberries, oranges, peaches, watermelon, pineapple, mandarins, pears) and ten vegetables (e.g., white non-fried potatoes, corn, carrots, broccoli, lettuce, green beans, tomatoes, cucumbers, green peas, cabbage) that are known to be commonly consumed by the target population based on previous studies and our own preliminary study. Response options for all FV items ranged from 0 to 5 (0 = did not have it; 1 = 1 time; 2 = 2 times; 3 = 3–4 times; 4 = 5–6 times; 5 = > 7 times). Child score for the F and V frequency intake had a possible score between 0 to 50. For example, a child who consumed three out of the ten F items 3–4 times over the past 7 days received a total F frequency intake score of 9.

The child FV taste preference measure was also adopted from the procedures used by Linneman et al. (2004). Parents were asked to report children's taste preferences for the same ten F and ten V items that were included in the modified Slu4Kids FFQ using the following responses: 1 = hates it; 2 = dislikes it; 3 = likes it; 4 = loves it/favorite (Haire-Joshu et al. 2008; Linneman et al. 2004). The child taste preference summed, composited scores for F and V each ranged from 10 to 40, with higher scores indicating greater taste preference.

Parental feeding style and taste preferences

The Caregiver's Feeding Style Questionnaire (CFSQ) was utilized to assess feeders' usual interactions with their child during a meal or snack (Hughes et al. 2005). From the original CFSQ, 19 items were used to classify parents into one of the four feeding styles of parents using the following answer choices on a Likert scale—1 = never; 2 = rarely; 3 = sometimes; 4 = most of the time; 5 = always—to describe the frequency of the situation presented in the questions. Parents' scores were assessed along the two dimensions of parenting, demandingness and responsiveness. The two dimensions were created using 7 child-centered directives that focused on child autonomy (e.g., complimenting the child on eating, allowing the child to choose from prepared foods) and 12 parent-centered directives that focused on control using external pressures (e.g., demanding the child to eat, withholding dessert until the plate is cleaned). As outlined in a study by Hughes et al. (2012), the scores for demandingness and responsiveness were calculated, and the median splits of 2.80 for demandingness and 1.16 for responsiveness were used as cutoff points to categorize the parents into one of the four parental feeding styles (Hughes et al. 2012). Using the cutoff values established by Hughes et al. (2012), parents were classified into one of two categories for the final analyses (0 = authoritative feeding style; 1 = other feeding styles).

Parental taste preferences for FV were also measured using a modified version of the child taste preference measure (Linneman et al. 2004). Parental FV taste preference score was used as a control variable in the final analyses, with the parental taste preference answer options ranging from 1 (hate it) to 4 (love it/my favorite) and the total parental F and V taste preference scores ranging from 10 to 40 for each, respectively.

Statistical analyses

Data in the current study were analyzed using the Statistical Package for Social Sciences for Windows (21.0 SPSS Inc., Chicago, IL, 2012). Two trained research assistants checked the data independently for accuracy. All continuous variables were checked for normal distribution and outliers, using visual inspection and q-q plots (Thode 2002; Wilk and Gnanadesikan 1968). Descriptive statistics (i.e., means, standard deviations and frequencies) were computed for all study variables.

Pearson's bivariate correlations were used to examine the associations between the key continuous study variables (i.e., child FV taste preferences, child FV intake frequency, child BMI z-scores and parental feeding style). Any variables that were significantly correlated with child frequency FV intakes were included in subsequent multiple regression models as control variables. Analysis of variance (ANOVA) was used to examine any potential differences in child FV frequency intake or taste preferences by race/ethnicity, income and education; any significance found resulted in the use of these as covariates in the moderated regression models for F and V. Statistical significance levels were set at $p < 0.05$.

Two hierarchical multiple regression models were utilized to test the interaction effects of child taste preferences and authoritative feeding style on child frequency of intake of F and V separately. Prior to running the regression models, continuous variables of child FV taste preferences, parental taste preferences and FV availability were centered to minimize multicollinearity (Aiken and West 1991).

Control variables, including race/ethnicity, education, marital status, parental taste preference for F or V, and household availability of F or V, were entered in the first block of each omnibus regression model followed by child taste preferences in block 2 and the moderating variable of the authoritative feeding style (dummy coded) in block 3. The interaction term between child taste preference and feeding style was entered in block 4. Tests of simple slopes were conducted if a significant interaction was detected. A significance level for the interaction effect was set at $p < 0.10$ based on a previous study that found 91% of stimulated correlations studies make type II errors in identifying moderation effects (McClelland and Judd 1993). Significance levels for all other tests were set at $p < 0.05$.

Results

From a total of 431 parents who initially expressed interest in participating in the study and provided their contact to receive further information about the study, 281 parents of 3–5-year-old children were eligible and completed the study (65%). The characteristics of the parents (i.e., primary feeders at home) and their children are displayed in Table 1. The majority of the parents were mothers (90%), and the remaining 10% reported being the child's grandmother/other family member. Using the feeding style typology, the greatest proportion of the sample was classified as parents who used an indulgent feeding style (35%), with 16% reporting the authoritative feeding style (16%). The majority of the sample reported receiving federal nutrition benefits based on low-income status (53–73%). The majority of the children were overweight (9%) or obese (38%), with 40% having a BMI-for-age percentile within a healthy range (Table 1). Preliminary bivariate correlational analyses revealed differential associations between key sociodemographic variables in relation to taste preferences, availability and intake between F and V (Tables 2 and 3). Child taste preferences for F were significantly associated with higher education (Table 2), whereas child taste preferences for V were correlated with greater income and availability, but not education (Table 3).

Table 1 Characteristics of the parent-child dyads in the sample ($n = 281$)

Variable	Descriptive statistics	
	Mean ± SD	*n* (%)
Parent characteristics		
Age (in years)	31.9 ± 7.8	
Weight status[a]		
Underweight		4 (1)
Normal weight		67 (24)
Overweight		80 (29)
Obese		120 (43)
Sex		
Female		265 (94)
Male		16 (6)
Race/ethnicity[b]		
African American		106 (38)
Non-Hispanic White		75 (27)
Hispanic White		100 (35)
Highest education[c]		
Less than high school		86 (31)
High school graduate		69 (25)
Some college/technical school/associate degree		105 (37)
College graduate and post-graduate study		18 (6)
Marital status[d]		
Never married/single		83 (30)
Married/living with a partner		170 (60)
Divorced/separated/widowed		27 (10)
Household income[c]		
Less than $10,000		93 (33)
$10,000–$34,999		163 (58)
More than $35,000		21 (8)
Child characteristics		
Age (in years)	4.35 ± 0.7	
Body mass index-for-age percentile	75.6 ± 28.2	
Sex[c]		
Female		131 (47)
Male		146 (52)
Weight status[e]		
Underweight		11 (4)
Normal weight		137 (49)
Overweight		26 (9)
Obese		107 (38)

[a] Cutoff values developed by CDC were used to categorize parents into weight categories based on their BMI: underweight = BMI < 18.5; healthy weight = BMI 18.5–24.9; overweight = BMI 25–29.9; overweight = BMI > 30; 3% of the sample had missing information for height and weight

[b] The variable included three categories based on the inclusion criteria of the larger study

[c] Four participants had missing information

[d] One participant had missing information

[e] Weight status was determined using the following CDC cutoff values: underweight = BMI < 18.5; healthy weight = BMI 18.5–24.9; overweight = BMI 25–29.9; overweight = BMI > 30. Sample mean values were used for missing height and weight data ($n = 25$)

Table 2 Bivariate correlations among sociodemographic characteristics, child fruit taste preferences, fruit frequency intake and authoritative feeding style

Variable	Parent race/ethnicity	Education	Income	Marital status	Fruit availability	Child fruit taste preferences	Child fruit frequency intake	Parent fruit taste preferences	Authoritative feeding style
Parent race/ethnicity[a]	–								
Education[b]	−0.285**	–							
Income[c]	0.154*	0.070	–						
Marital status[d]	0.262**	−0.150*	0.255**	–					
Fruit availability[e]	0.094	−0.195**	0.085	0.107	–				
Child fruit taste preferences	−0.221**	0.196**	−0.014	−0.059	−0.002	–			
Child fruit frequency intake	0.098	−0.188**	−0.005	0.102	0.491**	0.118	–		
Parent fruit taste preference	−0.172**	0.196**	−0.010	0.013	0.115	0.626**	0.117	–	
Authoritative feeding style[f]	−0.071	0.079	−0.076	−0.020	0.081	0.090	0.053	0.043	–

* $p < 0.05$; ** $p < 0.01$

[a] Parent race/ethnicity (0 = African American and Hispanic; 1 = White)

[b] Educationb (0 = ≤ high school; 1 = > high school)

[c] Income (0 = ≤ $10,000; 1 = > $10,000)

[d] Marital status[d] (0 = never married/single/divorced; 1 = married/living with partner)

[e] Fruit availability[e] (0 = no; 1 = yes)

[f] Authoritative feeding style (0 = no; 1 = yes)

Moderated regression analyses for fruit and vegetable frequency intake

The overall model was significant in predicting F frequency intake among children ($F(8,256) = 12.5$; $p < 0.001$) and explained 28.7% of the variance in children's F frequency intake over the past 7 days. Analyses revealed no significant interaction between child taste preferences for F and the authoritative feeding style on the child F frequency intake (unstandardized $b = 0.47$; $p = 0.875$). After controlling for race, education, marital status, parental F taste preferences and household availability of F, child taste preferences contributed a small but significant amount of unique variance to the overall model (R^2 change = 0.024; $p < 0.001$). Thus, children with higher F taste preferences consumed F more frequently (unstandardized $b = 3.83$; $p < 0.01$) (Table 4).

The regression analysis for child V intake revealed significance in the overall model [$F(8,246) = 11.46$; $p < 0.001$]. The regression model explained 27.8% of the variance in children's V frequency intake over the past 7 days. No significant interaction effect between the child taste preferences for V and the authoritative feeding style on children's V frequency intake was detected (unstandardized $b = -2.75$; $p = 0.259$). Household availability of V had a significant main effect on the child frequency intake of V (unstandardized $b = 0.97$; $p < 0.001$). A significant amount of variance in the child V intake was contributed to the child taste preferences for V (unstandardized $b = 4.67$; $p < 0.001$) after covariates, including household availability of V, were included in the model (R^2 change = 0.072; $p < 0.001$; Table 5).

Discussion

The main purpose of this study was to test whether authoritative feeding moderates the association between child taste preferences and FV consumption among young children. In our sample of low-income parents and their preschool-aged children, the authoritative feeding style did not influence the strength of the relationship for either F or V. Instead, FV availability and established taste preferences for FV served as the strongest predictors of children's FV consumption in our sample of low-income preschoolers. These findings expand the current body of literature on parental feeding style and children's dietary outcomes by demonstrating that children FV taste preferences have a strong influence on their consumption of both F and V and that this is the case regardless of the parenting style their parents use in the feeding context.

Authoritative feeding has been related to more favorable weight outcomes among children compared with the other

Table 3 Bivariate correlations among sociodemographic characteristics, child vegetable taste preferences, vegetable frequency intake and authoritative feeding style

Variable	Parent race/ethnicity	Education	Income	Marital status	Vegetable availability	Child vegetable taste preferences	Child vegetable frequency intake	Parent vegetable taste preferences	Authoritative feeding style
Parent race/ethnicity[a]	–								
Education[b]	−0.285**	–							
Income[c]	0.154*	0.070	–						
Marital status[d]	0.262**	−0.150*	0.255**	–					
Vegetable availability[e]	0.070	−0.051	0.050	0.122*	–				
Child vegetable taste preferences	−0.042	0.016	0.150*	0.092	0.228**	–			
Child vegetable frequency intake	0.190**	−0.174**	0.072	0.152*	0.405**	0.261**	–		
Parent vegetable taste preference	−0.222**	0.167**	0.000	0.009	0.324**	0.548**	0.112	–	
Authoritative feeding style[f]	−0.071	0.079	−0.076	−0.020	−0.018	−0.064	−0.036	0.071	–

* $p < 0.05$; ** $p < 0.01$

[a] Parent race/ethnicity (0 = African American and Hispanic; 1 = White)

[b] Educationb (0 = ≤ high school; 1 = > high school)

[c] Income (0 = ≤ $10,000; 1 = > $10,000)

[d] Marital status[d] (0 = never married/single/divorced; 1 = married/living with partner)

[e] Vegetable availability[e] (0 = no; 1 = yes)

[f] Authoritative feeding style (0 = no; 1 = yes)

feeding styles in previous research (Frankel et al. 2014; Shloim et al. 2015; Tovar et al. 2012). It has been proposed that parents who use the authoritative feeding style are able to create a less obesogenic feeding environment at home and that their children might be able to self-regulate eating more easily, thus having lower BMI z-scores compared with other children (Frankel et al. 2014). Although the specific mechanisms are not well understood in current literature, these studies represent evidence that the authoritative feeding style may provide protection against childhood obesity.

Research on the associations between feeding styles and children's dietary intake is less consistent than studies focused on feeding styles in relation to weight status and/or obesity risk as the main outcomes (Blissett 2011; Frankel et al. 2014; Hughes et al. 2005, 2012; Hughes et al. 2008; Kremers et al. 2003; Patrick et al. 2005; Tovar et al. 2012; Vollmer and Mobley 2013). A recent review suggests that parents who use the authoritative feeding style have greater control over meals and tend to provide higher nutrient-dense foods to their children compared with parents with permissive feeding styles (Vollmer and Mobley 2013). However, in our sample of 3- to 5-year-old children, authoritative feeding did not moderate the relationship between children's taste preferences and their F or V intake.

Feeding styles represent broader constructs, much like general parenting styles, that reflect the overall climate in the home, but may not capture specific strategies used by parents during meals/snacks (De Bourdeaudhuij et al. 2009; Hughes et al. 2013). Given the nature of the feeding style construct, it is possible that some parents in our sample were categorized as "authoritative feeders," despite using coercive feeding tactics to offer FV to their children. Thus, specific feeding practices, rather than feeding styles, might be more influential when encouraging a child to consume a specific food (Shriver and Buehler 2016). This is especially important when a child is resistant to eating or even trying foods that are less palatable to him/her. Therefore, our findings could be explained, at least in part, by the fact that feeding styles do not capture specific parenting practices that are important for children's FV consumption. The differences between feeding styles and feeding practices in relation to FV consumption have been well summarized in a review paper by Blissett (2011). The authors highlight potential impacts of parental feeding on children's FV intakes and emphasize the need to conduct further studies on the parental influences of children's consumption of nutrient-dense foods, including FV (Blissett 2011).

Table 4 Multiple regression analysis predicting child fruit frequency intake from child fruit taste preferences and authoritative feeding style

Variables	*B*	SE	Beta	*t* Test	Significance
Block 1: Control variables					
Race/ethnicity[a]	1.157	0.796	0.084	1.454	0.147
Education[b]	−1.170	0.779	−0.087	−1.502	0.134
Marital status[c]	0.888	0.767	0.065	1.157	0.248
Fruit availability[d]	1.427	0.175	0.457	8.152	0.000***
Parent fruit taste preferences[e]	−0.101	1.028	−0.007	−0.089	0.922
Block 2: Predictor					
Child fruit taste preferences[f]	3.829	1.308	0.198	2.926	0.004**
Block 3: Moderator					
Authoritative feeding style[g]	−0.571	0.988	−0.032	−0.578	0.564
Block 4: Interaction term					
Authoritative feeding style × children's fruit taste preferences	0.465	2.956	0.010	0.157	0.875

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Parent race/ethnicity (0 = African American and Hispanic; 1 = White)

[b] Education (1 = ≤ high school graduate; 2 = > high school graduate)

[c] Marital status (0 = never married/single/divorced; 1 = married/living with partner)

[d] Fruit availability; a continuous score ranging from 10 to 40

[e] Parent fruit taste preferences missing data (n = 2)

[f] Child fruit taste preferences, missing data ($n = 5$)

[g] Authoritative feeding style (0 = no; 1 = yes)

The main effect of child FV taste preferences on FV consumption identified in our study stresses the urgent need for increasing children's taste preferences for healthy foods very early in life (Amuta et al. 2015; Benton 2004; Blissett and Fogel 2013; Cooke 2007; Cooke et al. 2004; Di Noia and Byrd-Bredbenner 2014; Rasmussen et al. 2006). In addition to taste, many other factors, such as texture or visual senses, can influence children's acceptability of FV, especially of V that are more bitter and/or tart than F (Benton 2004; Blissett and Fogel 2013). While FV texture, color and visual characteristics that contribute to children's taste preferences were not examined in the current study, we found that children in our sample had much higher taste preferences for F over V. This is most likely due to the sweet taste of F and the natural predispositions of humans to like sweet and salty taste over bitter and sour taste (Birch 1999; Blissett and Fogel 2013; Desor et al. 1975). Thus, future studies should continue examining predictors of FV consumption separately, as F and V clearly represent two distinct food groups with differential correlates.

Many studies have found a positive link between parental taste preferences and children's taste preferences (Cooke 2007; Cooke et al. 2004; Di Noia and Byrd-Bredbenner 2014). Furthermore, recent studies suggest that parental influences on children's food preferences and choices might begin even before birth via taste exposures during pregnancy and/or via breastfeeding in early infancy (Blissett et al. 2012; Kong et al. 2016; Möller et al. 2013). In our sample, parental taste preferences for FV were strongly associated with children's taste preferences for both F and V; however, parental taste preferences became non-significant predictors of children's FV intake once the control variables were added to the model. Child taste preferences for both F and V were correlated with child intake of FV, with the link being even stronger for V. Given child taste preferences remained a key significant factor influencing children's intake of both F and V, further research on predictors of taste preferences among low-income preschool children is warranted. It is critical to expose young children to a variety of FV to ensure that taste preferences develop and track into later years. Thus, identification of specific target foci for positively influencing taste preferences is critical for future family- and community-level intervention programs for parents of young children (Cooke 2007).

Household availability of FV has been linked to greater intakes of FV among both adults and children (Amuta et al. 2015; Di Noia and Byrd-Bredbenner 2013; Gross et al. 2010; Rasmussen et al. 2006). Because FV must be available to children in order to develop taste preferences for them, availability directly and indirectly promotes development of taste preferences for FV among children (Di Noia and Byrd-Bredbenner 2013). In the current study, only household availability of V, not F, was associated with child taste preferences, although F availability was positively correlated with child F frequency intake. It is likely that children naturally have a strong preference for F due to its sweetness, whereas developing taste preferences for V is more complex (Birch 1999; Blissett and Fogel 2013). Thus, having V readily available in

Table 5 Multiple regression analyses predicting child vegetable frequency intake from child vegetable taste preferences and authoritative feeding style

Variables	*B*	SE	Beta	*t* Test	Significance
Block 1: Control variables					
Race/ethnicity[a]	1.132	0.743	0.094	1.524	0.129
Education[b]	−1.200	0.696	−0.102	−1.726	0.086
Marital status[c]	0.863	0.698	0.072	1.237	0.217
Vegetable availability[d]	0.971	0.188	0.306	5.155	0.000***
Parent vegetable taste preferences[e]	−1.101	0.956	−0.080	−1.152	0.251
Block 2: Predictor					
Child vegetable taste					
Preferences[f]	4.673	0.986	0.311	4.741	0.000***
Block 3: Moderator					
Authoritative feeding					
Style[g]	−1.011	0.915	−0.062	−1.104	0.271
Block 4: Interaction term					
Authoritative feeding					
Style × children's					
Vegetable taste preferences	−2.753	2.434	−0.068	−1.131	0.259

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[a] Parent race/ethnicity (0 = African American and Hispanic; 1 = White)

[b] Education (1 = ≤ high school graduate; 2 = > high school graduate)

[c] Marital status (0 = never married/single/divorced; 1 = married/living with partner)

[d] Vegetable availability; a continuous score ranging from 10 to 40

[e] Parent vegetable taste preferences missing data ($n = 2$)

[f] Child vegetable taste preferences, missing data ($n = 14$)

[g] Authoritative feeding style (0 = no; 1 = yes)

the home may make it easier for children to develop taste preferences for them. Our findings demonstrate the important role of household availability on FV intake in the target population, a trend that has been supported across many previous investigations (Amuta et al. 2015; Di Noia and Byrd-Bredbenner 2013; Gross et al. 2010).

The parent-child dyads in the current study were recruited from racially/ethnically diverse families enrolled in a childcare program with low-income status as one of the main admission criteria. Previous research has shown that this population is at high risk of malnutrition, poor diet quality as well as obesity risk, with limited resources and poor access to healthy nutritious foods (Di Noia and Byrd-Bredbenner 2014; Dubowitz et al. 2008; Guerrero and Chung 2016; Kong et al. 2016). It is important to note the very high obesity prevalence among both parents and children in our sample, with 38% of children being obese and 9% overweight. These estimates are significantly higher compared with the national obesity rate of 8% that was most recently reported for preschool-aged children (Ogden et al. 2014). Additionally, a total of 43% of parents were obese and 29% were overweight in our sample, with only 24% having a healthy weight. In the light of our findings, it is especially important to continue intense family- and community-level nutrition intervention efforts to improve public health outcomes in this at-risk population.

Our findings contribute significantly to the existing literature on predictors of FV intakes among low-income, racially diverse families with young children. The sample of child-parent dyads was relatively large and unique because participants were recruited from both rural and urban areas. The sample had similar characteristics in relation to feeding styles compared with studies by Hughes et al. (2012), thus allowing the use of the suggested standardized cutoff points to create feeding style categories. The study also had several limitations. First, children's FV intake in this study was based on a parent-reported food frequency questionnaire; utilization of multiple 24-h dietary recalls or more detailed FFQs that would cover longer periods of time was not feasible in the current study (Walker et al. 2003). The FFQ relied on parental recall of the child's intake over the past 7 days. Thus, parents could have over- or under-reported the frequency of FV intake for their child. Second, parents recalled 1 week's worth of FV intake during the one-on-one visit. Parents were interviewed at different times of the year, and therefore findings may have been influenced by FV seasonality, although the FFQ items included all FV forms (i.e., fresh, frozen, canned). Third, household availability of FV could have been affected by

the geographical location of the participant's homes (i.e., food deserts, living in areas with little to no access to fresh FV). Low-income families may have no or only one car, or have limited access to public transportation, which may affect availability of FV in their homes. Fourth, the focus of the study was on the child's FV intake in the presence of the parent; thus, the estimated frequency intake did not reflect children's overall FV consumption. Lastly, the sample was not nationally representative; thus, our findings cannot be generalized to other low-income families across the nation.

In the current study, FV taste preferences, along with household availability, served as the strongest predictors of young children's FV intake. While most parents are aware of the health benefits of FV, they struggle to encourage their children's FV consumption, especially vegetables. The current study is unique because it examines associations between the currently "recommended" feeding style and child taste preferences for FV and advances our understanding of whether and how parental behaviors interact to positively influence young children's FV intake. Our findings show that children's FV taste preferences represent a strong predictor of FV intake among 3–5-year-old children, regardless of whether parents use the authoritative feeding style. Thus, nutrition education for parents should emphasize the importance of offering a variety of FV starting in infancy to maximize children's FV taste preferences later in life.

Because taste preferences cannot be developed without repeated exposure to the target foods, availability and access to FV are critical for families with young children. Due to seasonally high prices, affordability of fresh produce is a common barrier to higher FV intake among socioeconomically disadvantaged families; therefore, canned and frozen FV should be promoted as healthy and acceptable nutrient-dense options. Furthermore, awareness should be improved among breastfeeding mothers about how their own FV intake may influence their children's future taste preferences for FV, and all parents should be encouraged to introduce a variety of FV to their infants once they reach an appropriate age for solid foods (Blissett et al. 2012; Kong et al. 2016; Möller et al. 2013). New efforts are also needed in the area of nutrition policies at the broader level that would increase access to and affordability of FV for low-income families with young children.

Given the significant health benefits of FV consumption and the prevalence of nutrition-related disparities in most developed countries, future research is warranted to further examine predictors of children's FV taste preferences in socioeconomically disadvantaged and racially/ethnically diverse families (Boeing et al. 2012). More importantly, longitudinal studies examining the influence of parental feeding behaviors in relation to children's FV taste preferences and FV consumption starting around the time of solid food introduction are much needed in the current literature.

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Compliance with ethical standards

The study was reviewed and approved by the IRB at the University of North Carolina Greensboro.

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