Maternal Executive Function and the Family Food Environment: A Cross-Sectional Study

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ABSTRACT

Background: Individuals with lower executive function (EF) have poorer quality dietary intake and are more likely to experience obesity, in part because of their limited ability to resist impulses and implement routines that promote healthy eating. It is unknown whether these negative impacts of lower EF among parents extend to the parenting practices and routines that support children's healthy eating and weight. The purpose of the current study is to examine associations between mothers' EF and characteristics of the family food environment that support children's healthy eating.

Methods: A cross-sectional study was conducted in August 2017 via Amazon Mechanical Turk of US-based mothers of 2 to 9-year-old children (N=492). EF was measured using the Behavior Rating of Executive Function-Adult Version. Family food environment characteristics were measured via self-report surveys. Standardized, linear regression models were used to examine covariate-adjusted associations and the potential for different associations between mothers' EF and family food environment characteristics by family socio-demographics.

Results: Low EF among mothers was associated with less engagement in positive food-related parenting practices and less presence of healthy family food environment characteristics including providing family meals, implementing consistent mealtime schedules and structure, and avoiding using food to regulate children's emotions. Few differences in these associations were observed by mothers' educational attainment, household income-to-needs ratio, or child age.

Conclusions and Implications: Maternal EF is associated with several features of the family food environment. Lower EF among mothers may interfere with their ability to implement recommending parenting practices that support children’s healthy eating and weight.

Keywords: Executive Function; Parenting; Diet, food, and nutrition

BACKGROUND

Executive functions (EF) refer to the higher order cognitive processes that allow individuals to control their thoughts, emotions, and actions (1). Individuals with poorer EF are more likely to engage in obesogenic eating behavior (2, 3), have less healthy dietary intake (4), and experience obesity more often than individuals with stronger EF (5). These associations are believed to exist because EF interferes with one's ability to create routines and environments that promote healthy eating. For example, individuals with lower EF may have difficulty avoiding unhealthy food purchases, implementing recipes to prepare home-cooked food, and maintaining regular eating schedules (2, 6).

While there is substantial evidence suggesting that an individual's EF impacts their own eating and weight, it has rarely been considered that within families, parents' EF may impact their children's eating and weight. Parent behavior and the home environment are believed to play an important role in children's dietary intake and eating behaviors. Availability of healthy food in the home, frequent family meals, and limited consumption of meals prepared outside the home have all been associated with healthier dietary quality among children (7, 8). Further, parents' use of specific food parenting practices, such as coercive controlling practices, may contribute to obesogenic eating behaviors among children (9, 10). Deficits in parents' EF may limit their ability to sustain healthy home food environments for their children and have been hypothesized to interfere with intentions to carry out positive food parenting practices (11).

Studies of the role of EF in parenting suggest that mothers with lower EF engage in harsher parenting (12, 13). Meanwhile, mothers with higher EF are more likely to demonstrate sensitive,

involved parenting and provide developmentally-appropriate supports for their children (14). This research lends support for a conceptual framework suggesting that parents' EF impacts the home environment and quality of parent/child relationships, ultimately affecting children's outcomes (15). To date, only one study has examined associations between parents' EF and engagement in food-specific parenting practices. Among mothers of infants, Fuglestad, et al. (16) observed that higher EF was associated with more appropriate responsiveness to babies' hunger cues at 2 weeks of age, which in turn predicted healthier growth between 2 weeks and 3 months.

The current study seeks to contribute to this emerging area of research by examining associations between mothers' EF and characteristics of the family food environment relevant to children's nutrition and weight. Further, to increase understanding of whether there are specific families for whom mothers' EF may present more or less of a barrier to effective food-related parenting, differences in the associations between mother's EF and family food environment characteristics by family sociodemographic characteristics (mothers' educational attainment, household income-to-needs ratio, and child age) were examined. We hypothesized that mothers who report greater EF problems will be less likely to engage in behaviors that promote children's healthy eating (e.g., having frequent family meals, limiting access to unhealthy foods) and that inverse associations between mothers' EF problems and the presence of nutrition-promoting family food environment characteristics will be stronger among lower income families, mothers with lower educational attainment, and families with younger children, as limited resources and more physically and emotionally dependent children may be more taxing on mothers' EF (17, 18). Understanding the relations between mothers' EF and engagement in food-related parenting and the home food environment can provide insight into why some families have difficulty

implementing parenting behaviors for nutrition promotion and obesity prevention, and ultimately, may help guide the development of more effective family-based child nutrition and obesity interventions.

METHODS

Study Sample and Data Collection Method

Mothers of 2 to 9 year-old children living in the US were recruited to complete an online survey via Amazon Mechanical Turk (MTurk) in August 2017. The study was advertised as a study to understand families' eating habits. Individuals interested in participating completed a screening survey and were eligible if they reported they were female, 18 years of age or older, had a child between the ages of 2 and 9 years old, were their child's legal guardian, and lived with their child at least 5 days per week. Of the 1013 individuals who completed the screener, 557 were eligible. Eligible participants were then invited to complete the study survey, which took on average 15 minutes to complete. If participants had multiple children within the target age range, they were asked to complete the survey with their youngest child in mind. Participants received a \$0.05 payment for completing the screening survey and a \$2.00 payment for completing at least 90% of the study survey. Of individuals who were eligible, 95% completed at least 90% of the study survey (N=537). Among these 537 mothers, 7% (N=35) were excluded due to infrequent or inconsistent responses on the BRIEF-A measure of EF, resulting in a final sample of 492. The University of Michigan determined this study was exempt from Institutional Review Board review.

Measures

Executive function. Mothers' EF was assessed using the Behavior Rating of Executive Function-Adult Version (BRIEF-A) (19), a standardized rating scale used to assess EF problems among adults. The 75-item measure assesses 9 non-overlapping aspects of EF: 3 core EF (response inhibition, working memory, and cognitive flexibility) and 6 EF-related skills (emotional control, initiation, planning and organizing, organization of materials, and self-monitoring). Participants rated statements (e.g., "I have trouble changing from one activity or task to another" and "I forget instructions easily") from 1 (Never) to 3 (Often) and responses were summed to create each sub-scale. Mothers' EF problems were identified by their Global Executive Composite (GEC) score, a composite of the 9 sub-scales (Cronbach's $\alpha = 0.97$). GEC T-scores were calculated in comparison to a normative sample comprised of 1050 self- and 1200 informant reports, with higher scores reflecting greater EF problems. The BRIEF-A has been used to assess EF problems among healthy and clinical populations (20-22).

Family food environment characteristics. Family food environment characteristics were selected based on evidence-driven hypotheses regarding characteristics known to support healthy home food environments and promote positive nutrition among children that may present a challenge for parents with EF deficits. For example, as suggested by the parenting literature (18), inhibiting instincts to appease children exhibiting negative emotions with food may be difficult for mothers with lower EF and as suggested by studies demonstrating that cognitive flexibility supports physical activity routines (23), implementing regular family meals may be difficult for mothers with lower EF.

Family meal characteristics. Qualities of family meals assessed included the frequency of family evening meals during the past 7 days (24), frequency of family evening meals prepared outside the home during the past 7 days (sum of 3 items assessing frequency of meals purchased from fast food restaurants (24), from another kind of restaurant, and purchased pre-prepared from a store), and the frequency of family evening meals cooked at home during the past 7 days.

Response options were on a 5-point scale ranging from “Never” (0) to “7 times” (7). Mothers also reported on mealtime structure (8 items), mealtime schedule (5 items), and the extent to which they allow between meal grazing (3 items) using sub-scales of The Feeding Strategies Questionnaire (25). Response options for all of these sub-scales were on a 5-point scale that ranged from “Strongly Disagree” (1) to “Strongly Agree” (5). In the current study, Mealtime Structure Cronbach’s $\alpha = 0.85$, Mealtime Schedule = 0.86, and Between Meal Grazing = 0.88.

Home food environment. Two scales measured availability of healthy food at home (4 items) and availability of unhealthy food at home (4 items) (26). Mothers reported how often fruits, vegetables, and whole wheat bread were available and/or served with meals in their home (healthy foods) and how often ‘junk food’, salty snacks, candy, and soda pop were available in their home (unhealthy foods). Response options ranged from “Never” (1) to “Always” (4) on a 4-point scale. Cronbach’s α for availability of healthy food = 0.65 and unhealthy food = 0.81.

Child feeding practices. Two child feeding practices, regulates child’s emotions with food and monitors child’s eating, were measured using the Emotion Regulation Scale (3 items) and the Monitoring Scale (4 items) of The Comprehensive Feeding Practices Questionnaire (27).

Response options for these scales were on a 5-point scale ranging from “Never” (1) to “Always” (5). Cronbach’s α for the Emotion Regulation Scale = 0.82 and 0.87 for the Monitoring Scale.

Sociodemographic characteristics and body mass index (BMI). Mothers reported their race/ethnicity, relationship status, educational attainment, total income of their household in the past year before taxes (6 response options), and how many people live in their household. Household income and number of people living in the household were used to calculate income-to-needs ratio as a proportion of the US federal poverty line. Mothers also reported their height in feet and inches and weight in pounds, from which BMI was calculated. Adult height and weight self-reported via online surveys has demonstrated high validity (28).

Statistical Analysis

Univariate statistics were used to examine the distributions of sociodemographic characteristics and mothers’ BMI. Associations between GEC T-score and these variables were examined using ANOVA and Pearson correlations. Family food environment measures were standardized to a mean of 0 and standard deviation of 1, and separate linear regression models were developed with GEC T-score as the independent variable and each family food environment measure as dependent variables, adjusted for sociodemographic characteristics and mothers’ BMI. Statistical significance was indicated by $p < .05$. Effect modification of the relations between maternal EF and family food environment characteristics by mothers’ educational attainment (3 levels: less than a high school degree or high school completed, some college, and completed college or an advanced degree), household income-to-needs ratio (3 levels: $<169\%$ of the federal poverty line, between 169% and 304% of the federal poverty line, and $>304\%$ of the federal poverty line), and

child age (2 levels: 2 to 5 years old versus 6 to 9 years old) was examined through the addition of an interaction term to the linear regression models. In cases where the interaction term was significant at $p < .05$, stratified analyses were conducted by level of the modifying variable.

RESULTS

Three-fourths (76.5%) of mothers identified as white, 9.2% Black, 5.7% Hispanic/Latina, and 5.5% Asian (Table 1). The majority (53.2%) completed college or had a graduate degree. Mothers' mean age was 34.2 years ($SD=6.7$) and mean BMI was 27.3 (7.0). GEC T-score differed across levels of maternal education and was modestly correlated with maternal BMI ($r=0.14$, $p=.002$), indicating higher maternal BMI was associated with greater EF problems.

Mothers with higher EF problems reported less frequent family meals, with fewer family meals prepared at home and more frequent family meals prepared outside the home, such as meals purchased from fast food restaurants, compared to mothers with lower EF problems (Table 2). Maternal EF problems were also negatively correlated with mealtime structure and scheduling, indicating families of mothers with lower EF experience less structured meals and less consistent scheduling of meals. Maternal EF problems were also associated with lower availability of healthy food at home and higher availability of unhealthy food. Mothers with higher EF problems were also more likely to report regulating children's emotions with food and were less likely to monitor children's eating. The only family food characteristics not associated with maternal EF was allowing between meal grazing.

Few differences in the associations between maternal EF and family food characteristics were observed by sociodemographic characteristics; 33 of 36 interaction terms were not statistically significant. However, associations between maternal EF and enjoyment of food purchasing and preparation, frequency of family evening meals, and allowing between meal grazing all varied by maternal education (p-value for interaction term = .02, .04, and .04 respectively). For these family food characteristics, associations with maternal EF were strongest among mothers with higher educational attainment. For example, higher EF problems were associated with less frequent family meals among mothers with a college or post-college degree (β (SE)=-0.26 (0.06), $p<.001$). No associations were observed between maternal EF and family meal frequency among mothers with a high school degree or less or who had completed some college (β (SE)=0.02 (0.15), $p=.91$ and β (SE)=-0.06 (0.08), $p=.48$, respectively).

DISCUSSION

Consistent with our hypothesis, several family food environment characteristics were associated with mothers' EF in the expected directions. For example, families of mothers with lower EF provided less frequent family meals, were less likely to have healthy food available at home. Mothers with lower EF also were more likely to seek to regulate children's emotions with food and were less likely to monitor their children's intake. These family food environment characteristics have been associated with less healthy dietary intake, higher weight status, and/or a greater likelihood of developing maladaptive eating behaviors among children.(9, 10) Counter to our hypothesis with regard to effect modification, the relations between maternal EF and family food environment characteristics often did not differ by sociodemographic characteristics.

However, there was some indication that lower EF may be a greater barrier to engaging in child nutrition-promoting parenting practices among mothers with higher educational attainment.

This study contributes to our growing understanding of how adults' EF is not only associated with their own dietary intake and obesity risk (2-5), but may affect their children's nutrition and weight. Building on evidence that as early as infancy, mothers' EF supports responsive feeding (16), the current study suggests that mothers' EF may also support engagement in parenting practices that impact older children's eating and establish positive nutrition throughout the lifespan. Further, recent evidence suggests that children of parents with lower EF are less likely to have consistent bedtime routines (29), another avenue through which lower parent EF may impact children's obesity risk (30). Parent-focused nutrition promotion and obesity prevention interventions may therefore be particularly needed by parents with low EF.

However, behavior change can be difficult for individuals with low EF (31). Poor quality sleep, physical inactivity, and obesity are all associated with lower EF among adults (32, 33).

Improving these conditions, as well as engaging in EF-specific activities, have demonstrated promise in strengthening EF, leading to improvements in behavior (34-36). For example, Episodic Future Thinking, where individuals are guided through an exercise to imagine future events and the decisions necessary for those events to occur, can improve impulse control and reduce obesogenic eating behaviors (37-39). Further, Cognitive Remediation Therapy, which seeks to improve thinking processes and strengthen metacognition, increases individuals' cognitive flexibility and has led to meaningful improvements in weight status among individuals seeking care for obesity (40). If future studies provide additional evidence regarding the potential

impacts of EF on food-related parenting, applying intervention strategies such as these to parent-focused programming may enhance behavior change among parents with low EF, providing improved opportunities for children to engage in healthy eating.

Findings should be considered in light of study limitations. Although use of MTurk to conduct population-based survey research is growing, the method may have some disadvantages over traditional recruitment methods as it is difficult to verify participant-provided information. However, survey-based studies are prone to similar limitations and validity checks within the BRIEF-A survey identified only a small number of incongruent response patterns. Second, while use of the BRIEF-A to identify problems in EF is common, we did not use gold-standard, laboratory-based objective tasks to measure participants' core EFs. Additional research is needed to replicate findings using varied measures of EF. Finally, this study only focused on mothers, despite fathers and other caregivers often having substantial roles in supporting the home food environment.

CONCLUSIONS

This study provides some of the first evidence that mothers' EF is associated with engagement in parenting behaviors that support children's healthy eating. Future research using objective assessments of EF and the family environment, and measures of child-level outcomes such as diet and BMI, will greatly enhance our understanding of the role of parents' EF in children's nutrition and growth. This knowledge may inform the development of intervention strategies that may be more effective than existing programming in supporting parents' behavior change to promote healthier home food environments.

List of abbreviations:

EF: Executive Function

BMI: Body Mass Index: BMI

MTurk: Amazon Mechanical Turk

BRIEF-A: Behavior Rating of Executive Function-Adult Version

GEC: Global Executive Function

SE: Standard Error

Declarations:

Ethics approval and consent to participate: The University of Michigan determined this study was exempt from Institutional Review Board review.

Consent for publication: N/A

Availability of data and material: The datasets used during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: KWB made substantial contributions to the conception and design of the study, acquisition of data, and analysis and interpretation of data. She drafted the manuscript and final version to be published and agrees to be accountable for all aspects of the work. HMW made substantial contributions to the acquisition and analysis of the data and was involved in drafting the manuscript. She gives final approval of the version to be published and agrees to be

accountable for all aspects of the work. JCL, ALM, and ANG all made substantial contributions to the conception and design of the study and analysis and interpretation of data. They critically revised the manuscript, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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Table 1. Maternal Characteristics: Descriptive Statistics and Bivariate Associations with Executive Function (N=492)¹

	Total % (n)	GEC T-Score Mean (SD)	Test Statistic F	P
Race/ethnicity			1.29	.27
White	76.5 (375)	50.8 (11.3)		
Black	9.2 (45)	48.8 (11.0)		
Hispanic/Latina	5.7 (28)	49.9 (11.6)		
Asian	5.5 (27)	49.7 (11.9)		
Mixed/other	3.1 (15)	56.2 (13.6)		
Highest educational attainment			3.23	.04
Less than high school degree or high school completed	11.6 (57)	52.1 (11.5)		
Some college	35.2 (173)	52.1 (9.5)		
Completed college or advanced degree	53.2 (261)	49.5 (11.7)		
Relationship status			2.30	.13
Married or in committed relationship	87.2 (428)	50.4 (11.4)		
Other	12.8 (63)	52.7 (11.7)		
Household income-to-needs ratio			0.40	.67
Low (< 1.69)	33.8 (163)	51.2 (11.6)		
Middle (1.69-3.04)	32.8 (158)	50.7 (11.6)		
High (> 3.04)	33.4 (161)	50.1 (11.1)		
	Mean (SD)		r	
Maternal age (years)	34.2 (6.7)	--	0.03	.46
Child age (years)	4.8 (2.1)	--	0.06	.18
Maternal BMI	27.3 (7.0)	--	0.14	.002

Abbreviations: GEC: Global Executive Composite, SD = Standard Deviation, BMI = Body Mass Index

¹ F statistic from ANOVA, r statistic = Pearson Correlation Coefficient

Table 2. Associations Between Family Food Environment Characteristics and Maternal Executive Function as indicated by GEC T-score.¹

	Total Sample Unadjusted Mean (SD)	β (SE)	p-value
Family meal characteristics			
Frequency of family evening meals	5.2 (1.79)	-0.16 (0.05)	<.001
Frequency of family evening meals prepared at home	5.0 (1.57)	-0.25 (0.05)	<.001
Frequency of family evening meals prepared outside home	2.9 (2.22)	0.23 (0.05)	<.001
Mealtime structure	3.8 (0.75)	-0.30 (0.04)	<.001
Mealtime schedule	3.3 (0.88)	-0.20 (0.05)	<.001
Allows between meal grazing	3.3 (0.96)	0.04 (0.05)	.38
Home food environment			
Healthy home food availability	3.3 (0.57)	-0.25 (0.04)	<.001
Unhealthy home food availability	2.3 (0.65)	0.13 (0.05)	.004
Child feeding practices			
Regulates emotions with food	1.9 (0.73)	0.23 (0.05)	<.001
Monitors eating	4.0 (0.90)	-0.21 (0.05)	<.001

Abbreviations: SD=Standard Deviation, SE = Standard Error

¹ N=537 mothers of 2 to 9 year-old children; higher GEC T-scores indicate greater executive function problems; linear regression adjusted for maternal race/ethnicity, maternal educational attainment, household income-to-needs ratio, and maternal body mass index