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Changes in food selectivity in children with autism spectrum disorder

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Abstract

Food selectivity is a common problem in children with autism spectrum disorder (ASD) and has an adverse impact on nutrient adequacy and family mealtimes. Despite recent research in this area, few studies have addressed whether food selectivity present in children with ASD persists into adolescence. In this study, we assessed food selectivity in 18 children with ASD at two time points (mean age = 6.8 and 13.2 years), and examined changes in food selectivity. While food refusal improved overall, we did not observe an increase in food repertoire (number of unique foods

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Compliance with Ethical Standards
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Parents provided written informed consent. The protocol, amended to include a follow-up contact, was approved by the University of Massachusetts Institutional Review Board.

Conflicts of Interest
The authors declare that they have no conflicts of interest.

eaten). These findings support the need for interventions early in childhood to increase variety and promote healthy eating among children with ASD.

Keywords

Autism spectrum disorder; food selectivity; food refusal; childhood; nutrition

An estimated 46–89% of children with autism spectrum disorder (ASD) have feeding problems (Ledford and Gast 2006), which may include unusual eating patterns, rituals, and food selectivity (Sharp et al. 2013). Higher levels of feeding problems in early childhood have been reported among children who were later diagnosed with ASD compared to those without an ASD diagnosis (Emond et al. 2010). Food selectivity, often referred to as "picky eating", is a common problem in children with ASD and is of particular concern because of its negative impact on nutrient adequacy and family mealtimes. Food selectivity in children with ASD has been associated with inadequate nutrient intake (Bandini et al. 2010; Zimmer et al. 2012), refusal of fruits and vegetables (Hubbard et al. 2014), mealtime behavior problems (Curtin et al. 2015), and parental stress (Postorino et al. 2015). Johnson et al. (2014) found an inverse correlation between the overall score on the Healthy Eating Index with a measure of feeding problems on the Brief Autism and Mealtime Behavior Inventory (Lukens and Linscheid 2008), suggesting that children with more feeding problems have lower quality diets. In an analysis of 54 children with ASD, Suarez and Crinion (2015) reported that children with food selectivity (defined as consuming 20 or fewer foods during the past month) had diets that contained fewer fruits and vegetables than the diets of less food-selective children. The nutritional impact may occasionally be severe; case reports have identified scurvy due to nutritional deficits in children with ASD (Gongidi et al. 2013; Ma et al. 2016).

Despite recent research in the area of food selectivity among children with autism spectrum disorder (Bandini et al. 2010; Emond et al. 2010; Hubbard et al. 2014; Ledford and Gast 2006; Sharp et al. 2013; Zimmer et al. 2012), few studies have examined whether food selectivity that is present in childhood persists into adolescence in children with ASD. In 2010, we reported on food selectivity in children with ASD participating in the Children's Activity and Meal Patterns study (CHAMPS) (Bandini et al. 2010). In that study, we compared children with ASD and typically developing (TD) children and found that food selectivity was prevalent in children with ASD and was much less common in TD children. We conceptualized food selectivity along two dimensions that could be measured empirically. *Food refusal* is measured as the proportion of foods offered to the child that are refused. *Food repertoire* consists of a count of unique foods consumed by the child which reflects the diversity of foods in the child's diet. Although CHAMPS was originally designed as a cross-sectional study, we capitalized on a unique opportunity to determine whether food selectivity persisted by conducting a follow-up study of children with ASD in the CHAMPS study. After an average of 6.4 years, we re-contacted the parents of children with ASD who had participated in the original study and invited them to participate in a follow-up visit. Our objective was to explore longitudinal changes in food selectivity and weight status and to examine the association between these two factors in children with

ASD. Due to the low frequency of food selectivity identified in TD children, and because our objective was to assess the persistence of food selectivity in children with ASD, we did not include TD children in the follow-up study.

Methods

Baseline visit

At the initial (baseline) visit in 2007–2008, all participants were seen at the Eunice Kennedy Shriver Center in Waltham, Massachusetts. Children were weighed and measured on a Seca scale and stadiometer. The presence of an autism diagnosis was confirmed by administering the Autism Diagnostic Interview-Revised to the parents. Cognitive and adaptive behavior skills were assessed in children with ASD by the Differential Abilities Scale-2 and the Vineland Adaptive Behavior Scales-II, respectively. At the visit, parents also completed a demographic questionnaire, a diet interview, and a modified food frequency questionnaire (FFQ). The FFQ assessed the child's consumption of 131 foods over the past year. Parents also completed the *Meals in Our Household Questionnaire (MIOH)* (Anderson et al. 2012) which assessed a variety of mealtime-related factors, including problematic mealtime behaviors. Parents were also taught how to complete a 3-day food diary that was completed at home on 2 weekdays and 1 weekend day. Children with the ability to understand and communicate about their food intake also participated in the food diary instruction so they could report to their parent any food eaten outside the home.

Follow-up visit

Using contact information from the initial study, and updated where possible, letters were sent to parents of all 53 children with ASD who participated in the original study. In total, we received 21 responses to our outreach efforts, and 18 families enrolled in the follow-up study. Because our facility had moved since the original study, we conducted study visits in our satellite offices in Charlestown, MA, at UMass Medical School in Worcester, MA, and at public libraries or community centers close to the participants' homes. The same procedures, measures, and questionnaires used at the baseline visit were repeated at the follow-up visit. Parents were also asked to complete a questionnaire that asked about their child's recent medication usage and time spent in physical activity.

A parent provided written informed consent at the initial study and as part of the follow-up visit. The University of Massachusetts Medical School Institutional Review Board reviewed and approved all study protocols. Parents and children received a gift card for their participation in the follow-up study.

Measures

Weight Status—Body mass index (BMI) and BMI z-score were calculated from the child's height and weight at follow-up. Six participants (33%) provided a height and weight from their child's pediatrician. Participants were considered overweight/obese if their sex-specific BMI-for-age z-score equaled or exceeded the 85^{th} percentile, based on CDC recommended definitions (Kuczmarski et al. 2000).

Food Selectivity—Parents were asked to complete a food frequency questionnaire (FFQ) for their child. We modified the Youth/Adolescent Questionnaire (YAQ) that was developed for the *Growing Up Today Study* (Field et al. 1999) and based on the original Harvard Food Frequency Questionnaire (Willet 1998) so that parents could report their child's frequency of intake of various foods and to identify what foods their child refused. Parents were also asked to keep a 3-day food record which required them to record all the food and beverages their child ate during two weekdays and one weekend day. As noted earlier, we operationalized food selectivity along two dimensions – food refusal and food repertoire (Bandini et al. 2010). *Food refusal* was assessed using information reported on the FFQ and was defined as the percentage of foods the child refused to eat among those foods that the child was offered. We also examined the absolute number of foods that a child refused and the absolute number of FFQ items not offered. We classified children as having "high food selectivity" if they refused >33% of foods offered them (Curtin et al. 2015). The FFQ was also used to assess the frequency of fruit, vegetable, snack, and beverage consumption. *Food repertoire* was assessed from the 3-day food record and was defined as the number of unique foods the child ate over a three-day period.

The diet interview was used to assess the extent to which children refused food based on its characteristics and presentation (i.e., texture, color, shape, foods mixed together, foods touching each other).

The frequency of problematic mealtime behaviors was assessed using questions from the Problematic Mealtime Behaviors domain of the MIOH questionnaire (Anderson et al. 2012). Parents were presented with 10 items, phrased as statements [e.g., (Child's Name) refuses to come when it is time to eat], and instructed to choose how often the statement described their child's eating behavior during the past 3 months, with five response options coded as: never (0), rarely (1), sometimes (2), often (3), very often (4). The responses to each of the ten questions were summed to create a summary measure (theoretical maximum=40) where higher scores indicate more frequent problematic mealtime behavior. We also present the percentage of parents of children with ASD who endorsed each item. We operationalized this as parent report of "often" or "very often" (Curtin et al. 2015).

Statistical Analyses

We compared children with ASD who participated in the follow-up (n=18) to those who did not participate (n=35) relative to baseline age, sex, cognitive and adaptive behavior skills, weight status, food selectivity, characteristics of food refusal, and frequency of mealtime behavior problems using independent sample t-tests. Baseline and follow-up measures were compared using paired t-tests for means and McNemar's test for proportions. Because the sample size was small, we also ran non-parametric tests to confirm that results did not depend on assumptions of normality. The correlation between change in weight status from baseline and follow-up with change in food selectivity was assessed using Spearman correlations. Multivariable logistic regression was used to investigate how change in food selectivity was related to the occurrence of overweight/obesity over the follow-up period after adjustment for covariates. All analyses were conducted in SAS Version 9.3 (Cary, NC).

Results

The average time interval between the baseline and follow-up visits was 6.4 years (range 5.1–8.2 years). We found no significant differences in baseline age, cognitive and adaptive functioning as determined from the Differential Ability Scales and Vineland Adaptive Behavior Scales, weight status, or food selectivity between those children who did (n=18) and did not (n=35) participate in the follow-up study (Table 1). Children who participated in the follow-up study had higher problematic mealtime behavior frequency scores at baseline compared to those who did not participate in the follow-up study (22.1 vs. 18.4, p=0.04).

On average, participants were 6.8 years old at baseline and 13.3 years old at follow-up (Table 2). Sixteen of the 18 participants were boys. Mean (SD) BMI z-score of participants was 0.34 (1.2) at baseline and 0.77 (1.0) at follow-up, corresponding to the 63rd and 78th BMI percentiles, respectively. The mean (SD) change in BMI z-score between baseline and follow-up was 0.44 (1.0) units, p=0.09). At baseline, five participants (28%) were overweight/obese (Table 2). These five participants remained overweight/obese at follow-up and an additional four participants became overweight/obese between baseline and follow-up, resulting in a total of nine (50%) participants who were overweight/obese at follow-up. This increase was statistically significant (p=0.045).

Food Selectivity

The children's food refusal improved between baseline and follow-up (Table 3). The overall percentage of foods refused of those offered decreased from 47% at baseline to 31% at follow-up (p=0.005). Fruit and vegetable refusal showed similar decreases between baseline and follow-up. The absolute number of foods refused also declined; participants refused an average of 51 foods at baseline and 33 foods at follow-up (p=0.01). The number of foods 'not offered' did not change significantly between baseline and follow-up (22 vs. 27, p=0.43). At baseline, 15 participants (83%) refused >33% of foods offered and met our definition of high food selectivity. At follow-up, 7 (39%) of these participants no longer had high food selectivity. Eight participants (44%) had high food selectivity at baseline and at follow-up. Three children were below the threshold for high food selectivity at both time-points.

In terms of food repertoire as assessed by a 3-day food record, participants consumed about 1.5 fewer foods on average at follow-up compared to baseline (18.9 vs. 17.6, p=0.28). While this difference was not statistically significant, almost two-thirds of participants (65%) had a decrease in food repertoire between baseline and follow-up, while 29% (n=5) increased their food repertoire. Consumption of fruits and vegetables increased about one serving per day between the two time points (2.2 vs. 3.4 servings per day, p=0.06) (Table 3).

Relationship between Weight Status and Change in Measures of Food Selectivity

There was no significant correlation between change in food refusal and change in weight status (BMI-for-age z-score) (r=−0.03, p=0.90). In a logistic regression model predicting overweight/obesity at follow-up, we found no significant effect of change in food refusal (p=0.66), even after adjustment for other variables (baseline BMI z-score, age, and sex). We found weak-to-moderate but non-significant correlations between change in weight status with change in food repertoire (r=−0.26, p=0.32) and between change in weight status and change in fruit and vegetable intake (r=−0.35, p=0.15). In logistic regression models (both crude and adjusted), these measures of food selectivity remained as non-significant predictors of overweight/obesity at follow-up.

Food Refusal Assessed by Diet Interview

We observed a significant decrease in the percentage of children whose parents reported that they refused foods based on texture (94% vs. 39%, p=0.002) and foods that are mixed together (50% vs. 28%, p=0.045) between baseline and follow-up. Other measures of food refusal assessed in the parent diet interview, such as refusing foods that are touching or refusing foods based on temperature, brand, shape, or color, did not differ significantly between baseline and follow-up (Table 4).

Change in Problematic Mealtime Behaviors

The frequency of problematic mealtime behaviors decreased significantly between baseline and follow-up from a mean score of 22 at baseline to 15 at follow-up (p<0.01) (Table 5). Of the individual items comprising the frequency of problematic mealtime behaviors scale, the largest decreases were seen in the percentage of children not staying seated during meals, the percentage of children squirming or fidgeting while eating, and the percentage of children refusing to eat what is served. Only one behavior had a higher frequency at follow-up compared to baseline ("My child overstuffs his/her mouth with food"), but the difference was small (n=5 (28%) at baseline vs. n=6 (33%) at follow-up).

Discussion

In our small follow-up study of children with ASD, we found that for many participants food refusal, including refusal of fruits and vegetables, decreased over the six and one-half year time interval between baseline and follow-up. However, despite the decrease in food refusal overall, we observed considerable variability among participants, where half of the participants with high food selectivity at baseline remained high at the follow-up.

Despite a growing literature on food selectivity in children with ASD (Bandini et al. 2010; Beighley et al. 2013; Dominick et al. 2007; Emond et al. 2010; Johnson et al. 2008; Kuschner et al. 2015; Ledford and Gast 2006; Lockner et al. 2008; Lukens and Linscheid 2008; Martins et al. 2008; Schreck and Williams 2006; Suarez et al. 2014), there have been few reports in the literature as to how food selectivity in children with ASD changes with age, and even fewer studies have examined food selectivity longitudinally. Our findings of a decline in food selectivity with age are in contrast to those of Mascola et al. (2010) who followed a subset of 120 of the original 216 newborns enrolled in the Stanford Infant Growth Study. These children were followed longitudinally from age 2 to age 11 years and both incidence (new cases of food selectivity) and prevalence were assessed, but there was no mention of whether any of the children had autism spectrum disorder. They found that although incidence declined with age, the prevalence of picky eating increased from age 2 to 5 and then leveled off (Mascola et al. 2010).

In a large cross-sectional study of children with ASD, Beighley et al. (2013) observed lower levels of food selectivity in older children. However, the classification of food selectivity was based on a single question obtained from the Autism Spectrum Disorder-Comorbidity for Children (ASD-CC) Scale which asked parents whether or not their child would only eat certain foods. Kuschner et al. (2015) reported that self-reported food selectivity was common in a sample of adolescents/young adults with ASD, suggesting that the problem persists throughout childhood. To date, Suarez et al. (2014) have conducted the only longitudinal study of food selectivity in children with ASD and found that food selectivity did not change over a 20-month period (mean age at follow up 8 years). However, classification of food selectivity in that study was limited to a single question that asked parents to estimate the number of foods their child ate; diet was not comprehensively assessed.

Although food refusal decreased over time, both as a proportion of foods refused of those offered and as an absolute count, food repertoire did not increase. The difference in findings between these two aspects of food selectivity may be due to several factors. First, it is possible that children refused fewer foods because parents stopped offering them. Although the number of foods that the parents reported that they did not offer increased from a mean of 22 to a mean of 27, there was substantial variability and the difference was not statistsically significant. Furthermore, the decline in the absolute number of foods refused from the baseline to the follow-up visit is consistent with a decrease in food refusal. Second, it is possible that even with a decrease in food refusal, parents served their child foods that they preferred and thus their repertoire did not change. Third, as Fodstad and Matson (2008) point out, the preference for sameness and routine may result in eating a narrow repertoire of food, even in the context of acceptance of more foods. Children with ASD may prefer to have the same foods every day. Although foods eaten during breakfast, lunch, and dinner may be different, consuming the same foods for these meals on a daily basis would result in a limited food repertoire.

Notably, we observed a significant increase in the prevalence of obesity at follow-up. Although our cohort was small and this could represent a chance finding, it does raise concerns about the risk for obesity in this population, and is consistent with other studies that have identified a higher prevalence of obesity in children with ASD (Chen et al. 2010; Corvey et al. 2016; Curtin et al. 2010; Dreyer Gillette et al. 2015).

We observed an increase in the number of servings per day of fruits and vegetables eaten between baseline and follow-up that was of borderline significance. Although we did not see a statistically significant relationship between fruit and vegetable intake and change in BMI, the magnitude of the negative correlation was moderate, and suggests that higher fruit and vegetable intake may be protective against excess weight gain. We did not assess physical activity using accelerometry in this follow-up study, so it is possible that declines in physical activity over the follow-up period could have impacted BMI as well. While we did not see any differences in physical activity between children with ASD and TD children in the original CHAMPS study (Bandini et al. 2013), in another study of adolescents with ASD we found that teens with ASD had lower physical activity levels than their TD peers (Bandini et al. 2013, unpublished data).

The major strengths of the current study are its long follow-up period, quantitative measures of food refusal and food repertoire, and use of the same methodology at each time point. However, there are also several limitations that warrant mention. This was a small follow-up study of children with ASD who participated in CHAMPS. Food refusal was based on a food frequency questionnaire and food repertoire was based on three days of intake, both by parent report. However, these assessments may not accurately capture overall dietary variety. Another source of error arises from the long time interval between visits, which averaged 6.4 years, but varied from 5.1 to 8.2 years. In addition, parents may have responded differently to the response choice of "do not offer" between the original and follow up study. They may have not checked "do not offer" at the initial visit because they had tried it but the child refused it, but over the intervening six years they may have stopped offering it altogether because they did not believe their child would eat it. In this scenario, the number of foods that a child would not eat would have declined simply because they were no longer offered. In addition, at initial enrollment, children were excluded if they were on any medications that impacted their appetites, while no such exclusions were applied at the follow-up visit. However, medication use in the follow-up study was assessed and was found to be minimal; none of the incident cases of obesity were taking medications known to cause weight gain. Finally, our small sample size limits our statistical power and may reduce the generalizability of our findings.

The decline in food refusal with age in children with ASD was marked and represents an encouraging finding. Nonetheless, the extent of change was quite variable, and half of the children in this small study remained highly food selective. The small sample size also limited our ability to examine factors that may have been associated with persistence of food selectivity or its remission such as whether the children had received any behavioral treatment or nutritional counseling for their eating habits. A larger longitudinal study is needed to examine the factors associated with the persistence of food selectivity.

Despite the observed decrease in food refusal, food repertoire did not appear to increase. The increase in overweight/obesity and the suggestion of a moderate inverse correlation with fruit and vegetable intake if confirmed supports the need for interventions to address food selectivity and increase fruit and vegetable intake to both promote nutrient adequacy and potentially to prevent obesity.

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Table 1

Comparison of baseline characteristics between those who did and did not participate in the follow-up

	CHAMPS Participants with ASD: included in follow-up?		
Measurments at Baseline[a]	***Yes (n=18)***	***No (n=35)***	**p-value**
Age, years	6.8 (2.3)	6.5 (2.0)	0.60
Sex, % male	89% (n=16)	80% (n=28)	0.41 *
VABS Score	71.7 (11.9)	70.8 (12.8)	0.79
DAS General Conceptual Ability Score[b]	88.5 (23.2)	84.5 (21.8)	0.57
BMIz Score	0.34 (1.2)	0.48 (1.2)	0.69
Percentage of FFQ items that child will not eat	47.2 (21.8)	39.9 (20.6)	0.18
Food Repertoire	18.9 (5.5)	19.1 (4.7)[c]	0.94
Problematic Mealtime Behavior Score	22.1 (5.9)	18.4 (6.2)	0.04

*p-value from X^2 test; all other p-values from independent sample t-tests

[a]all values are mean (standard deviation), except for percentage where indicated

[b]n=15 & 32

[c]n=30

Table 2

Participant characteristics at baseline and follow-up (n=18)

	Baseline	***Follow-Up***	**p-value**
Age, yrs (m, sd)	6.8 (2.3)	13.2 (2.5)	<0.001
BMI z-score[a] (m, sd)	0.34 (1.2)	0.77 (1.0)	0.09
Overweight/obese[b] (n, %)	5 (28%)	9 (50%)	0.045[*]

[*]p-value from McNemar test; all other p-values from paired t-test

[a]sex-specific BMI-for-age z-scores from CDC growth reference.

[b]overweight/obese defined as a BMI z-score ≥85th percentile

(m,sd: mean and standard deviation)

Table 3

Food Refusal, Food Repertoire, and Dietary Patterns among 18 children with ASD at baseline and follow-up

	Baseline	**Follow-Up**	**Change**	
	Mean (sd)	***Mean (sd)***	***Mean (sd)***	***p-value*** [*]
Percentage of FFQ items that child will not eat	47.2 (21.8)	31.1 (19.4)	−16.1 (20.6)	0.005
Number of FFQ items that child will not eat	51.1 (25.1)	33.2 (23.3)	−17.9 (27.3)	0.01
Number of FFQ items not offered	22.3 (17.1)	27.1 (24.1)	4.8 (25.6)	0.43
Percentage of Vegetable FFQ items that child will not eat [a]	62.3 (33.9)	43.6 (33.8)	−18.8 (26.0)	0.01
Percentage of Fruit FFQ items that child will not eat	55.6 (30.8)	42.1 (27.3)	−13.5 (23.2)	0.02
Daily servings of fruits and vegetables	2.2 (1.6)	3.4 (3.1)	1.1 (2.4)	0.06
Food Repertoire [a,b]	19.0 (5.7)	17.6 (5.1)	−1.4 (5.3)	0.29

[*] p-value from paired t-test

[a] n=17

[b] Food repertoire (number of unique foods eaten) calculated from 3-day food record; all other measures from FFQ

Table 4

Percentage of children at baseline and follow-up who refused foods based on characteristics of foods among 18 children with ASD

	Baseline	Follow-up	
Characteristic[a]	***n (%)***	***n (%)***	***p-value******
Child refuses food based on texture	17 (94)	7 (39)	0.002
Child refuses food that are touching each other	4 (22)	5 (28)	0.65
Child refuses food based on temperature	6 (33)	4 (22)	0.48
Child refuses foods that are mixed together	9 (50)	5 (28)	0.045
Child refuses food based on color	3 (17)	1 (6)	0.32
Child refuses food based on brand	4 (22)	3 (17)	0.56
Child refuses food based on shape	2 (11)	0	0.48

[a] Percent who indicated ‘agree’ or ‘strongly agree’ is tabulated in the table

[*] McNemar’s test

Table 5

Frequency of Problematic Mealtime Behaviors at baseline and follow-up among 18 children with ASD

Frequency of problematic child mealtime behaviors (10 items)[a]	**Baseline**	**Follow-Up**
	n (%)	***n (%)***
My child refuses to come when it is time to eat	6 (33.3)	4 (22.2)
My child has tantrums or acts out during meals	4 (22.2)	0
My child complains about what is served	8 (44.4)	4 (22.2)
I argue with my child about what he/she eats	5 (27.8)	2 (11.1)
My child seeks a lot of attention during meals *	5 (27.8)	1 (5.3)
My child does not stay seated during meals *	11 (61.1)	3 (16.7)
My child squirms or fidgets while eating *	10 (55.6)	4 (22.2)
My child has poor table manners	6 (33.3)	5 (27.8)
My child overstuffs his/her mouth with food	5 (27.8)	6 (33.3)
My child refuses to eat what is served *	8 (44.4)	2 (11.1)
Frequency of problematic mealtime behaviors scale [mean (SD)][b]	*22.1 (5.8)*	*15.3 (4.9)***

* $p<0.05$ by McNemar's test

[a] Number/Percentage who indicated 'often' or 'very often' tabulated in the table

[b] sum of all 10 questions coded 0–4;

** $p<0.01$ for Follow-up - baseline difference between, by paired t-test