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A comparison of food refusal related to characteristics of food in children with autism spectrum disorder and typically developing children

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Abstract

Parents of children with autism spectrum disorder (ASD) frequently report child food refusal based on characteristics of food. The present study sought to determine if parent report of food refusal based on the characteristics of food was: (1) greater in children with ASD than typically developing (TD) children; (2) associated with a greater percentage of foods refused of those offered; and (3) associated with fruit and vegetable intake. A modified food frequency

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Conflicts of Interest:

The authors have no conflicts of interest to declare.

questionnaire (FFQ) was used to determine overall food refusal as well as fruit and vegetable intake. Parent-reported food refusal related to characteristics of food (texture/consistency, temperature, brand, color, shape, taste/smell, foods mixed together, or foods touching other foods) was compared between 53 children with ASD and 58 TD children age 3–11 years in the Children's Activity and Meal Patterns Study (CHAMPS) (2007–2008). Children with ASD were significantly more likely to refuse foods based on texture/consistency (77.4% versus 36.2%), taste/smell (49.1% versus 5.2%), mixtures (45.3% versus 25.9%), brand (15.1% versus 1.7%), and shape (11.3% versus 1.7%). No differences between groups were found for food refusal based on temperature, foods touching other foods, or color. Irrespective of ASD status, the percentage of foods refused of those offered was associated with parent reports of food refusal based on all characteristics examined, except temperature. Food refusal based on color was inversely associated with vegetable consumption in both groups. Routine screening for food refusal among children with ASD is warranted to prevent dietary inadequacies that may be associated with selective eating habits. Future research is needed to develop effective and practical feeding approaches for children with ASD.

Keywords

autism spectrum disorder; nutrition; feeding; children; fruit and vegetable intake

Introduction

Children with autism spectrum disorder (ASD) experience significantly more feeding problems than typically developing (TD) children,¹ and food selectivity is particularly problematic. Food selectivity among children with ASD is a complex issue and an important one inasmuch as food selectivity has been associated with inadequate dietary intake.^{2,3} When compared to TD children, children with ASD demonstrate a number of dietary risk factors for inadequate nutrient intake that may be associated with selective eating, including lack of dietary variety,³ preferences for energy-dense/nutrient-poor foods,⁴ consumption of fewer fruits and vegetables, and higher consumption of sugar-sweetened beverages.⁵

It has been difficult to draw conclusions about the relationship between selective eating in children with ASD and dietary risk factors because food selectivity has not been consistently defined in a quantifiable manner in the literature. In a previous report, we provided an operational definition of food selectivity to include food refusal (number of foods refused of those offered) based on a food frequency questionnaire, and food repertoire (variety of foods eaten) determined from a three-day food diary to address these gaps.² We found a higher prevalence of food refusal and limited food repertoire among children with ASD. These children refused more vegetables than TD children, both in absolute amount, and as a percentage of foods offered.²

Much remains unknown about the specific etiology of food refusal. Food refusal among children with ASD may arise for multiple physiologic and/or behavioral reasons that may be difficult to disentangle.⁶ In descriptive studies, parents of children with ASD have reported texture,^{7–9} appearance,⁷ brand,^{8–10} packaging,⁹ temperature,⁷ food presentation,^{4,8,10}

color,¹⁰ and taste and smell^{7,8} as characteristics that influenced their children's food choices. Among quantitative studies with comparison groups, a greater prevalence of food choices based on the texture has been reported by parents of children with ASD compared to TD children.^{11–14} Few quantitative studies have examined differences in food refusal based on color,^{12,15} temperature, shape, or brand between children with ASD and TD children.

Whether children with ASD exhibit a greater prevalence of refusals based on food characteristics and whether these refusals are associated with lower fruit and vegetable intake is also poorly understood. Therefore, the purpose of this current investigation was threefold: 1) to determine if parent report of food refusal based on the characteristics of food was greater in children with ASD than TD children; 2) to determine if food refusal was related to parental report of food refusal based on the characteristics of food, and whether this relationship differed among children with ASD and TD children; and 3) to determine if fruit and vegetable intake and refusal were related to parental report of food refusal based on the characteristics of food, and whether this relationship differed among children with ASD and TD children. We hypothesized that children with ASD would have greater food refusal based on characteristics of food compared to TD children and that fruit and vegetable intake would be lower among children with ASD who refused foods based on certain characteristics.

Methods

The Children's Activity and Meal Patterns Study (CHAMPS) was a cross-sectional study conducted in 2007–2008 that included children with ASD and TD children ages 3–11 years. The study protocol, including participant recruitment, inclusion and exclusion criteria, and verification of diagnosis of ASD have been previously described.² Parents provided written informed consent. The study was approved by the Institutional Review Board at the University of Massachusetts Medical School.

Parents completed a self-administered demographic/medical questionnaire and the Sensory Profile,¹⁶ a 125-item questionnaire to determine the child's overall sensory processing including sensory sensitivity.¹⁶ Parents were interviewed by a trained interviewer about their child's dietary habits, use of special diets, and whether their child currently or in the past year refused foods based on 7 different characteristics; i.e., texture/consistency, temperature, brand, color, or shape, and whether foods were refused if they were mixed together or touching other foods. The questions were phrased as statements (e.g., {Child's Name} currently refuses to eat foods based on the color of the food), with response options of: strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree. There was a high level of concordance between current and past year refusal. Therefore for clarity, the results presented are based on report of current refusal. Children were categorized as refusing based on a particular characteristic if their parent indicated that they agreed or strongly agreed that their child currently refused foods based on the characteristic. The number of characteristics (0–7) for which the child refused foods was counted. One item from the Sensory Profile was used (SP 55: "Avoids certain tastes or food smells that are typically part of children's diets")¹⁶ to assess refusals based on tastes and smells.

Food refusal was assessed using a modified food frequency questionnaire (FFQ), based on the Youth/Adolescent Food Frequency Questionnaire (YAQ),¹⁷ as previously described.² The FFQ was modified for parent (rather than child) report; average frequency of consumption of common foods over the past year was assessed, and two response options were added: 1) N/A: don't offer (*i.e.* not applicable, food item is never offered to child); and 2) Never: will not eat (*i.e.* child refuses the food item) to assess the number of foods that they were never offered and how many foods children refused. Parents were also asked to write in foods that were not included on the FFQ if their child ate them regularly (*i.e.*, an average of at least once per week during the past year). Food refusal was quantified as the percentage of foods the child would not eat relative to the number of foods that were offered, overall and separately for fruits and vegetables. The FFQ was used to determine servings of fruits and vegetables eaten based on the frequency of reported intake.

Statistical Analysis

Demographic characteristics of children with ASD and TD children were compared using *t*-tests for continuous variables and *chi-square tests* for categorical variables. The percentage of children in each group (ASD and TD) who refused foods for each characteristic was calculated and differences between groups were assessed using *chi-square tests* and *Fisher's exact test*. The *Wilcoxon rank sum test* was used to determine whether children with ASD refused foods for more characteristics than did TD children. Means, medians, the percentage of children in each group who refused for three or more characteristics, and the percentage who refused for none of the characteristics are presented.

A series of linear regression models were used to assess, for each characteristic, how the strength with which parents agreed that their child refused foods for that characteristic was related to daily servings of fruits and vegetables and food refusal as measured by the FFQ. These regression models were adjusted for potential confounding variables including age, sex, race/ethnicity (non-Hispanic white vs non-white and Hispanic), and whether the child had siblings. Interaction terms were included to assess whether associations between food characteristics and servings of fruits and vegetables and food refusal as measured by the FFQ differed for children with ASD and TD children. Analyses were conducted using Statistical Analysis Software (SAS, Version 9.2, Cary, NC). *P-values* less than 0.05 were considered statistically significant.

Results

Table 1 presents participant characteristics. Mean age, race, gender, and parental education status were similar in the two groups. TD children were more likely to be an only child than were children with ASD (26% and 11% respectively, $p=0.05$). More children with ASD were on a special diet than TD children (11 vs. 0, $p<0.001$).

Consistency/texture was most frequently reported as a reason for food refusal both for ASD and TD children (Table 2), but the prevalence was much higher among children with ASD than TD children (77.4% vs. 36.2%, $p<0.0001$). Refusal of foods that were mixed together was reported as a reason for refusal by more parents of ASD children (45.3%) than TD

children (25.9%) ($p=0.03$). Children with ASD and TD children did not differ statistically in their refusal of food because of temperature ($p=0.47$) or because foods were touching other foods on the plate ($p=0.64$). Likewise, refusal based on color was not different between children with ASD compared to TD children (15.1% and 12.1%, respectively, $p=0.64$). Children with ASD were more likely than TD children to refuse foods based on brand and shape, but these reasons for food refusal were uncommon in both groups.

Children with ASD refused foods for more reasons than did TD children; of the 7 aforementioned characteristics, the median (mean) number of reasons for refusal reported for children with ASD was 2 (2.2) compared to 1 (1.2) for TD children ($p<0.01$). A large proportion (39.7%) of TD children did not report any of these characteristics for refusing food, whereas only 5 children with ASD (9.4%) were in this category ($p=0.0003$). Among parents of children with ASD, 35.8% reported 3 or more of these characteristics for food refusal compared with 15.5% of parents of TD children reporting 3 or more characteristics ($p=0.01$). Children with ASD differed from TD children in how likely they were to avoid certain tastes and smells. Almost half (49.1%) of children with ASD were reported to always or frequently avoid certain tastes or food smells compared to 5.2% of TD children ($p<0.0001$) (Table 2).

Table 3 presents results, for each characteristic, of regression models in which the outcome variable was food refusal as measured by the FFQ. How strongly the parent reported that the child refused food based on a characteristic (e.g., color) was associated with higher levels of food refusal as measured by the FFQ. This was true for each food characteristic except for temperature. Based on these models, a one category difference in how strongly the parent reported refusal based on a characteristic of food (i.e., whether strongly disagreed (1), disagreed (2), neither agreed nor disagreed (3), agreed (4), or strongly agreed (5) to the statement "My child currently refuses food based on...") was associated with approximately a six percentage point difference in the percentage of foods refused of those offered. Equivalently, results of these models predict a 24 percentage point difference in food refusal comparing a parent who strongly disagreed that their child refused food based on their texture to a parent who strongly agreed with that statement. These results are adjusted for potential confounding variables and there was no evidence that associations between food characteristics and food refusal differed for children with ASD and TD children (p -values for interactions were all >0.05).

Table 4 presents results of regression models in which the outcome variable was daily intake of vegetables, fruits, or fruits and vegetables combined. With the exception of color, refusals related to characteristics of food were not associated with fruit and/or vegetable consumption (Table 4). For color, a one category difference in how strongly the parent reported refusal based on a characteristic of food (i.e., whether strongly disagreed, disagreed, neither agreed nor disagreed, agreed, or strongly agreed) was associated with lower vegetable consumption of approximately one-third of a serving. There was no evidence that associations between characteristics of foods and fruit/vegetable consumption differed for children with ASD and TD children (p -values for interactions were all >0.05).

Discussion

Parents of children with ASD reported a greater prevalence of food refusals based on the texture of food, mixtures, brand, shape, and taste/smell than did TD children. Contrary to expectations, a similar prevalence of food refusal based on temperature, foods touching other foods, and color was found between children with ASD and TD children. Parents of children with ASD reported more reasons for food refusal, with over one-third of parents reporting refusal based on three or more characteristics of food.

Food refusal based on the characteristics of food may be related to impairments in sensory processing, oral or tactile sensitivity, or behavioral rigidity. Impairments in sensory processing impact an estimated 40–88% of children with disabilities^{18–21} and have been found to be as high as 95% in small samples of children with ASD.²² The act of eating requires the ability to simultaneously process information from a range of sensory subtypes, including vision, touch, taste and smell.²³ Foods possess many sensory characteristics, and children who have difficulty with sensory processing may exhibit a greater degree of food refusal based on the characteristics of food.

Characteristics of food that have a sensory basis (i.e., texture/consistency, and taste/smell) were more likely to be reported as the basis of food refusal among children with ASD compared to TD children. Refusals based on color, brand, and shape may not be related to sensory processing, but instead may be related to the “need for sameness” that commonly characterizes the behavior of children with ASD. Avoidance of foods mixed together and foods touching other foods may be related to sensory sensitivity (i.e. flavor changes when the foods are mixed or touching each other) or may be related to the need for sameness; for example preferring to have a food presented in one form only.

Our findings regarding refusal based on texture/consistency are in agreement with previous studies. Food refusal by texture was reported in a direct feeding assessment of children with ASD,²⁴ and other studies have found a greater prevalence¹³ and higher rate¹⁵ of parent-reported refusal based on texture compared to TD children. Greater impairments in taste and smell identification among children with ASD compared to TD children have also been found using objective measures.²⁵ Parents reported food preferences based on the flavor and texture of foods, and overall taste accuracy was associated with greater acceptance of food flavors and textures among children with Asperger’s syndrome, a high-functioning sub-type of ASD.¹¹ Another study based on parent report found that children with ASD were more likely to demonstrate greater taste and smell sensitivities and/or avoidance (as measured by the Sensory Profile) than TD children and children with other developmental disabilities.²⁶ The present findings with respect to parent reports of food refusal based on taste/smell are consistent with these results that suggest a sensory basis for food refusals among some children with ASD.

The majority of studies indicate that children with ASD consume fewer fruits and vegetables compared to current recommendations.^{5,27,28} Suboptimal consumption of fruits and vegetables in children with ASD may be related to impairments in sensory processing. For example, among TD children, Coulthard et al. found that children with sensitivities to taste

and smell, as measured by the Sensory Profile, ate fewer fruits and vegetables.²³ The results of the present study are in agreement with previous studies, indicating that parent-reported refusals based on taste and smell were significantly associated with refusal of both fruits and vegetables. Contrary to our hypotheses, however, there was little evidence that food refusal based on texture, mixtures, temperature, food touching other food, brand, shape, and taste and smell was associated with daily fruit and vegetable servings consumed. It is possible that despite refusal of different types of fruits and vegetables, children are still consuming similar quantities of fruits and vegetables, but of less variety.

The prevalence of food refusals based on color was low in both groups, and no difference in the percentage of children refusing based on color were observed between the groups, despite frequent anecdotal reports of food refusals based on color among children with ASD. Four other quantitative studies have compared food choices based on color among ASD and TD children. Dominick et al. found that 14% of parents reported their children with ASD were “sensitive to” the color of foods, but the authors did not state whether this differed significantly from the comparison group.²⁹ Johnson et al. found higher rates of parent-reported refusal among two- to four-year old children with ASD based on color¹⁵ compared to aged-matched TD children. However, in a small sample (n=38) Lockner et al. found only one child in each group (ASD vs. TD) had “limited intake to favorite colors.”¹² Similarly, Nadon et al. found no differences in parent-reported food refusals based on color when comparing children with ASD to their TD siblings.¹³

The present study has several limitations. First, refusal was based on parental report and reflected their perceptions rather than direct observations of children’s food choices. Foods have multiple characteristics but reports of food refusal may be based on the parent’s perception of the dominant characteristic of a particular food. For example, parents may report that their children refuse vegetables based on color, but additional reasons may contribute to refusal. Although most vegetables are colorful (i.e. green, yellow, red) they also vary in taste and texture. Thus, it may be difficult to ascertain the true reason for the refusal (color vs. taste vs. texture). Parents may make assumptions about the basis for food refusal in cases when the children cannot or do not communicate the reason. Second, interview questions examined food refusals categorically, but did not differentiate refusal across the range of characteristics within each category. For example, parents were asked whether their children refused foods based on texture but were not asked whether they refused foods that were crunchy or foods that were smooth. The question used from the Sensory Profile combines taste and smell precluding the ability to separate these characteristics. Last, the sample size may have limited the ability to detect significant differences between children with ASD and TD children.

Practice Implications

Early identification and treatment of selective eating habits that encompass food variety (limited food repertoire) and food refusal in children with ASD is critical; however, guidelines and tools to assess and effectively treat food selectivity in children with ASD are currently lacking. The potential for inadequate intake may be greater in cases when parents report multiple reasons for food refusal. In such cases, the registered dietitian can complete

an in-depth assessment of dietary intake and child preferences to provide guidance to families to improve nutritional adequacy of the diet.

Complex feeding problems in children with ASD extend beyond concerns for inadequate dietary intake to potential negative impacts on family life.⁶ Impairments in sensory processing can lead to frustration at mealtimes for children with ASD⁸ and their families, and also impact the ability of children with ASD to function in socially acceptable ways during mealtimes in environments outside of the home (e.g., school and community).^{6,13} Children with ASD with more complex feeding problems should have consultation with an interdisciplinary team that includes a registered dietitian to develop a child and family-centered treatment plan to minimize any adverse medical, nutritional, or behavioral consequences of food selectivity.³⁰ Occupational therapists and/or speech-language pathologists can determine the basis of refusals and provide recommendations for improving food acceptance when refusals have a sensory basis. Behavioral therapists can design home-based interventions to increase food repertoire, and social workers or psychologists can provide additional support when feeding problems increase family stress.

Conclusion

A consistent approach to screen for food refusal among children with ASD would aid the development of a research base. Our findings suggest the need to investigate food refusal cumulatively across multiple domains, as well as individual analysis regarding specific reasons for refusal. Developing practical and effective feeding approaches for children with ASD may help to maintain nutritional adequacy of the child's diet when food refusal is present. Additional studies are needed to better understand the impact of food refusal on nutrient intake, concomitant growth and development, and long-term health among children with ASD.

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Table 1

Demographic characteristics of children with autism spectrum disorder (ASD) and typically developing (TD) children

	Children with ASD (n=53)	TD children (n=58)	<i>P-value</i> ^a
Age, years: Mean (<i>SD</i>) ^b	6.6 (2.1)	6.7 (2.4)	0.75
VABS Score: Mean (<i>SD</i>) ^c	71.1 (12.4)	N/A	
DAS General Conceptual Ability Score: Mean (<i>SD</i>) ^d	85.8 (22.1) ^e	N/A	
Sex, male (%)	83	78	0.47
Race, non-Hispanic white (%) ^f	83	76	0.35
Maternal education, college degree (%)	74	72	0.89
Paternal education, college degree (%)	54 ^g	67	0.15
One or more parent with college degree (%)	81	81	0.99
Child is an only child (%)	11	26	0.05
Child is on a special diet (N) ^h	11	0	<0.001

^a *P* values for differences between ASD and TD children.

^b Age breakdown among children with ASD: 43% aged 3 – 5.99 years, 57% aged 6–12 years; age breakdown among TD children: 47% aged 3–5.99 years, 53% aged 6–12 years

^c Vineland Adaptive Behavior Scales (VABS) was used to characterize adaptive functioning

^d Differential Abilities Scales (DAS) was used to assess cognitive ability

^e n=47; There were 6 children for whom DAS GCA scores were not available: 2 took the DAS at a level which a GCA is not calculated; 1 refused testing; and 3 had problems with test administration such that their tests could not be scored.

^f Racial/ethnic breakdown for non-white and Hispanic participants: Black/African-American: 7% typically developing, 2% ASDs; Hispanic: 5% typically developing, 4% ASDs; Asian: 0% typically developing, 4% ASDs; More than 1 race/other: 12% typically developing, 8% ASDs

^g n=52

^h gluten-free, casein free diet, n=9; wheat-free diet, n=1; lactose-free diet, n=1

Table 2

Comparison of children's food refusal based on food characteristics between children with autism spectrum disorder (ASD) and typically developing (TD) children

Food characteristic	Reported food refusal based on food characteristic, N (%)		
	Children with ASD	TD children	<i>P-value</i> ^b
Consistency/texture ^a	41 (77.4%)	21 (36.2%)	<0.0001
Food mixed together ^a	24 (45.3%)	15 (25.9%)	0.03
Temperature ^a	16 (30.2%)	14 (24.1%)	0.47
Food touching other foods ^a	11 (20.8%)	10 (17.2%)	0.64
Color ^a	8 (15.1%)	7 (12.1%)	0.64
Brand ^a	8 (15.1%)	1 (1.7%)	0.01
Shape ^a	6 (11.3%)	1 (1.7%)	0.05
3 or more of above	19 (35.8%)	9 (15.5%)	0.01
None of the above	5 (9.4%)	23 (39.7%)	0.0003
Sensory Profile item 55			
Smell/Taste ^c	26 (49.1%)	3 (5.2%)	<0.0001

^a Binary variables constructed by combining strongly agree and agree from a 5-level Likert scale (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree).

^b *P* value from Chi-square test or Fisher's Exact test (if expected cell counts <5)

^c From Sensory Profile item 55 (Avoids certain tastes or food smells). Binary variables constructed by combining always and frequently from a 5-level Likert scale (always, frequently, occasionally, seldom, never)

Table 3

Association between food refusal based on food characteristics and food selectivity among children with and without autism spectrum disorder (ASD)

Characteristic of food ^b	Percentage of foods refused of those offered ^a					
	All foods		Vegetables		Fruits	
	Estimate (SE)	P-value	Estimate (SE)	P-value	Estimate (SE)	P-value
Consistency/texture	6.5 (1.6)	<0.0001	10.1 (2.5)	<0.0001	10.5 (2.4)	<0.0001
Food mixed together	6.9 (1.2)	<0.0001	9.3 (2.0)	<0.0001	6.3 (2.0)	0.003
Temperature	0.7 (1.4)	0.63	2.1 (2.2)	0.35	0.0 (2.2)	0.99
Food touching other foods	6.5 (1.5)	<0.0001	7.8 (2.4)	0.001	6.6 (2.3)	0.006
Color	5.4 (1.4)	0.0003	8.7 (2.3)	0.0002	5.3 (2.3)	0.023
Brand	6.8 (1.8)	0.0002	8.1 (2.8)	0.006	4.4 (2.8)	0.12
Shape	5.6 (2.0)	0.005	9.8 (3.1)	0.002	6.0 (3.1)	0.052
Smell/Taste (SP 55)	7.7 (1.5)	<0.0001	8.0 (2.5)	0.002	8.1 (2.4)	0.0009

^a from FFQ – Percent will not eat of those offered: Overall, Vegetables, Fruits

^b Each rated on a 5-level scale. 1=parent strongly disagrees that child refuses to eat foods based on that characteristic and 5=parent strongly agrees that child refuses to eat foods based on that characteristic. Estimates from individual linear regression models adjusted for age, sex, autism status, race/ethnicity, and only child. Outcome is percentage of foods refused of those offered from FFQ (overall, vegetables, and fruits).

Association between food refusal based on food characteristics and fruit/vegetable consumption among children with and without autism spectrum disorder (ASD)

Table 4

Characteristic of food ^a	Fruit and vegetable consumption, servings per day					
	Vegetables		Fruits		Fruits and Vegetables	
	Estimate (SE)	P-value	Estimate (SE)	P-value	Estimate (SE)	P-value
Consistency/texture	-0.20 (0.13)	0.12	-0.17 (0.13)	0.22	-0.36 (0.22)	0.095
Food mixed together	-0.14 (0.10)	0.17	-0.04 (0.11)	0.75	-0.18 (0.18)	0.32
Temperature	-0.02 (0.11)	0.86	0.08 (0.11)	0.51	0.06 (0.19)	0.76
Food touching other foods	-0.06 (0.12)	0.62	-0.05 (0.13)	0.69	-0.11 (0.20)	0.59
Color	-0.31 (0.11)	0.007	-0.18 (0.12)	0.13	-0.49 (0.19)	0.01
Brand	-0.11 (0.14)	0.44	0.12 (0.15)	0.41	0.01 (0.24)	0.96
Shape	-0.24 (0.15)	0.12	-0.02 (0.16)	0.89	-0.26 (0.26)	0.32
Smell/Taste (item SP 55)	-0.20 (0.12)	0.095	-0.10 (0.13)	0.43	-0.31 (0.21)	0.15

^a Each rated on a 5-level scale. 1=parent strongly disagrees that child refuses to eat foods based on that characteristic and 5=parent strongly agrees that child refuses to eat foods based on that characteristic. Estimates from individual linear regression models adjusted for age, sex, autism status, race/ethnicity, and only child. Outcome is daily servings as estimated by FFQ.