

Food Choices of Children With Autism Spectrum Disorders

Michelle Ann Suarez^{1,*}; Kristin Marria Crinion¹

¹Department of Occupational Therapy, Western Michigan University, Kalamazoo, USA

*Corresponding author: Michelle Ann Suarez, Western Michigan University, 1903 W. Michigan Ave. Kalamazoo, MI, 49008-5333, USA. Tel: +1-2693666094, E-mail: michelle.a.suarez@wmich.edu

Received: February 3, 2015; Accepted: May 19, 2015

Background: Food selectivity is common in children ASD and has significant implications for health and quality of life. Developing more information about the content and quality of the diets of children with ASD and food selectivity could inform treatment.

Objectives: The objective of this study was to describe the foods that children with autism and food selectivity eat and to compare the composition of the diets of children with and without food selectivity.

Patients and Methods: Data from 54 participants collected during a larger longitudinal survey study was analyzed. Parents of children with ASD completed a food inventory marking foods that their child had accepted over the past month. They also described the particular presentation (e.g. texture, particular plate) required for their child to eat the food. The compositions of the diet including the percentage of each food group in total diet and the percentage of empty calories in the total diet of the food repertoires of the children who accepted 20 or less compared to greater than 20 foods was analyzed using independent t-test. Qualitative descriptions of food presentation were analyzed using a phenomenological method.

Results: Parents rated foods from each group and the top rated vegetables and fruits were presented. Children who had 20 or less foods in their diet repertoire had a significantly lower percentage of vegetables and fruits, and a significantly higher percentage of dairy and grain/potato/snack foods than children with more than 20 foods as part of their regular diet. Also, children with 20 or less foods had a greater percentage of empty calories in their total diet compared to the children who had greater than 20 foods. Themes developed from the parents description of food presentation required to accept food included the visual presentation of the food and that food could not be mixed or touch other foods.

Conclusions: Information about which foods children with ASD and food selectivity accept could help inform decisions about which foods to introduce first in treatment. The fact that the children with fewer foods in their repertoire have a smaller percentage of whole vegetables and fruits in their total diet and more empty calories may have implications for future health outcomes.

Keywords: Autism; Food; Children

1. Background

Autism Spectrum Disorder (ASD) is characterized by deficits in communication and social interaction, as well as the presence of restrictive, repetitive and stereotyped patterns of behavior and/or interests (1). Food selectivity, defined as acceptance of a limited number of foods as part of the child's regular diet (2), is common in children with ASD (2, 3). Some estimates of the prevalence of food selectivity in ASD are as high as 72% (4).

Parents often struggle with adding foods to their child's diet and food refusal behavior is disruptive to the family unit (5) and resistant to change (6). Food selectivity also poses nutritional risks (4, 7) and may be linked to negative food related health outcomes. However, many children with ASD and food selectivity are not being treated to improve their mealtime behavior and diet (6). Understanding the content and quality of the food in the repertoires of these children could create greater urgency to act to remediate food selectivity and avoid some of the implications of food refusal behavior.

Children with autism and food selectivity often have disruptive food avoidance behavior that makes mealtime stressful for the entire family. Several qualitative studies have illustrated the stress, guilt and worry that food selectivity causes for parents of children with autism (8, 9). In addition, parents report a lack of understanding by helping professionals about the struggle to add additional foods to their child's diet. Sometimes, suggestions by professionals backfire, such as sneaking non-preferred food into preferred foods, and the child starts to refuse a previously accepted food (9). The reasons for food refusal are not clear. It is possible that children with ASD refuse foods based on their texture or presentation (4, 10). Greater understanding of what foods children with ASD and food selectivity typically eat may provide professionals and parents with a starting place for introducing new foods that the child is more likely to accept.

In addition to the struggle family's face with adding new foods to their child's diet, children with ASD may

have elevated risk for negative health outcomes related to dietary choices. Several studies that compare children with ASD with and without food selectivity have found nutritional deficits for the children with food selectivity in the ASD population. For example, Johnson and colleagues (5) found that problem feeding behaviors were predictive of dietary quality. Zimmer and colleagues (7) found a significant relationship between selective eating and presence of nutrient deficiency. Although research into the relationship between malnutrition and food selectivity is ongoing, evidence is building to support this link.

Children with ASD and food selectivity may not get nutritional needs met due to refusal to eat foods from entire food groups and there is evidence that these children eat fewer fruits and vegetables (2, 11). This could account for some of the deficits in nutrients and may contribute to negative health outcomes. Several studies have suggested a higher prevalence of obesity in children with ASD (12-14) and it is possible that this is related to refusal to eat healthy whole foods like vegetables and fruits (2, 15).

However, it is not clear whether eating fewer vegetables and fruits is a function of eating fewer foods in total (i.e. eat fewer dessert or snack foods as well as fewer vegetables and fruits) or if healthy whole foods like vegetables and fruits constitute less of a proportion of the foods accepted. Having a smaller proportion of healthy whole foods in their repertoire may mean more availability of empty calories and less opportunity for optimal nutrition.

Empty calories are calories from solid fats and/or added sugars (16) and high consumption has been correlated with obesity and cardiovascular disease risk (17). According to the Dietary Guidelines for Americans, empty calories should be limited to 8-19% of total energy intake. It is unclear whether children with ASD and food selectivity have a repertoire of foods that allows for the potential for them to meet this target.

2. Objectives

The purpose of this study was to describe the vegetables and fruits that parents of children with ASD reported their child ate and to describe the particular presentation required in order for the child to accept this food. In addition, to determine if the percentage of the total diet of vegetables, fruits, proteins, dairy, grains/snack foods/potato (e.g. chips and cheese puffs) and sweets (e.g. cakes, candy) was the same for children with and without food selectivity.

Finally, this study sought to compare the proportion of empty calories in the repertoires of the children with and without food selectivity.

3. Patients and Methods

This was a cross sectional study and data was drawn from a larger longitudinal survey study that gathered the

perceptions of parents of children with ASD in the United States (6). Original recruitment was facilitated by the Autism Speaks Interactive Research Network that emailed an invitation to participate to randomly selected parents in their database. The Human Subjects Institutional Review Board at Western Michigan University, Kalamazoo, MI, USA approved the original longitudinal study as well as the additional data analysis for this article.

3.1. Instrumentation

Information on the demographic characteristics of the sample (i.e. gender, race, ethnicity of the parent and age and gender of the child with autism) was gathered using a demographic questionnaire. Parents also indicated whether their child had an ASD diagnosis and specified the professional or group that provided this diagnosis.

Parents filled out a food inventory that contained 70 different foods from 5 different groups. This questionnaire was developed with permission from the Food Frequency Questionnaire used in the Bandini et al. study of food selectivity in children with autism (2). The Food Frequency Questionnaire has evidence of validity and reliability. Food groups in the questionnaire for the current study included vegetables, fruits, proteins, dairy, grains/snack foods/potatoes (e.g. chips and cheese puffs) and dessert/sweets (e.g. cakes, candy). For each food, they marked whether or not their child had eaten the food over the past month and whether they required a specific brand or presentation (e.g. particular plate, utensils, particular color or flavor). Parents were given space to write and describe the presentation their child required.

3.2. Data Analysis

Foods in each group were placed in rank order based on preference in the entire sample. Independent t-tests (or Mann Whitney U when distributions were not normal) were used to compare children with and without food selectivity on the percentage of each food group, the percentage of empty calories and the percentage of foods the child insisted on a particular presentation in the total food repertoires.

The parent's qualitative description of the particular presentation their child required to eat the accepted foods was analyzed using the phenomenological method recommended by Moustakas (1994) by the first author of the study. The parent's written description of the particular presentation was read multiple times in order to develop an understanding of the main ideas. Then, relevant statements were identified and categorized into themes. Examples (verbatim) were chosen to illustrate each theme.

4. Results

Fifty-four parents of children with autism completed the survey with food inventory. Of this group, 33% re-

ported that their child had 20 or less foods and 67% reported that their child had more than 20 foods in their repertoires. Participants were 96% Caucasian and 88% male. The age of the child ranged from 55 to 128 months. The child's autism diagnosis was based on parent report. For a full demographic description of participants see Suarez, Nelson, and Curtis (6).

Previous research by Cornish et al. (18) demonstrated nutritional risks for children who ate 20 or less foods and Suarez et al. (6) found significant differences in sensory processing for this group when compared to those that ate 21 or more foods. Based on these studies, food selectivity in this study was dichotomized by acceptance of 20 or less foods (moderate and severe food selectivity) compared to acceptance of greater than 21 foods (typically selective) (6, 18).

The top 6 foods in each category (or top five in dairy and eight in grains/snack foods/potatoes due to the number of items available in the inventory for these categories), were rated using the frequency in which they were accepted by the entire sample. This information was broken

down further by the accepted 20 or less or greater than 20 dichotomy. Table 1 summarizes fruit and vegetable acceptance data based on the top rated foods.

The percentage of vegetables, fruit, protein, dairy, grain/potato/snack and dessert/sweets as a function of the total diet for the children in the accepts 20 or less compared to greater than 20 foods was calculated and compared using an independent samples t-test or the non-parametric equivalent (Mann-Whitney U) when the variable deviated from a normal distribution. Table 2 contains a summary of this information. For the percentage of protein and dairy, Levene's test was less than 0.05 and results are reported for equal variances not assumed. Children who accepted 20 or less foods in their repertoire had a significantly less percentage of vegetables and fruits than children who accepted greater than 20 foods. Conversely, children who accepted 20 or less foods in their repertoire had a significantly greater percentage of dairy and grain/potato/snack in their repertoires compared to children with greater than 20 foods.

Table 1. Top Fruit and Vegetable Choices for Children

Rank			Food Level		Total
			≤ 20 n = 18	> 20 n = 36	
Vegetable					
1	Carrot	Accepts	4	23	27
2	Corn	Accepts	1	24	25
3	Broccoli	Accepts	1	19	20
4	Peas	Accepts	0	13	13
5	Lettuce	Accepts	0	11	11
Fruit					
1	Apple	Accepts	6	27	33
2	Banana	Accepts	4	26	30
3	Grape	Accepts	3	22	25
4	Strawberry	Accepts	0	21	21
5	Pear	Accepts	2	16	18

Table 2. Means, Standard Deviations and Results of Independent t test or Mann-Whitney U Comparing the Percentage of the Total Diet for each Food Group for Children who Accept 20 or Less or More than 20 Foods

	≤ 20 Foods (n = 18)	> 20 Foods (n = 36)	t (df) or Mann Whitney U and p
% Vegetable ^a	4.93 ± 8.33	12.18 ± 6.97	139.00, 0.001 ^b
% Fruit ^a	7.58 ± 8.73	16.99 ± 8.29	-124.00, < 0.001 ^b
% Protein	17.07 ± 10.26	19.83 ± 5.55	-1.07 (22.11), 0.298
% Dairy	11.59 ± 7.39	7.01 ± 3.80	2.47 (21.62), 0.022 ^b
% Grain/Pot/Snack ^a	50.71 ± 13.56	38.13 ± 8.75	128.50, < 0.001 ^b
% Dessert/Sweets ^a	19.71 ± 14.16	12.87 ± 5.05	231.50, 0.089

^a Not normality distributed.

^b Mann-Whitney U used to compare groups.

An independent-samples t-test was conducted to compare percent of the total repertoire of empty calories for children with 20 or less foods to those with greater than 20 foods. The children with 20 or less foods had a significantly greater percent of their total food repertoire composed of empty calories ($X = 25.45$, $SD = 8.23$) compared to those with greater than 20 foods ($X = 20.34$, $SD = 3.38$); $t(52) = 3.30$, $P = 0.002$.

In addition, parents who report that their children ate 20 or less foods insisted on a particular presentation for $x = 45.19\%$ of these foods ($SD = 40.13$) compared to $x = 14.43\%$ ($SD = 20.23$) of foods for children with greater than 20 foods. This data was not normally distributed so Mann Whitney U was used to compare these two groups. This was a significant difference; 152.5 , $P = 0.001$.

Thirty-one parents provided written descriptions of the particular presentation their child required in order eat. Several prevalent themes emerged from the analysis of the parents written descriptions of the particular presentation. It was very clear from the data that the visual presentation of the food was very important. The most common comment was that the child required a particular brand (e.g. "in the green carton"). Also many parents commented that their child needed the food cut a particular way (e.g. "cut down the middle, not across or triangle") or to be arranged on the plate a particular way (e.g. "only one food on her plate at a time"; "Catsup placed in the exact center of the plate"). Another common theme was that food could not be mixed or one food could not touch another ("will not eat mashed potatoes if they have anything else touching them, will not eat any type of casserole"). The "sameness" of the food was often mentioned (e.g. "could tell if it was a different brand and refused to eat"). Some children required particular utensils or plates ("e.g. only eats with plastic utensils") but this was relatively less commonly mentioned. The texture of the food (e.g. "likes crunchy") was mentioned but came up less than the brand and visual presentation.

Children who accepted 20 or less foods had a smaller percentage of their total diet of vegetables and fruits, and a greater percentage of dairy and grain/potato/snack foods than children with greater than 20 foods. They also had a greater percentage of empty calories in their repertoires and insisted on a particular presentation for accepted foods. However, parents who report that their child refuses food based on texture did not report more "particular presentation" requirements for accepted foods.

Prior research has shown that children with ASD eat fewer vegetables and fruits and this was true in the children with ASD with 20 or less foods compared to the children with greater than 20 foods in this study as well (2, 11). However, in this study the top 4 vegetables and fruits were the same for the children who ate 20 or less foods and the children who ate more than 20 foods. Introducing carrots, apples, bananas and grapes, may be a

place to start when attempting to add new whole foods to a child's diet.

5. Discussion

The etiology of food selectivity is unknown and it is likely that there are multiple physiological and behavioral reasons that children refuse foods (19). This study highlights the fact that reasons for food refusal are likely to go beyond the texture of the food presented. For example, the top 4 fruits and vegetables could each represent different texture groups. Carrots are a uniform consistency and are often served raw and crunchy. Apples are a mixed consistency when served with the peel, bananas are often mushy and grapes are juicy. Feeding therapists and families need to closely evaluate food acceptance patterns in individual children before making recommendations for how to approach adding foods to a child's diet. For example, the fact that the visual presentation and foods don't touch each other mattered to the children in this study may contraindicate techniques like sneaking non-preferred foods into preferred foods for some children.

In this study, there was a difference in the relative composition of foods in the repertoires of children who accepted 20 or less foods, compared to children that accepted greater than 20 foods. Acceptance of few vegetables and more grain/potato/snack foods may have contributed to a greater percentage of empty calories in the food repertoires of the children with 20 or less foods. This information could have implications for health outcomes. Although obesity is a complex, multi-faceted problem, the relative compositions of the diets of children with food selectivity could be one important contributing factor (12). In addition, heart disease and diabetes are crippling health problems that are also related to nutritional intake. Food selectivity may contribute to these health conditions (17). If this is the case, the urgency for providing treatment for food selectivity should be increased in order to avoid expensive, quality of life decreasing outcomes for this population.

This study had several limitations. First, the food inventory instrument was based on a valid and reliable instrument but psychometric properties of this revision have not yet been gathered. Also, the food inventory used in this study did not capture the frequency each child ate the foods endorsed by the parents. It is possible that they are eating particular foods more than others on a daily basis. This would change the empty calorie composition of their diet. Also, parents were reporting a subjective account of their child's food acceptance and the child's ASD diagnosis is not independently verified. There is no way to confirm that the parents report is free from bias. However, understanding the perceptions of parents regarding food acceptance for their children provides one starting place for the development of treatment protocols. Finally, this sample was drawn from the United States only. More research on food selectivity in the ASD popu-

lation that includes international samples to determine cultural influences is needed.

In conclusion, this study provides information about what children with ASD and food selectivity choose to eat. Food choices of the group of children with 20 or less foods as part of their food repertoires contained less whole fruits and vegetables and more empty calories. This provides one piece of evidence that children who present with nutrition related health conditions like obesity, should be screened for food selectivity. Treatment of food selectivity may contribute to better health outcomes for children with ASD.

Acknowledgements

This study was made possible through the recruitment assistance of the Interactive Autism Network (IAN) Project at the Kennedy Krieger Institute, Baltimore, Maryland.

Authors' Contributions

Michelle Suarez was primarily responsible for: Study concept and design, Acquisition of data, Analysis and interpretation of data, Drafting of the manuscript, Critical revision of the manuscript for important intellectual content, Statistical analysis, Administrative, technical, and material support, Study supervision, Kristin Crinion was secondarily responsible for analysis and interpretation of the data, and drafting of the manuscript.

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