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Looking Beyond the Growth Curve: A Retrospective Study on Nutrient Deficient Diets in Children with Severe Food Selectivity

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Abstract: Severe food selectivity places children at risk for nutrient deficiencies and long-term medical complications, if unaddressed. However, poor nutrition in highly selective eaters is often overlooked when considering other behavioral or medical concerns. Additionally, studies regarding food selectivity are sparse and limited to children with developmental delays. This study further investigates the nutritional deficiencies and growth characteristics of children with severe food selectivity to assist pediatricians in the earlier identification of patients for nutrition screening. A retrospective chart review was completed for 13 patients admitted to a pediatric feeding program solely for table-textured food selectivity. Nutrition and anthropometric data from the medical record were analyzed. All patients were determined to be following an age-appropriate growth curve but had multiple micronutrient deficiencies. Additionally, 6 children were typically developing outside of the feeding context. Results suggest that children with food selectivity may require more intensive and earlier nutrition screening beyond their growth patterns.

Key Words: malnutrition, nutrition screening, pediatric feeding disorder, picky eating

What Is Known?

- Pediatric feeding problems are common and one of the most frequent concerns presented to pediatricians.
- Severe food selectivity, if untreated, places children at higher risk for nutrient deficiencies and long-term medical complications.
- Severe food selectivity is common in children with autism spectrum disorders and developmental delays.

What Is New?

- All children in this study were following age-appropriate growth curves but still had multiple micronutrient deficiencies.
- Almost half of the children in this study were typically developing outside of their feeding difficulties.
- Earlier and more in-depth nutrition screening may be necessary for children with selective eating.

INTRODUCTION

Pediatric feeding problems are common in the general population (1) and are a frequent concern presented to pediatricians (2). These problems vary along a spectrum of complete dependence on enteral feeds to food selectivity (2). The severity of food selectivity ranges from the avoidance of certain foods, flavors, and textures to the avoidance of entire food groups. In severe cases, children rely on a few foods for all their nutrition. When children eliminate entire food groups and maintain extreme rigidity regarding food preparation, brand, flavor, or texture, they are at risk for nutrient deficiencies and long-term medical complications (eg, diabetes, hypertension, obesity, or scurvy) related to severe food selectivity, if this pattern continues (3–5).

Poor nutrition in selective eaters is often overlooked, possibly due to how malnutrition was previously assessed and diagnosed. Pediatric malnutrition was not well defined until 2013 and is now based on anthropometrics, chronicity/etiology, mechanism of malnutrition, and functional outcomes (6). Additional measures are recommended to assess pediatric malnutrition, including z-scores for weight-for-height/length, body mass index (BMI)-for-age, length/height-for-age, mid-upper arm circumference, weight gain velocity, weight loss, inadequate nutrient intake, and measurements of grip strength and muscle wasting (7,8). Despite the dissemination of a consistent definition and measurement criteria for malnutrition, a subset of children may be missed based solely on those anthropometric measures. Children with severe food selectivity often consume enough preferred foods to maintain adequate growth, and some studies have demonstrated that growth measures can be insufficient in identifying malnutrition (9–11). However, these studies are sparse and limited to children with autism spectrum disorders (ASD) or other developmental delays and only recommend closer monitoring of nutrient intake in children with ASD (9,12,13).

This study expands upon the current literature by investigating the demographic and growth characteristics of children with severe food selectivity admitted to an intensive feeding program, analyzing the potential nutritional deficiencies associated with food selectivity, and identifying factors that reduce the risk of these nutritional deficiencies. This study aims to assist pediatricians in identifying patients requiring earlier nutrition screening to prevent more significant medical complications. Recommendations are also provided for pediatricians, registered dietitians, and families to improve the nutritional status of children with severe selectivity until the underlying causes of the feeding disorder can be diagnosed and treated.

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METHODS

Participants

The retrospective chart review included data from 13 children admitted to an intensive pediatric feeding program at a Midwestern academic medical center and was approved by the Institutional Review Board. Patients admitted to the feeding program solely for table-textured food selectivity with no history of enteral feeding or failure to thrive were included. Ages ranged from 3 to 18 years (mean = 7.3 years). Table 1 includes additional demographic information.

Procedures

As a standard of care, the dietitian collected anthropometric data upon program admission. Laboratory measurement of micronutrient levels was conducted, and caregivers completed detailed 3-day food records. The dietitian completed nutrient analyses for each patient. Diet records, laboratory measurements, and anthropometric data from the medical record were reviewed and analyzed for all patients.

Measures

Anthropometrics

The dietitian conducted nutrition-focused physical assessments upon program admission, which included height, weight, and BMI. Percentiles were reported on the appropriate growth curves (Centers for Disease Control >2 years), which included height-for-age, weight-for-age, and BMI-for-age.

Food Records

Food records included detailed information regarding the amount of food and fluid offered and consumed, all ingredients, and times of meals and snacks for a 3-day period before admission. Given the selectivity of these patients, food logs were representative of their entire diets, per caregiver reports.

Laboratory Measurement of Micronutrient Levels

Laboratory measurements of micronutrient levels were completed for patients before program admission, which included iron studies (complete blood count, ferritin, transferrin, and total iron binding capacity), vitamin D, vitamin B_{12}, folate, methylmalonic acid, and a basic metabolic panel.

Analyses

Nutritionist Pro Diet Analysis software was used to analyze all micro and macronutrients from 3-day food records upon admission. Nutrients included in the analyses were vitamin A, vitamin C, vitamin D, thiamin, riboflavin, niacin, iron, zinc, vitamin B_{12}, calcium, fiber, and folate. Laboratory measurements were reviewed to correlate with potential micronutrient deficiencies noted in diet record analyses for each participant.

TABLE 1. Participant demographics

	Male n (%)	Female n (%)
Total	10 (77)	3 (23)
Race/ethnicity		
White	7 (54)	2 (15)
Middle Eastern	1 (8)	1 (8)
Multiracial	2 (15)	0 (0)
Developmental disabilities		
Autism spectrum disorder	5 (38.5)	2 (15)
Typically developing	5 (38.5)	1 (8)

RESULTS

Of the 13 children in the study, 11 were following an age-appropriate growth curve, and 2 children were on an increasing trend across curves. Patients had a mean BMI of 17.4 (57.5th percentile) with a standard deviation of 3.43 (29.6 percentiles) and a range of 14.5–22.4 (16.7–99.2 percentiles).

Table 2 represents nutrient deficiencies in the patients' diets. Only 12 children were included in the main nutrient analysis shown in Table 2 due to missing data for 1 child, which is discussed below. Six of the 12 children represented in Table 2 were typically developing, and 6 had a diagnosis of ASD. No differences were observed between diets in children with or without an ASD diagnosis. One child had an additional medical diagnosis of celiac disease but had been gluten-free for over 2 years before admission. Patients without fortified foods (eg, cereal, crackers, and breakfast bars) in their diet (participants 2, 7, 9, and 11) had diets deficient in 7 or more micronutrients. Patients consuming at least 1 fortified food had diets with 6 or fewer micronutrient deficiencies. Table 2 also displays the percent daily value of each micronutrient that each participant was consuming upon admission. Two children from this group had clinical diagnoses related to their diets, including scurvy, rickets, and anemia.

Preadmission nutrition data for the thirteenth child was not obtained due to emergency circumstances. This child was 7 years old and consumed only Lay's plain potato chips, McDonald's French fries, blue Kool-Aid, and Mountain Dew. Per the medical record, the child was following an increasing growth trajectory, and had a BMI of 20.2 (98th percentile) but then had multiple emergency department presentations, 2 hospital admissions, lost 15 pounds in 2 months, and was admitted to the hospital's pediatric intensive care unit due to severe protein-calorie malnutrition, prolonged QTc, acute kidney injury, hepatomegaly with fatty infiltrate, bilateral pleural effusions, and lactic acidosis, all as a result of severe food selectivity. The medical record indicated low sodium, potassium, phosphorus, and albumin. The child was deficient in folate, riboflavin, niacin, vitamins B_{12} and E, carnitine, iron, and zinc, and he was later diagnosed with wet beriberi. This child was admitted to the pediatric feeding program during his hospital stay and started on enteral feeds before treatment in the program, so initial nutrition data and laboratory measurements of micronutrient levels were not collected in the same manner as the other 12 children and therefore not included in Table 2. However, the patient still met the criteria for the study before his hospital admission.

DISCUSSION

This study expands upon recent literature indicating that children with food selectivity may require more intensive and earlier nutrition screening beyond their growth patterns. All children in this study had table-textured food selectivity with no history of enteral feeding or failure to thrive, and medical records indicated that they were following age-appropriate growth curves or were increasing across curves. Yet, they all had diet records and laboratory data suggesting multiple micronutrient deficiencies, which indicates that anthropometric measures may be inadequate markers of malnutrition for children with longstanding food selectivity. This study also highlights a severe case in which the child has significant long-term medical sequelae due to years of highly selective eating. Although that case may be rare, other similar cases are documented in the literature (9,10), and 2 other children had medical complications related to their diet, suggesting that earlier nutrition screening and intervention

TABLE 2. Participant nutritional analysis and percent of recommended daily values for nutrients

Participant	Vitamin A mcg/d (%)	Vitamin C mcg/d (%)	Vitamin D mcg/d (%)	Thiamin mcg/d (%)	Riboflavin mcg/d (%)	Niacin mcg/d (%)	Vitamin B_{12} mcg/d (%)	Folate mcg/d (%)	Calcium mcg/d (%)	Iron mcg/d (%)	Zinc mcg/d (%)	Fiber mcg/d (%)
1	180.53* (45*)	130.33 (521)	369.45 (62)	0.90 (150)	1.12 (186)	5.02 (63)	3.02 (251)	53.66* (27*)	855.61 (86)	4.69 (47)	5.69 (114)	2.40* (10*)
2	187.07* (47*)	8.62 (34)	207.4 (35)	0.49 (81)	0.83 (138)	2.46* (31*)	2.06 (171)	43.85* (22*)	561.50* (56*)	2.10* (21*)	3.08* (62*)	4.86* (19*)
3	465.52* (52*)	183.09 (244)	350.82 (88)	0.43* (35*)	1.11 (85)	4.35* (27*)	1.90 (79)	54.23* (14*)	1818.23 (140)	9.09 (83)	5.74* (52*)	16.11* (42*)
4	561.2 (140)	0* (0*)	622.2 (104)	0.92 (154)	2.37 (395)	4.69* (59*)	5.49 (458)	61* (31*)	1378.6 (138)	4.69 (47)	4.51 (90)	3* (12*)
5	116.10* (55*)	40.99 (273)	188.84* (31*)	0.47 (93)	0.77 (154)	4.60 (77)	1.55 (172)	121.98 (81)	592.09 (85)	6.54 (93)	3.29 (110)	6.43* (34*)
6	350.7 (88)	24 (96)	207.43 (35)	1.52 (253)	1.28 (213)	24.53 (307)	2.6 (217)	349.07 (175)	1066.67 (107)	14.49 (145)	4.42 (88)	7.25* (29*)
7	27.19* (7*)	8.51* (34*)	5.40* (1*)	0.45 (75)	0.30* (49*)	6.14 (77)	0.39* (33*)	109.16* (55*)	174.50* (17*)	4.04 (40)	3.60* (72*)	9.36* (37*)
8	448.69 (112)	164.22 (657)	324.43 (54)	1.16 (194)	1.76 (292)	14.20 (178)	3.35 (279)	346.19 (173)	1402.66 (140)	10.40 (104)	6.82 (136)	14.62* (58*)
9	42.27* (11*)	70.87 (283)	15.56* (3*)	0.18* (30*)	0.18* (30*)	2.57* (32*)	0.25* (21*)	59.37* (30*)	513.41* (51*)	11.78 (118)	15.13 (303)	14.97* (60*)
10	947.01 (237)	7.66* (31*)	741.59 (124)	1.17 (195)	2.41 (401)	9.85 (123)	7.06 (588)	234.10 (117)	2204.35 (220)	12.59 (126)	7.99 (160)	8.17* (33*)
11	164.98* (18*)	3.55* (5*)	1.49* (0*)	0.57 (47)	0.37* (29*)	7.90* (49*)	0.01* (0*)	86.54* (22*)	282.63* (22*)	6.27* (57*)	1.19* (11*)	8.77* (23*)
12	497.20 (124)	13.19* (53*)	96.08* (16*)	1.09 (182)	1.11 (186)	16.62 (208)	1.66 (138)	84.68* (42*)	232.57* (23*)	7.03 (70)	3.94 (78)	9.18* (37*)

Bold
* denotes nutritional deficiency based on Recommended Dietary Allowance or Adequate Intake. d = per day.

are needed to prevent serious medical complications resulting from food selectivity.

The existing literature on selectivity and nutrition focuses on children with ASD, but 6 of the 13 children in this review were typically developing. These results suggest that typically developing children with food selectivity may have a similar risk for malnutrition as those with developmental disabilities, which should be further studied. It is also a common assumption that selective eating occurs more frequently in toddlers and very young children, but severe selectivity is often persistent, which is reflected in this study with an average patient age of 7.3 years. Although children may have phases of food selectivity, if parents repeatedly report these concerns in primary care visits, it may indicate a need for further nutritional assessment, even if the growth chart appears unremarkable.

Furthermore, laboratory measurement of micronutrient levels captures nutritional deficiencies better than growth measures, but after 12 months of age, there are no routine laboratory measures for nutritional adequacy per the American Academy of Pediatrics guidelines. Instead, nutritional laboratory screening is only performed if deemed appropriate by the physician (14). Given that a host of concerns often need to be addressed within a limited pediatrician appointment time, little or no time may be spent assessing specific food intake. If a child is growing and gaining weight, screening and recognition of micronutrient deficiencies are often delayed, and early symptoms may not be identified until the problem becomes severe, especially with respect to rarer deficiencies and diseases, such as scurvy and rickets (15).

Even if pediatricians screen for nutritional deficiencies and malnutrition issues are identified, medical providers still need to determine how to intervene. If a child is referred to a dietitian, amelioration of the child's nutritional deficiencies may be outside of the dietitian's scope of practice given the many reasons a child may be selective (eg, oral-motor difficulties or anxiety (16)). In other words, a family will not make progress toward getting their child to eat the balanced diet recommended by the dietitian if the child engages in refusal behaviors driven by anxiety or lacks the oral-motor skills to chew and swallow more advanced textures.

A multidisciplinary approach to evaluation and treatment is recommended in the field of pediatric feeding disorders (16), but programs are scattered around the country and have waitlists. While children and their families inevitably wait for treatment, they will likely turn to their medical providers for guidance. In this study, children who ate at least 1 fortified food had diets with fewer and less severe micronutrient deficiencies. If families can add at least 1 fortified food, nutrition supplement, or multivitamin, it may be protective for their child's nutrition until they receive further treatment for their feeding disorder. Furthermore, children with food selectivity often have subtle oral-motor deficits that go unnoticed by family members and medical providers, so fortified foods that have a crunchy, dissolvable texture (eg, crackers or cereal) or in puree or fluid form are often easier options to try in the meantime. Finally, despite variability across nutrient deficiencies in this study, none of the children met the recommendations for daily fiber intake. Given the negative impact constipation has on feeding difficulties (17), this may be an area for pediatricians to target in the interim.

This study is limited by a small sample of children. Further research is needed to ensure generalizability across children based on demographics (age, race, socioeconomic status, etc.), various levels of food selectivity, and those not enrolled in a feeding program. Also, because this was a retrospective study, all participants did not have laboratory measurements of micronutrient levels and nutrition logs completed in the same manner (ie, participant 13), so results are limited to data in the medical record. More extensive laboratory measures for certain nutrients (vitamins A, C, and folate) were not the standard of care, so the data are based on diets deficient in those nutrients. Future prospective studies may benefit from including more sensitive laboratory measures.

This study provides preliminary evidence of the need for earlier, more in-depth nutrition screening, such as detailed food records and laboratory measures, in children with continued food selectivity, including those with otherwise typical growth and development. Children with severe food selectivity are unlikely to grow out of it (18,19), and families are likely to seek guidance first from their primary care providers. Earlier referrals to a dietitian for more comprehensive nutrition assessments may result in the earlier introduction of fortified foods or supplements, timelier referrals to feeding specialists, and prevention of severe and long-term medical complications.

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