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Food selectivity and sensory sensitivity in children with autism spectrum disorders

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Abstract

Autism spectrum disorders (ASDs) comprise a complex set of related developmental disorders that are characterized by impairments in communication, social interaction, and repetitive behaviors. Impairments in sensory processing are also extremely common. The prevalence of ASDs is increasing and is currently estimated to affect 1 in 150 children. ASDs are considered to be a major health and educational problem, affecting many areas of daily living, including eating. Children with ASDs are often described as picky or selective eaters. This paper provides a comprehensive narrative review of the empirical literature over the last 25 years on food selectivity and nutritional adequacy in children with ASDs. The possible contributions of sensory factors, such as sensory sensitivity, to food selectivity are discussed. The need for an interdisciplinary approach to managing atypical eating patterns in children with ASD is highlighted.

Keywords

autism; food selectivity; sensory sensitivity

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INTRODUCTION

Early childhood is a period when children experience new foods, tastes, and textures. Parents of toddlers and young children often describe their children as “picky eaters”, refusing to try or eat a variety of foods. Although picky eating is not uncommon among young children who are typically developing, pickiness in children with autism spectrum disorders (ASDs) may be even more restrictive and may extend beyond the early childhood period (1–3).

Autism spectrum disorders are life-long neurodevelopmental disorders characterized by impairments in three domains of functioning: social behavior, communication abilities, and restricted, repetitive or stereotyped patterns of behavior. ASD currently affects one in 150 children in the US (4), a prevalence that has quadrupled in the last 20 years. The implications of this rise in prevalence is on the scale of an epidemic, but as yet no definitive cause has been determined, and the efficacy of specific interventions are not yet clear. Parents of children with ASDs report many challenges with children’s daily activities, behavior, and communication. Parents also frequently express concern related to mealtimes.

Parents of children with ASDs often report that their children are highly selective eaters, with very restricted repertoires of food acceptance that may be limited to as few as five foods. Management of food selectivity and concerns about dietary adequacy have been found to be a major reason for referral of children for nutrition services (5). Picky eating, also referred to as food selectivity, is a significant problem because it may be associated with inadequate nutrition as a result of the restricted diet (6–12).

Despite considerable anecdotal evidence and case reports to support that food selectivity is a significant problem in children with ASDs, only a few empirical studies have compared food intake and eating patterns of children with ASDs to that of typically developing children or other clinical populations. Furthermore, food selectivity has not been operationally defined in a consistent manner and has been used to refer to picky eating, frequent food refusals, limited repertoires of foods, excessive intake of a few foods, and selective intake of certain food categories such as carbohydrates. In this narrative literature review, studies that have examined the phenomenon of food selectivity and nutritional intake in children with ASDs are reviewed. Numerous anecdotal reports and autobiographies of individuals with ASDs suggest that sensory factors such as smell, texture, color, and temperature can contribute to food selectivity. Thus, we have included in our review the literature on sensory sensitivity in children with ASDs and explore how this may be an important dimension in understanding food selectivity. This paper concludes with a discussion of the need to understand food selectivity in this population and the importance of an interdisciplinary approach in addressing the needs of children who demonstrate significant food selectivity.

METHODS

The search used the electronic data bases of Medline, Cinahl, PsychInfo and Web of Science to locate pertinent literature published in English in the last 25 years. In the food selectivity and nutrient intake sections, search term combinations included a population term (autism, autism spectrum disorder, Asperger, pervasive developmental disorder) and a food-related term (food, feeding, mealtime, selectivity, picky, eating, nutrient, nutrition). In the sensory processing section, the population term was combined with a sensory term (sensory, reactivity, response, tactile, oral, gustatory, olfactory). Reference lists of the papers obtained were manually searched for additional references. Studies with empirical data were included; single subject intervention studies designed to modify eating behavior were not

included nor were case studies. A limited number of research studies on food selectivity in children with ASD were identified. This included 12 articles, five without a comparison group, four with a typical comparison group (two used the same sample), and three with a special needs comparison group. An even more limited number of studies on nutritional status/diet adequacy in children with ASD were identified; three studies were identified that did not include a comparison group and four studies included a control group with typically developing peers. Of these studies, three examined both food selectivity and nutritional adequacy. Almost all studies were based on food records, questionnaires, or interviews involving parent report. Only one study observed actual food intake in which the type of food was manipulated. Due to the small number of studies, all were included in the review. (See Tables 1 and 2 for a summary of studies.) Parent and client reports using books, web sites, and contacts with individuals with autism were also examined to provide anecdotal reports to illustrate points.

Food Selectivity in Children with Autism Spectrum Disorders

Studies examining food selectivity in children with ASD include: those with an ASD group only, those with a typically developing comparison group, and those with a comparison group of children with other special needs. In the UK, Cornish (6) examined the diets and weight status of 17 children with ASDs, ages 3 to 10 years, and found that 10 of the 17 children (59%) ate fewer than 20 different foods. In a survey sent to parents of 43 children and adolescents with ASDs 4 to 26 years about dental treatment, oral hygiene behavior, and nutrition, including food preferences and eating patterns, Klein and Nowak (13) found that 53% of the participants were reported to be reluctant to try new foods. Williams et al. (12) surveyed 100 parents of children with ASDs ages 22 months to 10 years; 67% of the parents reported that their child was a “picky eater”, in spite of the fact that nearly three quarters (73%) reported that their child had a good appetite for foods that they liked. This suggests that picky eating is not associated with a lack of appetite. The authors reported that the factors parents felt influenced food selectivity were: texture (69%), appearance (58%), taste (45%), smell (36%), and temperature (22%). The most frequently reported eating and oral behavior problems were reluctance to try new foods (69%), resistance to taking medicine (62%), eating too few foods (60%), mouthing objects (56%), and rituals surrounding eating (46%). Similarly, in a qualitative analysis of parent reports of 100 children with ASDs (79 children with autism, 21 with Asperger syndrome) ages 2 to 16 years, Whiteley et al. (14) found that eighty-three percent (83%) of parents reported that their child ate a restricted repertoire of foods as their core diet. Physical texture or consistency of food was often cited as the underlying factor in the choice of foods, although characteristics of food such as the brand, product name, or packaging/wrapping were also reported as determining factors. While these studies indicate that a high percentage of children with autism are selective eaters, the lack of a comparison group makes it is difficult to tell whether these characteristics more prevalent in children with ASD than in a sample of typically developing children.

Raiten and Massaro (10) published one of the first studies designed to compare the dietary intakes of children with ASDs and typically developing children. In their study of 40 children with ASDs and 34 typically developing children, the authors found that children with ASDs were more likely to adhere to the same foods and to show more food preferences than their typically developing peers. However, no statistical analyses were reported to indicate whether these differences were significant.

In a more recent and larger scale study, Schreck et al. (15) compared food selectivity in 138 children with ASDs and 298 typically developing controls, ages 7.0–9.5 years. Parents completed a food preference inventory developed by the author to assess the extent to which children ate a variety of foods. Parents of children with ASDs reported that their children

refused significantly more foods and had a less varied diet than did parents of children without ASDs. In addition, the children with ASDs were reported to eat fewer foods within each food group category; in general, children with ASDs ate about half the number of foods in each food group except starches, where they ate about two-thirds the number of foods as typically developing children. Children with ASDs also were significantly more likely to accept only low-texture foods such as those that had been pureed. The authors concluded that children with ASDs had a significantly greater degree of food selectivity than typically developing children. Using the same data set in a subsequent analysis, Schreck et al. (16) reported that most of the restricted food intake in children with ASDs could be attributed to food presentation, such as different food items touching on a plate or specific utensil requirements. Across all food groups, children with ASDs ate fewer types of foods than did other members of their family. However, food preference (as defined by the number of different foods eaten) was also found to be related to the family's food preferences. In this study, as in the other studies described above, food selectivity remained broadly defined, and food texture was not defined.

In a study to examine the eating behaviors and nutrient intakes of children with ASDs, Schmitt and colleagues (11) asked the parents of 20 boys with ASDs and 18 typically developing boys ages 7–10 years to complete a questionnaire on eating behaviors and food preferences and a 3-day food record. Boys with autism spectrum disorders ate a considerably smaller variety of foods than controls (17±6 vs. 22±6 over a three-day period) and more often made their food choices based on texture than did the boys in the control group. Seventy percent of children with autism chose their food based on texture, compared to 11% of children without autism. Further, the parents of boys with ASDs reported having greater difficulty getting their child to eat. Boys with ASDs also had a particular aversion to mushy food. However, the authors did not provide any specific information on how they categorized food to determine variety or how they defined mushy foods since the sensory characteristics of "mushy" food are not clear. In addition, there were no diagnostic criteria for autism; it was determined by parental report.

Several studies have compared food selectivity in children with ASDs to that of children in other clinical populations. In a retrospective chart review of 349 children ages 1 month to 12 years referred for a feeding evaluation (225 had developmental disabilities, 26 had ASDs), Field et al. (17) found that the prevalence of food selectivity by type of food was significantly higher for children with ASDs than the other children in the study. However, information was obtained from a chart review based on interdisciplinary team evaluations and medical records, but no specific information was provided on how assessments were made.

In another study on food selectivity in children with ASDs and other developmental disabilities, Williams et al. (18) conducted a review of 178 children with and without developmental disabilities, ages 2 to 12 years, referred to a feeding program for selective eating. The sample included three groups: typically developing (n=69), ASDs (n=64), and other special needs (n=45). The evaluation incorporated a food frequency questionnaire which asked parents to report how many foods their child had eaten and also included a 3-day food record. The authors did not find differences between groups in the types or variety of foods consumed. However, the authors categorized their data by food group and did not appear to assess the numbers of different foods independent of food group that the child ate. Furthermore, all the children studied were referred for selective eating; therefore, it cannot be determined whether picky eating is more common in children with ASDs.

Using a parent interview, Dominick et al. (19) studied the prevalence of atypical behavior, including atypical eating behavior, in 67 children with ASDs and 39 children with a history

of language disorders, ages 4–14 years. Atypical eating behavior was defined as food refusal, selectivity, or unusual behaviors or rituals associated with mealtimes. In the sample of children with ASDs, more than three quarters showed atypical eating behavior compared with only 16% of the children with a history of language disorders. Sixty-three percent (63%) of the children with ASDs were reported to eat a restricted range of foods. Over 30% of parents of children with ASDs reported that their child showed a preference for food based on textures. Problems were reported to have begun in the first year of life, with almost all the children demonstrating these behaviors prior to age 3. At the time of the study, 88% of children continued to have atypical eating problems, indicative of a persistent problem.

Whereas the studies reported above all were based on parent report, Ahearn et al. (20) conducted a laboratory-based observational study of food acceptance in 30 children, ages 3 to 14 years, with autism or pervasive developmental disorder-not otherwise specified (PDD-NOS). Children were seen for six separate sessions during which time their acceptance of 12 foods from four different categories of food (i.e., fruit, vegetable, starch, or protein) was assessed. Each session consisted of six consecutive presentations of each of four food items, one from each category. One of the four foods was offered in a pureed form. Food acceptance was determined and categorized as low, moderate, or high, depending upon the number of bites of food the child took. Food selectivity was classified as over-selective, moderately selective, or mildly selective, based on bites accepted within a food group. There was also an additional category for texture selectivity. Seventeen of the children were categorized as having low food acceptance, and 17 were categorized as being selective for either food type or texture. The authors reported that the findings were significant based on a chi-square analysis. These findings support the hypothesis that food selectivity is high in children with ASDs. The authors point out that food was offered as bites rather than servings which may have altered acceptance. Additionally, four children refused all foods presented during the assessment; however, these children were reported to accept at least two of the food items at other times. It was suggested that this discrepancy may have been the result of a new environment with unfamiliar staff and an unusual feeding procedure.

The studies described above indicate that food selectivity is a significant problem for many children with ASDs. However, the lack of a clear definition of food selectivity, the small numbers of children in most of the studies, and the lack of a control group make it difficult to draw conclusions regarding the magnitude and impact of the problem.

Food selectivity and nutritional adequacy

Restricted intakes of food can lead to nutritional insufficiency if the types and variety of foods remain restricted. This makes food selectivity a potential health risk. However, despite the widespread concern over food selectivity in children with ASDs, only a few studies have actually assessed the nutritional adequacy of these children’s diets and they have revealed mixed findings. Two of the studies that reported a high degree of food selectivity in children with autism also assessed the nutrient adequacy of the children’s diet. Raiten and Massaro (10) analyzed a 7-day diet record for 40 children with ASD and 34 typically developing children. They also assessed caregivers’ perceptions of their children’s eating habits and clustered these into the categories of sameness, specific eating behaviors, and specific food preferences. Despite the fact that there were higher numbers of children with ASDs in each cluster, they found no difference in the adequacy of the nutrient intakes between the two groups. However, overall adequacy of the diet based on nutrient needs was not provided.

In a small study, Schmitt et al. (11) compared the nutrient intake of 20 boys with autism and 18 controls 7–10 years of age using a 3-day food diary. There was no difference in nutrient intake between the two groups, although as noted earlier, the eating behaviors differed among the boys with ASD and the controls. In another small study of children ages 3 to 5

years with and without ASDs, Lockner et al. (9) found that most children met the EARs for selected nutrients. However, a greater proportion of children with ASDs was below the EAR for vitamin A.

In contrast, Cornish (6) reported inadequate nutrient intakes in children with autism based on a 3-day dietary recall and a food frequency checklist. Nine of 17 children with autism (53%) had intakes that were below the recommended nutrient intake for one or more nutrients. There was an inverse relationship between variety and nutritional adequacy; as the daily variety decreased, the number of nutrient intakes that fell below the recommended amount increased. Intake of protein, vitamin A, thiamin, vitamin B12, folic acid, sodium, potassium, magnesium, phosphorous, and copper were determined to be adequate for all children. Inadequate intakes of iron, vitamin D, vitamin C, niacin, riboflavin, and zinc were found in one or more children. The majority of children did not consume adequate amounts of fruit and vegetables, but 94% of the children ate foods on a daily basis that the authors considered to be in the “fatty” and “sugary” food groups. Two other studies collected 3-day food records in groups of children with ASDs. Ho and Eaves (12) reported low calcium intake in their sample; however, limited conclusions can be drawn from their data because the overall number of children for whom calcium intake was inadequate was not reported. Information was also lacking on the intake of other micronutrients. Levy et al. (22) only reported on the macronutrient content of children’s diets which was found to be adequate in almost all the children. A substantial number of children also had a high protein intake. They provided no information on the micronutrient content of the diets.

In a recent study to examine nutritional intake between children with ASD and typically developing children, Herndon et al. (8) used a 3-day diet record and found that a large number of both children with ASDs and typically developing children consumed less than the recommended dietary intakes for several nutrients, including calcium, iron, vitamins D and E, and fiber. Children with ASDs were also found to have higher intakes of vitamins B-6 and E and lower intakes of calcium than typically developing children. When the analysis excluded children on gluten-free/casein-free (GFCF) diets, these differences were no longer significant, except for higher vitamin B-6 intake in the children with ASDs.

In summary, results of studies of nutrient intake of children with ASDs have produced conflicting results with different studies indicating that the nutrient intakes of children with autism are below, above or the same as children without ASDs. Several studies have compared the intakes of children with ASDs to dietary standards but they did not include a control group so it was not possible to consider what was unique to ASD. Even more importantly, most studies did not compare children with ASDs with and without food selectivity so it was not possible to determine whether food selectivity placed children at risk.

Various factors such as changing definitions of ASDs and parental dietary restrictions such as GFCF diets may influence current findings such that it is not clear if differences between children with ASDs are due to parental dietary restrictions or to food selectivity. Determining nutritional risk of this population is essential to develop strategies to maximize health. Similarly, examining data for individual children is critical given the high variability within this population.

Autism Spectrum Disorders, Sensory Sensitivity, and Food Selectivity

Various factors may contribute to food selectivity and a number of explanations have been proposed (14). One of these factors relates to sensory sensitivity (also referred to as sensory defensiveness or sensory over-responsivity). Ayres (23) first described sensory defensiveness in the tactile domain (tactile defensiveness) in some children with learning

and behavioral disorders. She described tactile defensiveness as an over-reaction to certain experiences of touch, often resulting in an observable aversion or negative behavioral response to certain tactile stimuli that most people would find innocuous. For example, children who show tactile defensiveness often have difficulty being cuddled and pull away from touch. It is possible that early tactile sensitivity may contribute to some of the sensory feeding issues such as difficulty with food textures seen in children with ASDs.

Early descriptive research identified the problem of tactile defensiveness in children with ASDs, although they did not use that terminology. Ornitz and Ritvo (24) described behaviors in children with ASDs that were characterized by the inability to tolerate certain tactile materials such as woolen blankets or clothes that came in contact with their skin. In his initial description of children with Asperger's syndrome, Hans Asperger (1944, cited in 25) also described the sensory over- and under-sensitivities in this population. Numerous individuals with ASDs and their families have identified atypical processing of sensory information (26). Recent research has reported a high prevalence of sensory processing disorders in children across the autism spectrum and at various ages. For example, Leekam (27) reported that in a sample of 200 children with ASDs, >90% had sensory abnormalities and sensory symptoms and that these occurred in multiple domains. In particular, the proximal domains of touch and smell/taste distinguished autism and non-autism groups. Dunn, Myles, and Orr (28) examined the differences between children with Asperger syndrome and typically developing children and found differences on almost all (96%) of the items on the Sensory Profile (29), a parent questionnaire that assesses children's responses to every day sensory activities. Rogers et al. (30) reported that both children with ASDs and children with Fragile X syndrome had more sensory sensitivity symptoms than children with other developmental disabilities or typically developing children. Ben-Sasson et al. (31) examined young children and found that toddlers with ASDs showed high frequency of under-responsivity (89%) and over-responsivity (75%), with 67% of the group showing both under- and over-responsivity. Baranek et al. (32) reported similar findings in a sample of children ages 2 to 7 years with ASDs, although the prevalence was somewhat lower (63% under-responsiveness, 56% over-responsiveness, and 38% both over-responsiveness and under-responsiveness). In a recent meta-analysis, Ben-Sasson et al. (33), reviewed results from 14 studies (of 97 potential studies identified), 13 of which included a comparison group of typically developing children and four of which included a comparison group of children with developmental disabilities. The meta-analysis found significant between-group (ASD:comparison) differences. Mean effect sizes across studies was high and significant, with the majority of 42 individual effect sizes Cohen's d >.81 indicating that children with ASDs were much more likely to have sensory processing challenges than children without ASDs.

Overall, research indicates that sensory issues are extremely common in children with ASDs. In fact, some researchers have argued that atypical sensory processing should be one of the diagnostic criteria of ASDs (26, 34). Sensory issues are seen in very young children, seem to persist, and are seen across a range of severity of ASDs.

Effects of Sensory Sensitivity on Eating

Many researchers as well as individuals with ASDs have suggested that there is a link between the sensory processing problems that a person experiences and difficulties managing daily life (25, 35–37). Eating is one of the areas of daily life activities that may be negatively affected by sensory aversions (1, 3, 12, 29, 38, 39). Oral defensiveness, which may be a component of tactile defensiveness, is defined as an avoidance of certain textures of food and avoidance of activities using the mouth, such as tooth brushing. Tactile defensiveness and oral defensiveness may be part of a larger problem in modulating sensory input which can take different forms. Oral over-responsiveness (defensiveness) may result in

difficulty with food textures and therefore food selectivity. Oral under-responsiveness, in which the child does not appear to adequately perceive sensations, may result in the child over-stuffing his/her mouth. Oral seeking behavior may result in the child putting everything in his/her mouth for the purposes of oral stimulation. Such concerns can be seen in multiple sensory modalities such as hearing, vision, taste, smell, and touch. Of particular interest in this paper is sensory over-responsivity, which may result in a child being a "picky" or selective eater.

Smith et al. (40) studied children ages 3–10 years with and without tactile defensiveness who did not have autism. Using the Sensory Profile (29), the authors reported that children who showed tactile defensiveness had significant differences in eating habits and food choices as compared to children who scored in the normal range. The children with tactile defensiveness were reported to have a fair to poor appetite, hesitated to eat unfamiliar foods, did not eat at other people's houses, and refused certain foods because of smell and temperature. They also were resistant to eating vegetables, with overall vegetable consumption being half that of children without tactile defensiveness. Children with tactile defensiveness also were reported to gag and/or bite their inner lips and cheeks. Furthermore, these children showed more limited selection of foods and had a pronounced aversion toward textures, smells, and temperatures of food compared to children who did not show tactile defensiveness. This study suggested that food selectivity is not a unique characteristic of autism per se, but may reflect sensory defensiveness.

It has been suggested that sensory sensitivity may lead children with ASDs to restrict their intake to food of preferred, tolerable, and manageable textures (1, 3, 12, 17, 20). In the studies described here, the texture of foods was consistently identified as a related aspect of food acceptance, suggesting that sensory sensitivity may be a contributing factor to food selectivity. Attwood (25) pointed out that the resistance to eating certain types of food may relate to texture or smell. For example, olfactory over-responsivity may result in a person becoming highly uncomfortable in the school cafeteria, being bothered by the smells of other children's foods. In describing the effects of food textures, Stephen Shore (41), an adult with high functioning autism, wrote,

> "Canned asparagus was intolerable due to its slimy texture, and I didn't eat tomatoes for a year after a cherry tomato had burst in my mouth while I was eating it. The sensory stimulation of having that small piece of fruit explode in my mouth was too much to bear and I was not going to take any chances of that happening again." (p. 44).
>
> "Carrots in a green salad and celery in tuna fish salad are still intolerable to me because of the contrast in texture between carrots or celery and salad or tuna fish is too great. However, I enjoy eating celery and baby carrots by themselves." (p. 44).

Such narrative descriptions are supported by the parental reports described previously in this paper (12, 14).

In addition to the relation between food selectivity and sensory sensitivity, it is also possible that the mealtime behavior problems frequently seen in children with ASDs may reflect problems with sensory sensitivity. Leekam et al. (27) suggested that particular sensory inputs can cause behavior problems in individuals with ASDs who are unable to describe their distress. Of importance is the finding that sensory-based feeding issues create increased stress and negatively affect family mealtimes and quality of life (1, 42–44). Fiese and Schwartz (45) emphasized the importance of mealtimes since it is the primary daily activity that families share as a group and highlighted the importance of a positive family climate during mealtimes. Child behavior problems during mealtimes increase family stress and are disruptive to the family climate.

In summary, research and clinical observations indicate that food selectivity is a major problem in children with ASDs. One of the consistent themes in the food selectivity literature relates to food textures. It is possible that sensory sensitivity experienced by many children with ASDs may contribute to their difficulty with food texture and resultant food selectivity. Further research is needed to inform appropriate interventions.

Implications for Practice

Evidence to date suggests that food selectivity is a frequently occurring problem in children with ASDs and that their unusual eating patterns may be a significant stressor for their families (1, 44). Some literature suggests that the diets of children with ASDs are nutritionally inadequate, although these findings are mixed. Moreover, research indicates that sensory sensitivity is frequently seen in children with ASDs and may explain their difficulty with food textures, smells, and tastes and may contribute to the development of food selectivity. Greater insight into the factors that give rise to eating difficulties is important because it allows for the design of more focused interventions.

Feeding problems are complex and often multi-factorial. Complex problems are often best addressed using an interdisciplinary approach. In the case of children with ASDs who are displaying highly selective eating patterns, interventions might be devised using the input of a dietitian, an occupational therapist, and a behavioral psychologist. Children with food selectivity are often first referred to dietitians for help with eating and nutrition. Parents are often concerned that their child is not eating a nutritionally adequate diet. Since sensory issues are so common in children with ASDs and may influence feeding and family mealtimes, it is important for dietitians to talk with families about children's responses to different types of sensory input, particularly tactile/texture, gustatory, and olfactory input. If it appears that sensory issues are a concern, the child can be referred to an occupational therapist for an evaluation of sensory processing. The occupational therapist will typically interview the parent and may administer a parent questionnaire such as The Sensory Profile (29), which includes a section on Oral Sensitivity.

If sensory sensitivity contributes to the child's food selectivity, this can be targeted by multiple approaches. Occupational therapists can help parents understand that the child's seemingly uncooperative behavior and limited food repertoire may actually be the result of sensory sensitivities that can cause great discomfort, and that the child's food refusals may reflect an attempt to cope or compensate for this discomfort (38, 41). Dietitians can identify whether nutritional intake is adequate and can work with parents and occupational therapists to identify alternative foods or alternative food preparation strategies to yield different sensory characteristics that will provide adequate intake of nutrients. Nutritional assessment is essential to the rest of the team members' understanding of how urgent the problem is and what interventions are needed. The initial assessment should include anthropometric measures (height and weight) and comparison to age and sex associated reference data to see how well the child is growing. Significant variation in growth from established reference norms may be related to nutritional inadequacy. The degree of under or over nutrition should be categorized and monitored.

The use of food records and/or 24-hour diet recalls can help provide information on the total intake profile to guide determination of at-risk nutrients (calories, micro and macronutrients). Nutrition support may be needed in the form of vitamin and mineral supplementation. This may be especially true when the child is a selective eater and is on a specific diet such as a gluten-free, casein-free diet. The dietitian or other nutrition professional can also suggest ways to enrich the diet so that every bite contributes to nutritional adequacy in the child's diet. While working on increasing the acceptable foods, nutrition counseling is critical.

Programs and strategies also can be developed to reduce the child's sensory defensiveness (43). For example, occupational therapy using a sensory integration approach can provide activities that incorporate deep touch pressure and proprioception, which have been reported to decrease sensory defensiveness (46, 47). The therapist can also develop social stories (48), sensory stories (49, 50), mealtime stories (51), or written charts (1) to help prepare the child to anticipate different foods. The occupational therapist can make suggestions to modify the environment such as dimming the lights or playing soft music, which can help reduce the child's general arousal levels and facilitate his/her ability to tolerate the sensory stressors presented by food (52). The dietician, occupational therapist, and family can also work with a psychologist to incorporate behavioral approaches to shape the child's acceptance of various food textures (e.g., 53).

Collaboration among dietitians, occupational therapists, and psychologists can enhance the effectiveness of the dietary intervention. Identifying appropriate foods, modifying the sensory characteristics (i.e., texture) of the food, providing appropriate eating utensils, modifying the environment (stimuli), and incorporating supportive behavioral interventions can help facilitate adequate nutrition and reduce family stress at mealtimes, ultimately enhancing the health of the child.

CONCLUSIONS

Food selectivity appears to be a significant issue for many children with ASDs. However, the construct of food selectivity has not been operationally defined and there are not "gold standard" measures. Food selectivity in children with ASDs may occur for a number of reasons. Sensory sensitivity has been suggested as one possible mechanism to explain, in part, the food selectivity of children with ASDs. Further research is needed to examine factors associated with food selectivity including sensory issues, behavior problems, parental preferences, and family mealtimes. Another important area worthy of future research is a critical examination of the effect of food selectivity on nutritional adequacy, which has implications for child health. Finally, it is critical to examine the outcomes of interventions designed to affect food selectivity in children with ASDs and to improve the nutritional status of this population of children.

The criteria for autism spectrum disorders has shifted over time, making it difficult to compare studies and to determine whether subgroups of children with ASDs are at greater or lesser risk for food selectivity and whether this problem attenuates or persists over time. Moreover, the relation of food selectivity, special diets, and nutritional adequacy needs to be examined. Additional research is needed in studies that include carefully characterized participants so that the phenomenon of food selectivity across the spectrum of autistic disorders can be understood.

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Table 1

Summary of research on food selectivity in children with autism spectrum disorders

Author(s), year	Participants	Age (y)	Method
Ahearn and colleagues, 2001 (20)	Autism and PDD-NOS[c] (n=30)	3–14	Laboratory-based
Cornish, 1998 (6)	ASD[a] (n=17) No comparison group	3.6–9.9	3-day dietary recall; food frequency checklist
Dominick and colleagues, 2007 (19)	ASD (n=67) Language impaired (n=39)	4–14	Parent interview
Field and colleagues, 2003 (17)	ASD (n=26) DD[b] (n=225)	1 mo-12 y	Retrospective chart review
Klein and Nowak, 1999 (13)	ASD (n=43) No comparison group	4–26	Parent Survey
Raiten and Massaro, 1986 (10)	ASD (n=40) Typically developing (n=34)	ASD: 10.6±4.3[d] Typical: 8.8±4.8[d]	7-day food record; Questionnaire to measure parental attitudes, beliefs, and knowledge of nutrition
Schmitt and colleagues, 2008 (11)	ASD (n=20) Typically developing (n=18)	7–10	Parent questionnaire; 3-day food record
Schreck and colleagues, 2004 (15)	ASD (n=138) Typically developing (n=298)	7–9.5	Food Preference Inventory; Children's Eating Behavior Inventory
Schreck and Williams, 2006 (16)	ASD (n=138)	4.4–12.6	Food Preference Inventory; Children's Eating Behavior Inventory
Whiteley and colleagues, 2000 (14)	ASD (n=100) No comparison group	2.3–16.2	Parent report
Williams and colleagues, 2000 (12)	ASD (n=100) No comparison group	1.8–10	Parent survey
Williams and colleagues, 2005 (18)	ASD (n=64) DD (n=45) Typically developing (n=69)	2–12.4	Parent report; Food frequency questionnaire; 3-day food record

[a] ASD = autism spectrum disorders.

[b] DD = developmental disability.

[c] PDD-NOS = pervasive developmental disorder not otherwise specified.

[d] Mean ± standard deviation.

Table 2

Summary of research examining nutritional adequacy of dietary intake of children with autism spectrum disorders

Author(s), year	Participants	Age (y)	Method
Cornish, 1998 (6)	ASD (n=17) No comparison group	3.6–9.9	3-day dietary recall; food frequency checklist
Herndon and colleagues, 2009 (8)	ASD (n=46) Typically developing (n=31)	2.5–8	3-day food record
Ho and Eaves, 1997 (21)	ASD (n=54) No comparison group	13.3[c]	3-day food record
Levy and colleagues, 2007 (22)	ASD (n=52) No comparison group	3–8	3-day food record
Lockner and colleagues, 2008 (9)	ASD (n=20) Typically developing (n=20)	3–5	3-day food record
Raiten and Massaro, 1986 (10)	ASD[a] (n=40) Typically developing (n=34)	ASD: 10.6±4.3[b] Typical: 8.8±4.8[b]	7-day food record; Questionnaire on attitudes and beliefs about nutritional knowledge
Schmitt and colleagues, 2008 (11)	ASD (n=20) Typical (n=18)	7–10	Questionnaire 3-day food record

[a]ASD = autism spectrum disorder.

[b]Mean ± standard deviation.

[c]Mean age.