
A UTISM SPECTRUM DISORDER (ASD) is characterized by a core deficit in social communication with concomitant repetitive/perseverative behaviors and restriction in interests, and individuals with ASD experience varying degrees of impairment. The estimated prevalence of ASD in pediatric populations has climbed dramatically during the past decade, with approximately 1 in every 68 children currently meeting diagnostic criteria in the United States. High prevalence occurs against a backdrop of increased health care costs and social burden. Medical comorbidities are significantly over-represented compared with other pediatric populations, and children with ASD often present with medical conditions affecting multiple organ systems. Dysfunction of the gastrointestinal (GI) tract is among the most frequently cited comorbidities. A recent meta-analysis indicated that children with ASD were four times more likely to experience general GI complaints, are more than three times more prone to experience constipation and diarrhea, and complain twice as frequently about abdominal pain compared with peers. Lack of data prevented analysis of other GI symptoms (eg, gastroesophageal reflux, celiac disease, lactose intolerance) typically associated with organic etiologies; however, a 2010 consensus report concluded that, at a minimum, rates of other GI pathophysiology in ASD should be viewed as occurring at similar levels to those observed in the general population. This includes consideration of the potential contribution of factors such as GI motility, altered gut microbiome, immune abnormalities, and food allergy when GI symptoms are detected. In addition to calling for greater research scrutiny in this area, the expert panel of pediatric gastroenterologists also emphasized the need to develop evidence-based standards for the evaluation and treatment of GI symptoms in ASD.

Nutrition management is often critical in the treatment of GI symptoms in other pediatric populations, however, no guidelines are available for adapting existing practices for use among children with ASD. Current standards of care might be neither practical nor feasible, given the combination of behavioral, developmental, medical, and social deficits associated with the condition. For example, children with ASD often present with limited communication and, as a result, their symptom presentation may be unusual compared with that of their peers. In many cases, GI symptoms might only manifest as a change in behavior, such as the emergence or exacerbation of problem behaviors like aggression, self-injury, sleep disturbance, or irritability. As a result, recognition and treatment of GI disorders in children with ASD remain ill-defined and poorly understood, particularly when it comes to the challenge of untangling the relative contribution of diet when underlying GI pathology is suspected.

The diagnostic and intervention process is further complicated by the high prevalence of feeding problems in ASD. Evidence suggests children with ASD have a fivefold increase in problematic eating and feeding behaviors compared with typically developing peers. Food selectivity, defined as a limited food repertoire (eg, only eating a few foods and/or rejection of one or more food groups) or high intake of a single food, is the most frequently documented feeding issue associated with ASD. Dietary intake in ASD often involves strong preferences for highly processed foods, snacks, and sweets, and a lower intake of fruits and vegetables. High intake of simple carbohydrates and fat coinciding with low intake of fiber complicates the diagnostic process, making it difficult to determine whether food selectivity directly contributes to the onset of GI symptoms or simply exacerbates a preexisting GI condition. For example, a child may be constipated due to poor motility as the result of impaired gastric emptying and/or low muscle tone, with more severe symptom presentation in cases involving poor dietary diversity. Additionally, constipation could be the direct result of a diet lacking in fruits, vegetables, and whole grains and, therefore, low in fiber and fluid. In both cases, nutrition intervention can improve overall

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symptom presentation, however, a more detailed medical workup (e.g., allergy, GI) would also be necessary if possible organic etiology is suspected.

When developing a nutrition intervention, food selectivity may place limits on introducing and/or removing foods from the diet. Specifically, restricted patterns of intake in ASD are often maintained by refusal behaviors (e.g., tantrums, aggression) in response to the presentation of nonpreferred foods or novel feeding demands.20 As a result, caregivers may be unable to adhere to clinical recommendations due to the intensity of their child’s behavioral response to the new therapeutic diet. In addition, it may be difficult to anticipate how a child will respond to efforts to remove and/or replace preferred foods, including the possibility of further self-imposed dietary restriction after intervention beyond targeted foods. With this in mind, the clinician must determine how to best manage the child’s nutrition while considering his or her overall medical status.

Nutrition management must also account for the proliferation of caregiver-mediated dietary restrictions in the ASD community. Children with ASD are significantly more likely to be placed on caregiver-initiated complementary/alternative diet therapies as compared to peers.21 Common dietary interventions applied in this population are listed in Figure 1. In general, these diets restrict or completely eliminate certain food groups. For example, the gluten-free, casein-free diet, arguably the most well-known type of dietary manipulation in ASD, eliminates gluten (found in wheat, barley, and rye) and casein (found in cow’s milk dairy products).28 Without the guidance of a registered dietitian nutritionist (RDN), this level of restriction may increase the risk of macronutrient and micronutrient deficiencies in a population already prone for underlying dietary insufficiencies related to food selectivity.14 and the potential for further nutritional deficits and associated health concerns presents unique challenges for designing interventions. When a caregiver-initiated or other restrictive diet is in place, the RDN must work with the family to determine which foods (if any) can be added, removed, and/or reintroduced to alleviate GI concerns, while concurrently attempting to best meet nutrition needs. Many caregivers, however, may be resistant to incorporate recommendations that involve the reintroduction of currently restricted foods. If specific foods previously removed place the child at nutrition risk and cannot be reintroduced, appropriate substitutions need to be identified; although this may be difficult in cases involving extremely limited food repertoires and resistance to the introduction of new foods.

The unique dietary, medical, and behavioral challenges observed in children with ASD combined with an overall lack of data on management of GI disorders in this population14 presents a pressing need to develop a guideline for nutrition intervention. Consistent with previous work to develop standards of care in ASD,11 expert opinion was viewed as a critical first step in this process, given the absence of relevant data. Therefore, a committee of RDNs specializing in the nutrition care of children with ASD was formed and a focus group was conducted to develop a clinical practice guideline. This article describes the process of convening the expert committee, outlines considerations for adapting existing nutrition practice, and presents a guideline for the nutrition management of GI symptoms in children with ASD.

### Diet  Foods restricted

<table>
<thead>
<tr>
<th>Diet</th>
<th>Foods restricted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination diets/elemental diet22,23</td>
<td>Elimination diet (6 foods): milk, egg, wheat, soy, peanuts/tree nuts, fish/shellfish</td>
</tr>
<tr>
<td>Fermentable oligo-disaccharides and polyols24,25</td>
<td>Elemental: all foods except an amino acid-based formula</td>
</tr>
<tr>
<td>Food coloring/food additives avoidance26,27</td>
<td>Foods containing fructose (eg, fruit, high-fructose corn syrup), lactose (eg, cow’s milk dairy), fructans (eg, wheat, onion, garlic), galactans (eg, legumes), and polyols (eg, sorbitol, cherries, avocados)</td>
</tr>
<tr>
<td>Gluten-free, casein-free28-30</td>
<td>Foods containing gluten (eg, bread, pasta) and casein (eg, cow’s milk, yogurt)</td>
</tr>
<tr>
<td>Ketogenic diet or modified Atkins diet31,32</td>
<td>Carbohydrate-rich foods, including sugar</td>
</tr>
<tr>
<td>Specific carbohydrate diet29,33,34</td>
<td>Cereal grains (eg, wheat, oats, rice), processed meats (eg, lunch meats, hot dogs), canned vegetables, canned fruits, most fruit juices, soy beans, chick peas, bean sprouts, mung beans, fava beans, yogurt, milk, processed cheese, tubers (eg, potatoes, yams), curry, onion powder, garlic powder</td>
</tr>
</tbody>
</table>

Figure 1. Possible caregiver-initiated restrictions in autism spectrum disorder (in alphabetical order).

### FOCUS GROUP MEETING AND ALGORITHM DEVELOPMENT

The first step toward creating a standard of care for RDNs to use when working with children with GI symptoms and ASD involved identifying experts in the field. Our search process consisted of contacting major autism treatment centers in the United States, listserv solicitation through the Autism Speaks’ Autism Treatment Network, and comprehensive review of the literature. The selection criteria required committee members to be certified as an RDN; spend at least 25% of professional time engaged in clinical nutrition activities (assessment and/or treatment) with children with ASD; have practiced in the field of nutrition for at least 3 years; and possess experience (past or current) working in a multidisciplinary environment (eg,
medical or research center, feeding clinic. The final six-member committee (authors Berry, Novak, Withrow, Schmidt, Rarback, and Feucht) has a combined 125 years of clinical experience working in the field of nutrition and with children with ASD.

Once identified, the expert panel assembled for a focus group in August 2014. A trained facilitator moderated the meeting using a semi-structured interview guide to elicit information about nutrition management of GI symptoms in this population. The committee subsequently used this information to develop clinical practice recommendations for conditions in which nutrition management is clinically indicated based on established models of care. [22] Available guidelines and algorithms for constipation management in children [13, 22] served as templates for an ASD-specific algorithm and accompanying text. The Pediatric Nutrition Care Manual, [29] which provides evidence-based practice guidelines for pediatric RDNs working in a variety of clinical settings, also informed the development process. To ensure relevant evidence was not omitted from the algorithm, comprehensive literature reviews regarding GI concerns, [7] prevalence of feeding problems, [6, 4] and treatment of feeding disorders [36] in ASD were reviewed for additional data.

DESCRIPTION OF THE ALGORITHM

Evaluation and intervention recommendations were designed to assist clinicians with navigating potential barriers associated with food selectivity, caregiver-initiated complementary/alternative diet therapies, and/or nutritional deficits/excesses often observed in this population. [14, 37] The committee also emphasized the importance of a multidisciplinary approach during assessment and intervention to elucidate the causal relationship between nutritional intake and possible organic etiology, as well as provide complementary treatment avenues in cases involving severe food selectivity and/or lack of response to dietary intervention. This included coordinating care with input from medicine, behavioral psychology, occupational therapy, and speech-language pathology. [20] Finally, the committee highlighted the need to consider a child’s possible behavioral response (eg, tantrums, aggression) to changes in mealtime routine (eg, introduction of novel or non-preferred feeding demands) when planning an intervention.

The derived algorithm describes 11 steps in nutrition evaluation and management of GI concerns in children with ASD to guide development and application of a prescriptive diet (Figure 2). A smooth-edged box represents a starting or ending point, a diamond shape indicates a question or decision, and a sharp-edged box corresponds to specific action or process undertaken by the clinician. Each shape is assigned a number that corresponds to accompanying text providing further detail (Figure 3). The algorithm begins with development of a prescriptive diet to alleviate GI dysfunction, which involves identifying potential barriers (ie, food selectivity, caregiver-initiated restrictions, gaps in knowledge) that would limit possible therapeutic foods. In cases involving dietary restriction (either child- or caregiver-mediated), the RDN must determine whether there is enough flexibility within the diet to develop an intervention. If foods are available, the prescriptive diet involves working within the confines of dietary restriction to increase daily servings of target foods and/or concurrently reduce intake of highly preferred food items (eg, crackers, chips). In cases involving severe food selectivity (ie, eating fewer than six different food items), nutrition therapy should occur concurrently with feeding therapy. During the assessment process, the RDN can help to identify safe foods as well as determine which foods might be causing the child pain and should therefore be avoided. Feeding therapy focuses on acceptance and increased (or decreased) intake of targeted foods for the dietary intervention. [20, 39] Greater flexibility with meal planning is possible for cases in which a family is willing to consider modifications to previously recommended and/or implemented diets. In such cases, the RDN has a greater palette of foods available with which to create a prescription diet to address GI symptoms consistent with medical nutrition therapy guidelines. [29] With this said, insistence on sameness and behavioral rigidity are core features of ASD [7] and the possibility of a reaction to the therapeutic diet should be considered throughout the assessment and treatment process. If a strong reaction is anticipated, caregivers are resistant to or are unwilling to modify or discontinue a current dietary treatment (eg, gluten-free, casein-free), and/or no foods can be identified for intervention, alternative medical strategies should be considered in consultation with a pediatric gastroenterologist.

The algorithm also involves determining whether there are remaining gaps in the diet that need to be targeted by feeding intervention and/or the use of nutrition supplementation before arranging follow-up care. Supplementation in the form of vitamins and/or minerals, in cases of micronutrient deficits, or nutritionally complete drinks, in cases of energy deficits and/or macronutrient deficits in addition to micronutrient deficits, may be indicated if the child is not able to consume a nutritionally complete diet using food alone. This may be due to caregiver restriction or medically indicated elimination (ie, allergy/intolerance). Consistent with nutrition therapy in the general population, this should include use of elemental formula when medically suggested for conditions such as eosinophilic esophagitis (EoE), milk-protein intolerance, and multiple food allergies. The use of supplementation should also be considered if the current diet does not meet nutrition needs due to food selectivity, while concurrently referring to feeding therapy. As noted in the algorithm (Figure 3), the nutrition assessment should include screening for food intolerances, food allergies, and foods causing GI discomfort. Finally, to help practitioners apply this approach in the community setting and support future evaluation of the algorithm, descriptions on the application of the model with constipation and EoE were completed (Figure 4). Constipation was selected because it is one of the most common GI disorders among children with ASD [31]; EoE was chosen as an example due to established evidence regarding dietary intervention as a treatment for this GI disorder. [40]

IMPLICATIONS FOR CLINICAL PRACTICE

Greater risk of general GI symptoms among children with ASD is well
Figure 2. Algorithm for nutrition management of gastrointestinal concerns in children with autism spectrum disorder.
**Box Details**

1. Full nutrition assessment after referral to address GI symptoms. In addition to a standard assessment (ie, food intake analysis, anthropometrics, labs), assessment should include detailed discussion and identification of potential foods that may be causing an adverse reaction in the child. This includes assessment of known food allergies, as well as evaluation of risk for additional food allergies, food intolerances (ie, lactose intolerance), and other potential adverse reactions to foods (ie, celiac disease).

2. Food selectivity is present if child has a limited food repertoire, high-frequency consumption of a few foods, and significant problem behaviors, including, but not limited to crying, leaving the meal, gagging, aggressing, and/or vomiting when nonpreferred foods are presented.

2a. Full assessment of dietary repertoire, including detailed examination of foods accepted by major food group (fruits, vegetables, meats/beans, dairy, grains).
   - Include questions to determine the volume and frequency of intake.
   - Assess responses to changes in meal routines, such as environment, temperature, method of presentation, and food type/texture presented.

2b. Current list of accepted foods evaluated to determine if consistent with proposed medical nutrition therapy guidelines.

3. Caregiver-initiated diet includes alternative diet therapies (eg, gluten-free, casein-free) and medically prescribed diets (eg, hypoallergenic).

3a. Discuss with caregiver acceptability and ability to veer from current dietary plan. This precludes medically indicated diets based on underlying organic pathology (eg, celiac disease, food allergy).

3b. Full assessment of acceptable foods within dietary restrictions, including detailed examination of foods accepted by major food group (fruits, vegetables, meats/beans, dairy, grains).
   - Include questions to determine the volume and frequency of intake.
   - Assess behavioral response to changes in meal routines, such environment, temperature, method of presentation, and food presented.
   - Consider how dietary changes will impact development and social inclusion.

3c. Clinician works to find foods that are congruent with dietary repertoire and will meet medical nutrition therapy guidelines for GI symptoms.

3d. If nutrition intervention is not possible based on restrictions, a two-pronged approach is warranted:
   - Assess for any nutritional insufficiencies and whether supplementation is indicated.
   - Determine the most effective method to assure formula acceptance.
   - Refer to medical provider to consider alternative treatment approaches.

4. No level of dietary restriction (food selectivity or caregiver-initiated) identified. Caregiver and child will be able to follow recommendations as outlined by registered dietitian nutritionist.

4a. Typical nutrition assessment of factors influencing nutritional status, such as meal planning, food security, and ability to prepare food. Additional barriers to consider can include the child’s general behavior, sensory processing, cognitive development, communication skills, oral health and motor planning, family socioeconomic circumstances, and community support and resources.

4b. Assess whether barriers fall within the scope of dietetics. Concerns falling outside of scope include need for parent training to address disruptive behavior, motor dysfunction, sensory concerns, and/or possible neglect.

4c. If nutrition intervention is not possible based on restrictions, a two-pronged approach is warranted:
   - Refer to feeding team.
   - Refer to medical provider to consider alternative treatment approaches (including nonoral feeds, if indicated).

5. Treatment approach involves using only preferred foods to create a prescription diet to address GI concerns. Volumes of foods typically presented might be adjusted to meet treatment needs.

*(continued on next page)*

**Figure 3.** Accompanying text for algorithm for nutrition management of gastrointestinal concerns in children with autism spectrum disorder.
documented, yet much remains unknown regarding the recognition and treatment of these concerns due to lack of conclusive research on this topic. Dietary modification often plays a central role in managing GI symptoms in pediatric populations, as highlighted by a recent guideline for treating constipation in children with ASD. Clinical experience and review of the literature, however, suggest that high prevalence of food selectivity combined with frequent use of caregiver-initiated dietary restrictions necessitates modifications to existing practice. By combining data from clinical expertise and the extant literature, an expert committee established an algorithm for applying evidence-based nutrition practice guidelines to the evaluation and management of GI symptoms in ASD. In doing so, the project represents a critical first step toward developing standards of care that take into consideration the unique combination of dietary restriction and related medical/nutrition concerns in this population.

As emphasized by the algorithm, nutrition management in ASD should involve a tiered approach. This involves first identifying and working through barriers that might impede the development of a prescriptive diet (eg, food selectivity) targeting GI concerns, followed by a more general focus on assuring that all nutrition-related concerns are evaluated and addressed during the course of intervention. Multidisciplinary collaboration in the evaluation and treatment process is also recommended, including coordinating care with a pediatric gastroenterologist, as well as involvement of feeding therapy in cases where severe food selectivity and/or behavior management during meals falls outside the RDN's scope of practice. At this time, behavioral intervention is the only treatment for severe food selectivity in ASD with well-established empirical support, yet treatment must also consider factors influencing eating, such as GI discomfort, food allergies, sensory processing, and oral-motor skills, during assessment and intervention to maximize effectiveness.

Finally, RDNs should assess a child's possible behavioral response (eg, tantrums, aggression) to change in the meal, a consideration that should be foremost in the minds of clinics when planning intervention, given the ubiquity of feeding problems in this population. A practice guideline of this nature reflects a more general need to further elucidate the role of nutrition management in ASD. Diet and ASD are frequently linked due to the prevalence of food selectivity, frequent use of diet as a complementary/alternative treatment avenue in this population, and an increased incidence of GI symptoms. In addition, food selectivity increases the risk of nutrition and/or medical concerns in ASD, including significant specific deficits (eg, lower intake of calcium and protein) and a higher number of overall nutritional deficits. This risk, however, may go undetected in pediatric settings without a detailed examination of nutrient intake because it does not necessarily translate into compromised growth or decreased energy intake, which typically trigger attention in pediatric settings. Evidence indicates that excessive consumption of processed snacks and calorie-dense foods is associated with overweight and obesity, which, in turn, is associated with increased prevalence of diet-related diseases (eg, obesity, cardiovascular disease) in both children and adults. Children with ASD experience obesity at higher rates compared to peers. A recent large-scale chart review suggests this trend extends into adulthood. When compared to typically developing peers, adults with ASD experienced a 69% higher incidence of obesity, 42% greater risk of hypertension, and 50% increase in diabetes. This highlights the need to enhance involvement of RDNs in the broader diagnostic and treatment process, which would necessitate more definitive guidance regarding the timing and scope of...
involvement (possibly in a manner similar to the current algorithm) in order to maximize the contribution and subsequent benefit of nutrition management in ASD.

Finally, recommendations were designed to provide clinicians with a general roadmap for nutrition intervention in ASD vs a model for counseling caregivers on the merits and risks of elimination diets. Clinicians, however, will likely encounter this topic in practice, particularly when making inquiries about the use of and possible deviation from caregiver-initiated complementary/alternative diet therapies. With this in mind, an overarching consideration for nutrition management in ASD is to assure a healthy and well-balanced diet. In general, complementary/alternative

<table>
<thead>
<tr>
<th>Condition</th>
<th>Nutrition Treatment</th>
<th>Autism Spectrum Disorder – Specific Considerations (Algorithm Box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constipation</td>
<td>Increase fluid and fiber in the diet (fruit, vegetables, whole grains)</td>
<td>Will the child eat fruits, vegetables, and whole grains (2)? If yes, are there enough accepted foods in the diet to create a nutritionally adequate diet (7)? If no, should the child be referred to feeding therapy (8)? Are some whole-grain products restricted by caregivers (3)? Is the caregiver open to adding whole-grain products to the diet (3a)? Are there other sources of fiber in the child’s diet (3c)? Does the caregiver know to offer fruits, vegetables, and whole grains (4)?</td>
</tr>
<tr>
<td>Daily physical activity</td>
<td></td>
<td>Does the child resist activity (4a)? Does the child have motor-planning concerns that require a specialist to determine physical activity options (4b)?</td>
</tr>
<tr>
<td>Add a bulk-forming agent/prebiotic/probiotic to child’s daily regimen</td>
<td></td>
<td>Will the child take the supplement (2)? Does adding the supplement to food or drink increase the risk of refusal (2a)?</td>
</tr>
<tr>
<td>Eosinophilic esophagitis</td>
<td>Correct nutritional deficiencies</td>
<td>Will the child eat the foods identified to correct nutritional deficiencies (2b)? Is the child only eating pureed foods due to difficulties swallowing? Are these foods commercially prepared infant foods (2)? Is the RDN able to create a nutritionally complete diet given this selectivity (7)? Will the child eat appropriate volumes of less preferred foods to meet nutrition needs (5)?</td>
</tr>
<tr>
<td>Eliminate allergens in the diet</td>
<td></td>
<td>Are there enough foods in the child’s repertoire once allergens have been eliminated (2b)? Is the allergen-free diet in conflict with a caregiver-initiated diet (3)? Does the child need a supplement due to number of allergens (9) and will the child accept the supplement (2)?</td>
</tr>
<tr>
<td>Counsel on elimination diet</td>
<td></td>
<td>Are there enough foods in the child’s repertoire once allergens have been eliminated (2b)? Will the child need to participate in feeding therapy to consume enough foods to create a nutritionally complete diet (8)? Should supplementation be considered, given diet inadequacies (9)?</td>
</tr>
</tbody>
</table>

Figure 4. Practical application of nutrition-management algorithm for gastrointestinal symptoms in autism spectrum disorder with constipation and eosinophilic esophagitis.

*RDN=registered dietitian nutritionist.*
diets target core features of ASD (i.e., impairments in social communication, restriction in interests, and repetitive behaviors) as opposed to treating underlying GI concerns. Many different dietary treatments have been proposed to treat ASD, yet empirical investigation has not substantiated the use of dietary manipulation as an ASD-focused treatment. Without RDN guidance, the associated risks of these diets may outweigh the benefits. For example, provisional evidence suggests that use of a gluten-free, casein-free diet can lead to greater deficits in bone development among children with ASD. Despite the lack of evidence on the effectiveness of dietary intervention to influence behavioral expression of ASD, Elder and colleagues report that parents chose to continue with the diet after study conclusion due to perceived benefit, reinforcing the importance of nutrition management to assure a child’s diet is nutritionally adequate.

**FUTURE DIRECTIONS**

The use of the algorithm proposed here provides a structured approach for management of GI symptoms in ASD and is intended to serve as a tool to individualize treatment to address GI symptoms, while lessening the risk of exacerbating potential nutrient deficiencies due to behavioral feeding concerns and caregiver-initiated restriction. Although there are unique barriers in working with children with ASD, the overarching goals of medical nutrition therapy are the same as they are in the general population: to provide adequate intake of macro- and micronutrients to promote optimal growth and development. Development of recommendations was based on expert opinion and clinical experience due to lack of consensus on nutrition management in ASD. Although constipation and EoE are conditions was based on expert opinion and response to novel feeding demands in this population. With this in mind, this project represents an important first step toward developing and evaluating nutrition-management strategies specifically tailored to the distinct dietary challenges in this population. A detailed algorithm is provided for clinicians in the hope of accelerating adoption of practice recommendations. Moving forward, greater clinical and research scrutiny is needed to increase awareness on this topic and support development of the best standards of care.

**References**


DISCLOSURES

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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