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# Dietary status and nutrient intake of children with autism spectrum disorder: A case-control study

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ABSTRACT

*Background:* Parents and caregivers of children with Autism Spectrum Disorders (ASD) often report that their children are picky or problem eaters. Additionally, it has been reported that children with ASD often experience gastrointestinal problems such as constipation, diarrhea, flatulence, cramping, bloating, and pain. These factors raise concerns for the nutritional status of children with ASD, given that refusal to consume particular foods coupled with the inability to tolerate, digest, and/or absorb these foods can compromise overall nutritional status.

*Method:* This case-control study investigated dietary intake of 86 children with ASD aged 2–8 years and 57 age-matched peers without ASD. Caregivers of participants who met inclusion criteria completed a health history questionnaire, provided information on dietary intake and feeding behavior, and completed a nutrition physical.

*Results:* The majority of participants (both with and without ASD) met or exceeded macronutrient intake recommendations and dietary percentages for total energy, protein, carbohydrate, and fat consumption. Approximately 25% of participants consumed an inadequate or borderline amount of total calories per day based on Dietary Reference Intake (DRI) guidelines created by US Institute of Medicine (IOM). The majority of participants consumed inadequate amounts of vitamins A, D, E, folic acid and calcium. Furthermore, children with ASD consumed lower levels of protein and calcium, and were deficient in a number of B vitamins, including B1, B2, B3, B6, and folate, compared to similarly-aged children without ASD.

*Conclusion:* Given the impact of nutrition on growth and health status, a formal dietary assessment for all children with ASD is recommended.

## 1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that can cause significant deficits in communication and social interaction, and restricted, repetitive, and stereotyped behavior, interests or activities (American Psychiatric Association, 2013). The prevalence of ASD has increased significantly in recent years, with United States (US) prevalence of ASD of 1 in 68 for all children, and 1 in 42 boys (Christensen et al., 2016). Over the past 20 years, studies have identified complex medical comorbidities associated

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with ASD that may play a role in an individual's behavior, including aggression, self-injurious behavior, sterotyped behavior, focus and attention, sleep patterns, and food selectivity (Bauman, 2010; Kohane et al., 2012; Schieve et al., 2012). In fact, children with ASD are more likely to have food selectivity and feeding issues resulting in challenging behaviors surrounding food intake than their typically developing peers (Curtin et al., 2015; S. Mari-Bauset, I. Zazpe, A. Mari-Sanchis, A. Llopis-Gonzalez, & M. Morales-Suarez-Varela, 2014c; Volkert & Vaz, 2010).

Children with ASD have a five-fold elevated risk of developing a feeding problem compared with their peers (Sharp et al., 2013). Food selectivity, defined as the consumption of an abnormally limited variety of food (Dovey, Staples, Gibson, & Halford, 2008) is the most common feeding concern reported in children with ASD (Cornish, 1998; Ledford & Gast, 2006), and may affect nutritional status and growth (Evans et al., 2012; Herndon, DiGuiseppi, Johnson, Leiferman, & Reynolds, 2009; Schwarz, 2003). There are a number of physiological factors, such as impaired sensory-motor processing, perseveration, behavioral rigidity, impulsivity, fear of novelty, cognitive and emotional dysfunction, and biological food intolerance (Coury et al., 2012; Ledford & Gast, 2006; Matson, Matson, & Beighley, 2011; Twachtman-Reilly, Amaral, & Zebrowski, 2008) that may contribute to food selectivity behaviors. Additionally, social reinforcers, such as parental anxiety, communication difficulties, and reinforcement of negative feeding patterns or inappropriate feeding strategies, can also contribute to maladaptive feeding behaviors in children (Field, Garland, & Williams, 2003; Shaw, Garcia, Thorn, Farley, & Flanagan, 2003).

Gastrointestinal (GI) symptoms have been well documented in ASD (Buie et al., 2010; Ibrahim, Voigt, Katusic, Weaver, & Barbaresi, 2009; McElhanon, McCracken, Karpen, & Sharp, 2014) affecting as many as 70% of children (Erickson et al., 2005). GI symptoms reported include constipation, diarrhea, abdominal pain, encopresis, bloating, and gastroesophageal reflux disease (GERD) (Buie et al., 2010), although symptoms vary widely across studies (Holingue, Newill, Lee, Pasricha, & Daniele Fallin, 2018). Research indicates that children with ASD and GI concerns are at a higher risk of developing problem feeding behaviors than children with ASD who do not have these symptoms (Chaidez, Hansen, & Hertz-Picciotto, 2014; Emond, Emmett, Steer, & Golding, 2010; Erickson et al., 2005), although a clear mechanism among children with ASD has yet to be clearly elucidated (Vissoker, Latzer, & Gal, 2015).

The issue of dietary intake and nutritional status in children with ASD has not been well studied. Vitamin and mineral deficiencies associated with food selectivity in children with ASD have been identified in the literature in recent years, though results remain mixed (Mari-Bauset et al., 2014b; Sharp et al., 2013). Decreased intake of calcium and vitamin D appear to be one of the most consistent findings in children with ASD (Cornish, 1998; Hediger et al., 2008; Herndon et al., 2009; Sadowska & Cierebiej, 2011; Xia, Zhou, Sun, Wang, & Wu, 2010; Zimmer et al., 2012). While the intake of B vitamins, magnesium, iron, vitamin A, vitamin C, and folic acid also appears to be inadequate in some studies, the nutritional requirements in these children in terms of energy and macronutrients seems to be satisfied (Emond et al., 2010; Hyman et al., 2012; Levy et al., 2007; Xia et al., 2010). Given the limited amount of studies available regarding this topic and the mixed results reported to date (Cermak, Curtin, & Bandini, 2010; Mari-Bauset et al., 2014a; Sharp et al., 2013), this aim of this study was to compare dietary intake in 2-to-8-year-old US children with and without an ASD diagnosis.

## 2. Measures and statistical methods

This study was approved by the Austin Multi-Institutional Review Board and the procedures followed were in accordance with the ethical standards of the responsible institutional committee on human experimentation and in accordance with the Helsinki Declaration of 1975 as revised in 1983. ASD participants were recruited from an out-patient clinic for children with ASD and other developmental disabilities. Control participants were recruited through informational flyers placed in local businesses and social media tools. Written informed consent was obtained from the parent or legal guardian of all children who participated in the study.

Participants in this study included 86 children aged 2 to 8 years diagnosed with ASD based on criteria set forth in both the DSM-IV and DSM-5 and 57 aged-matched healthy controls. All children included in the ASD group either received a clinical ASD diagnosis prior to study participation, or completed a comprehensive diagnostic assessment at the time of study enrollment. All prior formal diagnostic assessments were completed by appropriately trained clinicians, including psychologists, psychiatrists, developmental pediatricians, or neurologists. These diagnoses were verified at the time of study initiation by appropriately research-trained professionals. Diagnostic assessment at the time of study enrollment was completed by a psychologist utilizing SCQ, ADI-R, and ADOS instruments. All study participants in the ASD group met the criteria for an ASD diagnosis regarding age of onset, repetitive, stereotypical behavior, and significant deficits in social interaction and communication. For the control group, all subjects underwent a developmental screening using the Adaptive Behavior Assessment System-Second Edition (ABAS-II) that was assessed by a psychologist. Control subjects were excluded if their score on the ABAS-II suggested possible abnormal development and the need for further evaluation. Exclusion criteria also included those children with a co-morbid diagnosis that may affect growth status or dietary intake, those with a history of major chronic disease, and those who had used medication known to affect growth or nutritional status at any time. Study participants were seeking services at an outpatient clinic offering a comprehensive and multidisciplinary program for children with developmental disorders. The clinic provides diagnostic and educational consultation, counseling, ABA therapy, medical care, dietetic support, and family support services (Hewitson et al., 2016). Participants were not under the care of a registered dietitian prior to study enrollment, nor were they specifically seeking a dietetic evaluation.

Parents were given detailed instructions developed by a licensed, registered dietitian (RD) for collecting accurate data for the purpose of a food diary analysis, with additional training and instructions providing information on quantifying portion sizes and estimating ingredients for all types of food. Visual tools and references were provided for families in clinical consultation to ensure accuracy of data collection. The RD was available for questions throughout the course of each participant's data collection. Parents provided detailed dietary information via a food diary, chronicling their child's dietary consumption over a 3-day time frame,