Dietary intake in children on the autism spectrum is altered and linked to differences in autistic traits and sensory processing styles

Author:
Mathew, NE; Mallitt, KA; Masi, A; Katz, T; Walker, AK; Morris, MJ; Ooi, CY

Publication details:
Autism Research
v. 15
Chapter No. 10
Medium: Print-Electronic
pp. 1824 - 1839
1939-3792 (ISSN); 1939-3806 (ISSN)

Publication Date:
2022-10-01

Publisher DOI:
https://doi.org/10.1002/aur.2798

Received: 3 January 2022 | Accepted: 10 August 2022

DOI: 10.1002/aur.2798

RESEARCH ARTICLE

Dietary intake in children on the autism spectrum is altered and linked to differences in autistic traits and sensory processing styles

Nisha E. Mathew[1,2] | Kylie-Ann Mallitt[3,4] | Anne Masi[4] | Tamarah Katz[1,5] | Adam K. Walker[2,4,6] | Margaret J. Morris[7] | Chee Y. Ooi[1,8]

[1]Discipline of Paediatrics & Child Health, School of Clinical Medicine, UNSW Medicine and Health, University of New South Wales, Sydney, New South Wales, Australia

[2]Laboratory of ImmunoPsychiatry, Neuroscience Research Australia, Sydney, New South Wales, Australia

[3]Sydney School of Public Health, Faculty of Medicine and Health, University of Sydney, Sydney, New South Wales, Australia

[4]Discipline of Psychiatry and Mental Health, School of Clinical Medicine, UNSW Medicine and Health, University of New South Wales, Sydney, New South Wales, Australia

[5]Department of Nutrition and Dietetics, Sydney Children's Hospital, Sydney, New South Wales, Australia

[6]Drug Discovery Biology Theme, Monash Institute of Pharmaceutical Sciences, Monash University, Parkville, Victoria, Australia

[7]School of Medical Sciences, University of New South Wales, Sydney, New South Wales, Australia

[8]Department of Gastroenterology, Sydney Children's Hospital, Sydney, New South Wales, Australia

Correspondence
Margaret J. Morris, School of Medical Sciences, University of New South Wales, Sydney, New South Wales 2052, Australia.
Email: m.morris@unsw.edu.au

Chee Y. Ooi, School of Clinical Medicine, Discipline of Paediatrics & Child Health, UNSW Medicine and Health, University of New South Wales, Sydney, New South Wales 2052, Australia.
Email: keith.ooi@unsw.edu.au

Funding information
Australian Government Department of Education, Skills and Employment Research Training Program; Neuroscience Research Australia, Grant/Award Number: GXX0049; Sydney Partnership for Health Education Research and Enterprise, Grant/Award Numbers: PS56837, O200005; National Health and Medical Research Council, Grant/Award Number: APP1194358

Abstract

Diets of children and adolescents on the autism spectrum often differ when compared to their non-autistic peers. Most dietary studies have been limited by small sample sizes and rarely assess the heterogeneity of autism. Addressing this gap, this study compared the anthropometrics, dietary composition, dietary quality, and food variety of 154 Australian children and adolescents on the spectrum and 213 non-autistic children (71 siblings and 142 unrelated controls). Beyond the case-control approach, within-group comparisons assessed the influence of autism clinical presentations and sensory processing styles on body mass index (BMI) and measures of dietary intake among those on the spectrum. In this word first study of diet that included between-group comparisons with non-autistic peers (siblings and an unrelated comparison group) and within-autism group comparisons, we found that children on the spectrum consumed limited variety and lower quality of food and non-autistic siblings also ate comparably higher levels of energy-dense, nutrient poor food, and less diary. This may be due to autistic traits influencing family's diets or shared sensory sensitivities driving dietary intake. Within the autism group, higher autistic traits were associated with lower BMIs and a specific dietary pattern higher in simple carbohydrates and lower in unprocessed protein. Contrastingly, greater sensitivity to sensory stimuli was associated with a healthier diet. Increased age was linked to more varied diets but also diets higher in saturated fats and energy-dense, nutrient poor foods. Overall, this research highlights that potential mediators of dietary intake, such as familial influences, autistic traits, sensory processing styles, age and sex, need to be considered when assessing diet in the autistic population.

Lay Summary: In this study of dietary differences linked to autism, children, and teenagers on the spectrum ate fewer different foods and were less likely to eat recommended amounts of fruits and vegetables when compared to non-autistic siblings and unrelated children and teenagers. There were also family differences, in that those on the spectrum and their siblings ate more unhealthy foods and less dairy. Among those on the spectrum, dietary differences were linked to age, sex, autistic traits and sensory processing styles.

KEYWORDS
adolescents, autism, children, diet intake, diet quality, eating, sensory processing

INTRODUCTION

Children on the autism spectrum are five times more likely than non-autistic children to have feeding problems, including food refusal, diets restricted in variety and rigid behavioral patterns which impact mealtimes (Sharp et al., 2013). These differences appear as early as 6 months of age (Emond et al., 2010) and is a key concern in clinical practice (Hyman et al., 2012). Children on the spectrum often consume a less diverse diet (Emond et al., 2010; Nadon et al., 2011) which has been linked to higher rates of nutritional deficiencies (Zimmer et al., 2012). Being over or underweight is another consequence of these feeding difficulties that is often associated with autism (Li et al., 2020). While some of these feeding difficulties improve with age (Bandini et al., 2017; Beighley et al., 2013), others persist into adolescence and adulthood (Kuschner et al., 2015).

Relative to non-autistic children, in some studies children on the autism spectrum ate diets higher in sugar, simple carbohydrates and energy dense, nutrient poor (EDNP) foods and lower in nutrient dense (ND) foods (Ahearn et al., 2001; Canals-Sans et al., 2021; Evans et al., 2012; Ho et al., 1997; Schreck & Williams, 2006). Such dietary patterns, high in simple carbohydrates and EDNP foods, are associated with diet-linked metabolic conditions, and systemic and central inflammation (Minihane et al., 2015; Nishida et al., 2004). Dietary quality indices, which account for the nutritional quality of foods and adherence to national dietary guidelines, are rarely used in studies of diet in autism despite associations with relevant health outcomes in pediatric populations (see Marshall et al., 2014 for a review).

Given that not all children and adolescents on the spectrum experience feeding difficulties, understanding the drivers of this heterogeneity is important (Page et al., 2021). While comparisons to control groups have identified differences associated with autism, the heterogeneity within autism is understudied (Lombardo et al., 2019). Among those with a diagnosis of autism, higher levels of restricted and repetitive behaviors and higher overall autism-linked traits have been linked to higher food selectivity (Page et al., 2021; Yap et al., 2021) and increased nutritional inadequacy (Johnson et al., 2014). Small studies examining narrow conceptions of sensory processing, as captured by the Short Sensory Profile (SSP), have found associations between atypical taste sensitivity and lower vegetable consumption, limited food variety, and more feeding problems (Chistol et al., 2018; Lane et al., 2014; Panerai et al., 2020). The relationship between the diets of those on the autism spectrum with a more representative sensory profile across modalities including hyperresponsivity and sensory seeking, that are not captured by the original SSP (Williams et al., 2018), has not yet been examined.

A major challenge in understanding the dietary preferences associated with autism is disentangling the role of genetic, familial, and psychosocial factors from the dietary restrictions and preferences of children on the spectrum. Yet another influence on family dietary habits and food choices is the cultural background of parents and grandparents, particularly among culturally and linguistically diverse families (Rhodes et al., 2016). One method of identifying dietary differences linked to a diagnosis of autism, as distinct from other influences, is through comparisons with the diets of non-autistic siblings who share genetic backgrounds, family environment, socioeconomic status, and approaches to parenting (Hopper et al., 2005; Weinberg & Umbach, 2000). Most published studies including non-autistic siblings have small sample sizes and focused on food selectivity, rather than nutrient intake or diet quality. Across these studies, children on the spectrum typically eat less varied diets than their siblings do (Aponte & Romanczyk, 2016; Collins et al., 2003; Martins et al., 2008; Nadon et al., 2011; Schreck & Williams, 2006; Shmaya et al., 2015). To date, no study including non-autistic siblings -has comprehensively examined dietary composition or dietary quality.

The aims of this paper are to explore (i) whether autism is associated with differences in diet and (ii) whether dietary intake among children and adolescents on the autism spectrum is influenced by the levels of autistic traits, sensory processing profiles, and demographic characteristics. We examined the anthropometrics and diets of Australian children aged between 2 and 17 with a DSM-IV or DSM-5 diagnosis of autism spectrum disorder (ASD) relative to two comparison groups without an autism diagnosis, namely their siblings and unrelated non-autistic children. To achieve the second aim, we examined the impact of sex, age, autism traits and sensory processing profiles on body mass index (BMI) and select dietary measures among the autism spectrum group.

METHODS

Participants

Participants in this study came from two datasets: the Australian Autism Biobank (AAB) and the Dietary Intake Study in cHildren (DISH). The AAB participants were recruited between May 2017 and June 2018 from four sites in Australia: (1) Telethon Kids Institute, University of Western Australia; (2) Olga Tennison Autism Research Centre, La Trobe University; (3) University of New South Wales, and (4) Lady Cilento Children's Hospital, Brisbane, Queensland. The AAB participants included children and adolescents with an ASD diagnosis, their siblings without a diagnosis of ASD and children without a diagnosis of ASD and no first-degree relative diagnosed with ASD (unrelated "controls") (Alvares et al., 2018). The AAB data was supplemented with DISH study controls who were non-autistic children recruited between January 2015 and October 2016 through the Sydney Children's Hospital Randwick, New South Wales (Sutherland et al., 2018). Details of consent and recruitment procedures are available in the original reports (Alvares et al., 2018; Sutherland et al., 2018). Ethics approval for the analyses in this paper was obtained from the Human Research Ethics Advisory Panel G: Medical and Community at the University of New South Wales (HC190922).

Anthropometric and demographic measures

Height, weight, and BMI *z*-scores were calculated for all participants using the method described by Flegal and Cole (2013). Any potentially biologically implausible values based on the weight, height and BMI values as per the CDC's modified *z*-score criteria were excluded (Centers for Disease Control and Prevention, 2000). Culture can have significant effects on food intakes however, detailed information about the cultural background of participants was not collected in both datasets. The closest proxy measure of culture available was the participating parents' country of birth (Table S1). Meaningful analysis of this data was not possible as the majority of parents who reported country of birth were born in Australia or New Zealand.

Dietary assessment

Dietary intakes were assessed using the Australian Child and Adolescent Eating Survey (ACAES), a 120-item semi-quantitative food frequency questionnaire. Among Australian toddlers and children aged between 2–18 years, the ACAES has been validated against relevant biomarkers and dietician food records and demonstrates acceptable accuracy in relation to nutrient intakes (Burrows et al., 2014; Collins et al., 2013; Marshall et al., 2012; Watson et al., 2009). Standardized instructions asked for parents and caregivers, or the child themself (if developmentally appropriate as determined by their parent or caregiver and aged over 9 years), to report the child's habitual intakes of specific food items over the preceding 6 months. The option of self-reporting was given to older children as the ACAES results in valid estimates of intake based on reports from children themselves if aged over 8 years old (Burrows et al., 2013). The ACAES was completed in person by DISH participants and remotely by AAB participants. Portion sizes assigned to each food item were age specific and measures of dietary composition, dietary quality and food variety were calculated from these reports. Details of the specific dietary measures analyzed as part of aims 1 and 2 are presented in Table 1.

TABLE 1 Specific measures of dietary intake examined as part of the between-group comparisons and the within-group comparisons in this study

Dietary composition	(i) Total energy intake[a] (ii) Total energy-dense, nutrient poor (EDNP) food intake[b] (iii) Intake of EDNP food subtypes (sweet drinks, packaged snacks, confectionary, baked goods, takeaway, condiments, fatty meats)[a] (iv) Total nutrient dense (ND) food intake[a] (v) Intake of ND food subtypes (fruits, vegetables, vegetarian proteins [plant proteins and eggs], unprocessed meat, grains, dairy)[b] (vi) Macronutrient intake (proteins, fats, carbohydrates, dietary fiber)[b] (vii) Micronutrient intake (vitamins and minerals calculated as a proportion of age and sex adjusted recommended daily intakes (RDIs) or adequate intakes (AIs) where RDIs did not exist)[a]
Dietary quality and diversity	The Australian Recommended Food Score (ARFS), a diet quality score that measures dietary diversity and adherence to national dietary recommendations (NHMRC, 2013). The ARFS is validated for use in Australian pediatric populations (Burrows et al., 2014; Marshall et al., 2012). The following ARFS scores were analyzed: (i) Total diet (Maximum Score 73)[b] (ii) Fruits (Maximum Score 12)[a] (iii) Vegetables (Maximum Score 21)[a] (iv) Vegetarian proteins (Maximum Score 6)[a] (v) Unprocessed meat (Maximum Score 7)[a] (vii) Grains (Maximum Score 13)[a] (viii) Dairy (Maximum Score 11)[a]
Food variety	(i) Total number of foods eaten in the preceding 6 months (Maximum 115)[b] (ii) Total number of ND foods eaten in the preceding 6 months (Maximum 68)[b]

[a]Measures used for between group comparisons (relative to sibling and unrelated controls) for aim 1.
[b]Measures used for both between (aim 1) and within group (aim 2) comparisons.

Micronutrient intakes for all children were quantified as absolute intake and relative to dietary recommendations. Individual consumption of each nutrient was calculated as a percentage of age and sex specific recommended dietary intakes (RDIs), defined as the levels of essential nutrient intakes considered to be adequate to meet the nutritional needs of healthy children. Adequate intakes (AIs) were used where RDIs did not exist in line with the nutrient reference values for Australia and New Zealand (NHMRC, 2006). The average AI is defined by the guidelines as the daily nutrient intake level that is assumed to be adequate to meet the needs of healthy people based on observed or experimentally determined approximations or estimates of nutrient intake. Mean percentage RDI or AI and the proportion of children not meeting their recommendations were calculated for each group.

Clinical and behavioral measures in participants on the autism spectrum

Autistic traits were assessed using the Autism Diagnostic Observation Schedule (ADOS) (2nd edition; Lord et al., 2012). The ADOS is a semi-structured, standardized assessment of autism-linked differences in communication, social interaction and restricted and repetitive behaviors. Higher calibrated severity scores reflect greater levels of autism-associated traits after accounting for age and language ability. For analysis, we categorized participants as having low (minimal to mild scores), moderate or high levels of autism-associated traits based on the total calibrated severity scores (Table 2). Given previous findings of a link between restricted repetitive behaviors (RRBs) and dietary patterns (Johnson et al., 2014; Yap et al., 2021), we also calculated calibrated severity scores for the RRB subscale of the ADOS (Hus et al., 2014) and categorized children as having a low, moderate or high level of RRBs (Table 2).

The second edition of the SSP (SSP-2) is a 36-item parent-reported rating of sensory processing and responding across modalities (Dunn, 2014). Parents rated behaviors on a 5-point scale from 1 (almost never) to 5 (almost always). The SSP-2 categorizes the extent to which children fit into four quadrants of sensory functioning (Seeking: high scores indicate active seeking of sensory input, Avoidance: high scores indicate active

TABLE 2 Demographic and clinical characteristics of each of the three participant groups

	Autism group	Sibling group	Unrelated control group
	n (%) or mean (SD)	*n* (%) or mean (SD)	*n* (%) or mean (SD)
Sex			
Female	32 (21%)	35 (49%)	71 (50%)
Male	123 (79%)	36 (51%)	71 (50%)
Age (years)	7.8 (3.3)	7.9 (4.2)	8.1 (4.4)
Preschool aged (2–5 years)	50 (32.5%)	27 (38.0%)	56 (39.4%)
School aged (6–12 years)	93 (60.4%)	34 (47.9%)	62 (43.7%)
Adolescent (≥13 years)	11 (7.1%)	10 (14.1%)	24 (16.9%)
Weight (kg)	31.1 (14.6)	32.9 (19.5)	31.8 (17.9)
Height (cm)	129.2 (20.0)	129.27 (27.3)	128.8 (27.0)
Body mass index (BMI)			
Underweight (<5th percentile)	4 (2.6%)	5 (7.0%)	4 (2.8%)
Healthy weight (5th–<85th percentile)	107 (69.5%)	47 (66.2%)	96 (67.6%)
Overweight (85th–<95th percentile)	25 (16.2%)	13 (18.3%)	30 (21.1%)
Obese (≥95th percentile)	18 (11.7%)	6 (8.5%)	12 (8.5%)
ADOS calibrated severity scores	6.6 (2.0)	N/A	N/A
Low	13 (8.5%)		
Medium	91 (59.1%)		
High	41 (26.7%)		
Missing	9 (5.8%)		
ADOS RRB calibrated severity scores	6.9 (2.1)	N/A	N/A
Low	10 (6.5%)		
Medium	71 (46.1%)		
High	64 (43.1%)		
Missing	9 (5.8%)		

Abbreviations: ADOS, Autism Diagnostic Observation Schedule; RRB, Restricted, repetitive behaviors.

avoidance of sensory input, Sensitivity: high scores reflect hypersensitivity to sensory input and Registration: high scores reflect a tendency to miss sensory input). The SSP-2 includes two broader subscales which capture the extent to which sensory input is detected (Sensory) and responded to (Behavioral). Scores on the four quadrants and two SSP-2 subscales were dichotomised and all analyses compared those on the spectrum who scored within the above average range (>1 SD) to those who scored within the average range. One child scored in below average range (<1 SD) of the Registration quadrant and one child scored in the below average range (<1 SD) of the Behavioral subscale and this data were not analyzed.

Statistical analysis

Nested mixed effects linear models were fitted to the data, using the lme4 (Bates et al., 2015) and lmerTest packages (Kuznetsova et al., 2017). To account for the statistical dependency within the data resulting from the inclusion of multiple members of a family who share genetic backgrounds and environmental exposures, all analyses included a random effect that nested participants within families. Diagnosis (autism vs. siblings, autism vs. unrelated children), sex and age were included as fixed effects. All models in this study are maximum likelihood generalized linear mixed models. To account for multiple testing, *q*-values based on the false discovery rate correction were calculated for all group comparisons (Benjamini & Hochberg, 1995).

For the analyses of within group differences, nested linear models, with participants nested within families and no fixed effects were used. As these analyses were exploratory, we did not correct for multiple comparisons. R Statistical Software (version 4.0.3; R Foundation for Statistical Computing, Vienna, Austria) was used for all statistical analyses.

RESULTS

We accessed the data for 322 children from the AAB and 81 DISH children aged between 2 and 17 years. This study excluded five children following prescription elimination diets (four from the autism group, one from the sibling group) and children who were vegetarian or vegan (two autism). Nine children (four autism, two sibling, and three unrelated) were excluded for inaccurate BMIs or biologically implausible values based on the CDC's modified *z*-score criteria (Centers for Disease Control and Prevention, 2000). Individual estimated energy requirements (EER) based on the child's weight and age were calculated for each participant (Schofield, 1985). Forms were excluded if reported intakes corresponded with more than 200% of the EER based on a high level of physical activity or less than 50% of the EER of a sedentary child (six autism, two unrelated). After scanning the AES for completeness and reliability, 10 forms containing missing or inaccurate data were excluded (seven autism, three siblings, and one unrelated). The final analysis included 154 children on the autism spectrum and 213 non-autistic children (71 siblings, 142 unrelated children).

Anthropometric and demographic measures

Table 2 contains information about the demographic and anthropometric characteristics of all groups and the clinical and behavioral characteristics of the autism group. Consistent with previous research, there were more boys than girls in the autism group while the two comparison groups had equal sex ratios (comparisons using Chi-squared tests $p < 0.001$). There were no differences in ages of the participants in the autism group compared to the comparison groups (autism vs. sibling: $t(225) = -0.177$, $p = 0.860$; autism vs. unrelated: $t(294) = -0.698$, $p = 0.486$).

There were no significant differences between the weight, height or BMI *z*-scores in the autism, sibling and unrelated comparison groups (Table 3).

TABLE 3 Analysis of anthropometrics in children and adolescents on the spectrum ($n = 154$), their non-autistic siblings ($n = 71$) and unrelated, non-autistic controls ($n = 142$)

	Autism group	Sibling group	Unrelated group	Comparison: Autism versus sibling		Comparison: Autism versus unrelated	
	Median (IQR)	Median (IQR)	Median (IQR)	*b* (CI)	*p*-value	*b* (CI)	*p*-value
Weight (modified *z*-score)	0.45 (−0.01, 1.12)	0.42 (−0.11, 1.01)	0.32 (−0.12, 0.86)	−0.09 (−0.38, 0.19)	0.524	−0.15 (−0.39, 0.09)	0.226
Height (modified *z*-score)	0.80 (−0.08, 1.48)	0.58 (−0.06, 1.32)	0.46 (−0.27, 1.22)	−0.03 (−0.32, 0.25)	0.818	−0.19 (−0.45, 0.07)	0.150
BMI (modified *z*-score)	0.21 (−0.24, 0.73)	0.25 (−0.18, 0.83)	0.14 (−0.16, 0.86)	−0.11 (−0.39, 0.18)	0.461	−0.04 (−0.29, 0.21)	0.773
Overweight or obese[a]	27.9%	26.8%	29.6%	−0.04 (0.78, 0.71)	0.925	0.35 (0.26, 0.96)	0.266

Note: All analyses adjusted for sex, age, and family. All *p*-values reported were generated before correction for multiple comparisons.
[a]A child with a BMI-for-age score of >85th percentile is classified as overweight and a child with a score of >95th percentile is classified as obese. This was coded as a binary variable and was analyzed adjusting for sex, age, and family.

Children on the autism spectrum eat lower quality diets than their non-autistic siblings and unrelated, non-autistic controls

Energy and micronutrient intakes were broadly comparable across the three groups. Participants on the spectrum consumed significantly less energy from protein than their non-autistic siblings (FDR>0.15). There were no other differences in macronutrient (Table 4), mineral (Table S2) or vitamin intake (Table S3). A sizeable proportion of children across the three groups did not meet RDIs for potassium, calcium, iron, folate and Vitamin A and exceeded the upper limit for sodium consumption (Table S2 and S3).

The diets of children on the spectrum were lower in diary and higher in EDNP foods when compared to unrelated children but not when compared to non-autistic siblings (Table 5).

Overall, dietary quality (ARFS) and total food variety among those on the spectrum was significantly lower than those of the non-autistic comparison groups (Table 6). The diversity of fruits consumed was higher in both comparison groups and siblings ate a greater diversity of vegetables.

Heterogeneity in diet is influenced by demographic, clinical and sensory characteristics among children on the autism spectrum

For the second aim of this study, we examined the impact of autism-linked traits (ADOS: n = 149), sensory perception measures (SSP-2: n = 1510), sex and age on BMI percentiles and select markers of

TABLE 4 Total overall energy intake and macronutrients consumed by children and adolescents on the spectrum (n = 154), their non-autistic siblings (n = 71) and unrelated, non-autistic controls (n = 142)

	Autism group	Sibling group	Unrelated group	Comparison: Autism versus sibling		Comparison: Autism versus unrelated	
	Median (IQR)	Median (IQR)	Median (IQR)	*b* (CI)	*p*-value	*b* (CI)	*p*-value
Energy							
Tota Intake (kcal/day)	2309 (1719, 2876)	2103 (1300, 2749)	2151 (1571, 2639)	−144 (−355, 65)	0.175	−55 (−245, 135)	0.597
Protein							
Intake (g/day)	95.8 (76.6, 127)	89.8 (56.8, 124)	96.2 (66.8, 119)	−1.2 (−11, 8.1)	0.800	1.4 (−7.6, 10)	0.758
% TE	17 (15, 19)	17 (16, 19)	17.4 (16.0. 19.1)	0.78 (0.10, 1.4)	0.024	0.66 (−0.05, 1.4)	0.067
Fat							
Intake (g/day)	81.4 (61.6, 111)	77.3 (51.4, 97.6)	74.9 (57.8, 100.5)	−5.5 (−14, 3.0)	0.200	−3.4 (−11, 4.5)	0.396
% TE	33 (30, 36)	34 (30, 37)	33.0 (30.7, 35.6)	0.16 (−1.0, 1.4)	0.789	−0.51 (−1.6, 0.56)	0.350
Saturated fat							
Intake (g/day)	37.6 (27.4, 50.9)	34.5 (22.5, 43.6)	34.9 (25.9, 45.9)	−3.3 (−7.4, 0.88)	0.121	−1.5 (−5.4, 2.3)	0.435
% TE	15 (13, 17)	15 (13, 17)	15.2 (13.4, 16.8)	−0.31 (−1.1, 0.48)	0.442	−0.14 (−0.87, 0.59)	0.706
Polyunsaturated fat							
Intake (g/day)	8.6 (6.2, 12.2)	8.5 (5.9, 11.0)	8.1 (5.8, 10.8)	−0.18 (−1.1, 0.77)	0.703	−0.32 (−1.3, 0.61)	0.499
% TE	3 (3, 4)	4 (3, 4)	3.4 (3.0, 4.0)	0.21 (0.01, 0.42)	0.043	−0.06 (−0.28, 0.16)	0.577
Monounsaturated fat							
Intake (g/day)	28.6 (20.9, 38.0)	27.3 (18.3, 35.7)	26.6 (19.9, 35.6)	−1.7 (−4.7, 1.2)	0.248	−1.4 (−4.2, 1.4)	0.332
% TE	12 (10, 13)	11 (12, 13)	11.6 (10.5, 12.5)	0.16 (−0.29, 0.60)	0.492	−0.34 (−0.75, 0.08)	0.112
Cholesterol (mg)	282 (203, 400)	286 (195, 372)	294 (190, 394)	2.6 (−34, 39)	0.888	5.4 (−29, 40)	0.758
Carbohydrates							
Intake (g/day)	288 (203, 343)	246 (152, 336)	246 (173, 323)	−23 (−49, 3.7)	0.091	−8.4 (−31, 15)	0.473
% TE	48 (44, 52)	46 (43, 51)	47.8 (44.2, 50.5)	−1.1 (−2.5, 0.32)	0.129	0.03 (−1.3, 1.4)	0.967
Sugar							
Intake (g/day)	131 (100, 168)	125 (80, 160)	130 (89, 168)	−11 (−26, 4.3)	0.158	3 (−11, 17)	0.672
% TE	24 (20, 28)	23 (19, 27)	24.1 (20.0, 28.1)	−0.38 (−1.7, 1.0)	0.580	1 (−0.43, 2.5)	0.165
Fiber							
Intake (g/day)	27.2 (19.9, 33.9)	23.4 (17.0, 33.8)	26.3 (16.4, 32.9)	−0.17 (−3.0, 2.7)	0.904	0.64 (−2.0, 3.3)	0.636
% AI	141 (100, 178)	125 (96, 178)	133 (93, 175)	−1.4 (−16, 13)	0.850	4.2 (−9.6, 18)	0.553

Note: %TE = intake as a percentage of total energy intake; %AI = intake as a percentage of adequate intake as defined in the Nutrient Reference Values for Australia and New Zealand (NHMRC, 2006). All analysis adjusted for sex, age, and family. All *p*-values reported were generated before correction for multiple comparisons. No findings remained significant after FDR correction $q < 0.15$.

TABLE 5 Absolute and relative contribution of energy-dense nutrient-poor (EDNP) and nutrient-dense (ND) foods to the daily dietary intake among children and adolescents on the autism spectrum ($n = 154$), their non-autistic siblings ($n = 71$) and unrelated, non-autistic controls ($n = 142$)

	Autism group	Sibling group	Unrelated group	Comparison: Autism versus sibling		Comparison: Autism versus unrelated	
	Median (IQR)	Median (IQR)	Median (IQR)	*b* (CI)	*p*-value	*b* (CI)	*p*-value
ND intake (kcal)	1365 (1020, 1737)	1192 (890, 1732)	1379 (956, 1734)	−14 (−151, 124)	0.843	104 (−30, 238)	0.127
EDNP intake (kcal)	885 (580, 1240)	759 (402, 1131)	674 (442, 1024)	−123 (−240, −5.5)	0.040	**−147 (−264, −30)**	**0.014**
All EDNP foods (%TE)	40 (29.25, 49)	37 (27, 47)	35 (28, 42.75)	−2.3 (−5.2, 0.5)	0.114	**−5.8 (−9.1, −2.4)**	**<0.001**
Sweet drinks	1 (0, 4)	1 (0, 3)	1 (0, 3)	−0.54 (−1.4, 0.32)	0.220	−0.32 (−1.2, 0.60)	0.490
Packaged snacks	5.5 (2, 9)	6 (2, 8)	4 (2, 8)	0 (−1.3, 1.3)	0.998	−0.47 (−1.8, 0.89)	0.499
Confectionary	5 (3, 9)	6 (3, 11)	5 (3, 7)	0.37 (−0.93, 1.7)	0.574	−0.88 (−2.1, 0.33)	0.155
Baked goods	6 (3, 9)	6 (4, 9)	4 (3, 8)	0.29 (−0.85, 1.4)	0.612	−1.1 (−2.1, −0.03)	0.043
Takeaway	9 (6, 13)	9 (5, 12)	8 (5, 11)	−0.82 (−2.5, 0.83)	0.326	−0.91 (−2.5, 0.69)	0.264
Condiments	2 (1, 3)	1 (1, 3)	2 (1, 4)	−0.12 (−0.66, 0.43)	0.675	0.62 (0.05, 1.2)	0.033
Fatty meats	1 (0, 3)	2 (1, 3)	1 (1, 2.75)	0.49 (0.07, 0.90)	0.022	0.18 (−0.25, 0.61)	0.414
All ND foods (%TE)							
Vegetables	4 (2, 6)	5 (3, 7)	4 (3, 6)	0.81 (−0.02, 1.6)	0.056	−0.08 (−0.85, 0.68)	0.832
Fruit	8 (5, 13)	9 (6, 14)	9 (6, 13)	1 (−0.65, 2.6)	0.239	1 (−0.52, 2.5)	0.196
Unprocessed meat	10 (6.25, 14)	8 (11, 14)	10 (8, 13)	0.58 (−1.2, 2.3)	0.517	−0.19 (−1.7, 1.3)	0.804
Vegetarian protein	2 (1, 4)	3 (1, 6)	2 (1, 4)	0.58 (−0.17, 1.3)	0.129	−0.27 (−1.0, 0.44)	0.456
Grains	19 (12, 23)	18 (13, 22)	19 (14, 24)	−0.53 (−2.6, 1.6)	0.620	0.64 (−1.3, 2.6)	0.524
Dairy	14 (8, 21)	10 (6, 22)	17 (10.25, 24)	−0.83 (−3.3, 1.6)	0.507	**3.5 (0.84, 6.2)**	**0.010**

Note: %TE = intake as a percentage of total energy intake. All analysis adjusted for sex, age, and family. All *p*-values reported were generated before correction for multiple comparisons. Bold text highlights findings that remain significant after FDR correction $q < 0.15$.

TABLE 6 Diet quality and diversity as measured by Australian Recommended Food Scores (ARFS) and food variety scores among children and adolescents on the autism spectrum ($n = 154$), their non-autistic siblings ($n = 71$) and unrelated, non-autistic controls ($n = 142$)

	Autism group	Sibling group	Unrelated group	Comparison: Autism versus sibling		Comparison: Autism versus unrelated	
	Median (IQR)	Median (IQR)	Median (IQR)	*b* (CI)	*p*-value	*b* (CI)	*p*-value
Total ARFS	30 (21.25, 36)	33 (27, 39)	32.5 (26.2, 39.75)	**4.5 (1.8, 7.3)**	**0.001**	**4 (1.4, 6.7)**	**0.003**
Vegetable ARFS	8 (5, 12)	10 (7.5, 14)	10 (6, 13)	**2.5 (1.3, 3.8)**	**<0.001**	1.3 (−0.02, 2.6)	0.053
Fruit ARFS	6 (3, 8)	7 (5, 9)	7 (5, 9)	**1 (0.23, 1.8)**	**0.011**	**1.2 (0.42, 1.9)**	**0.002**
Unprocessed meat ARFS	1 (1, 2)	2 (2, 3)	2 (2, 3)	0.25 (−0.04, 0.54)	0.089	0.1 (−0.20, 0.40)	0.523
Vegetarian protein ARFS	1 (1, 2)	2 (1, 3)	2 (1, 3)	0.26 (−0.10, 0.61)	0.162	0.19 (−0.14, 0.52)	0.254
Grains ARFS	5 (4, 7)	6 (4, 7)	6 (4, 7)	0.32 (−0.15, 0.78)	0.178	0.5 (−0.01, 1.0)	0.056
Dairy ARFS	4 (2, 6)	4 (2, 5)	5 (3, 6)	0.04 (−0.49, 0.57)	0.889	0.5 (−0.01, 1.0)	0.053
Food Variety Score	73.5 (58, 88)	79 (68, 86.5)	82 (70, 93)	**8.8 (4.1, 13)**	**<0.001**	**10 (5.3, 15)**	**<0.001**
ND Food Variety Score	41 (30, 53)	46 (39.5, 55)	50 (42, 56)	**6 (2.8, 9.2)**	**<0.001**	**7.2 (3.8, 11)**	**<0.001**

Note: All analysis adjusted for sex, age, and family. All *p*-values reported were generated before correction for multiple comparisons. Bold text highlights findings that remain significant after FDR correction $q < 0.15$.

dietary composition, dietary quality and food variety among the participants on the autism spectrum (Figures 1–3).

Autism-linked traits

Moderate and high levels of autism-related traits as assessed by the ADOS was associated with lower BMIs

(Figure 1a: low vs. moderate $p = 0.008$, low vs. high $p = 0.045$). Compared to their autistic peers, these children also consumed more carbohydrates (Figure 2a: low vs. moderate $p = 0.025$, low vs. high $p = 0.037$) and had a lower protein intake (Figure 2d: low vs. moderate $p = 0.002$, low vs. high $p = 0.010$)and ate less unprocessed meat (Figure 3d: low vs. moderate: $p = 0.003$, low vs. high $p = 0.001$). Notably, the three subgroups consumed comparable amounts of dietary fiber despite differences in carbohydrate intakes (Figure 2c: low vs. moderate $p = 0.894$; low vs. high $p = 0.698$). Moderate levels of autistic traits was associated with higher consumption of sugar (Figure 2b: low vs. moderate $p = 0.031$) and fruits (Figure 3a: low vs. moderate $p = 0.046$).

Restricted and repetitive behaviors and interests

Children on the spectrum with low levels of RRBs as assessed by the ADOS consumed less sugar than those with moderate and high levels of RRBs (Figure 2b; low vs. moderate: $p = 0.032$ and low vs. high: $p = 0.0120$). This group of children also consumed more unprocessed meat than those with moderate and high levels of RRBs (Figure 3d; low vs. moderate: $p = 0.044$ and low vs. high: $p = 0.023$).

Sensory processing profiles

Those who were more likely to actively avoid sensory input, with above average scores on the Avoidant quadrant, consumed less dairy as a proportion of their total diet (Figure 3f: $p = 0.035$). Children who were more likely to actively seek sensory input, with above average scores on the Seeking quadrant, consumed more fruit (Figure 3a: $p = 0.016$) and fewer grains (Figure 3c: $p = 0.018$) but more fiber (Figure 2c: $p = 0.003$) indicating higher complex carbohydrate consumption.

Those who were hypersensitive to sensory input, based on above average scores on the Sensitivity

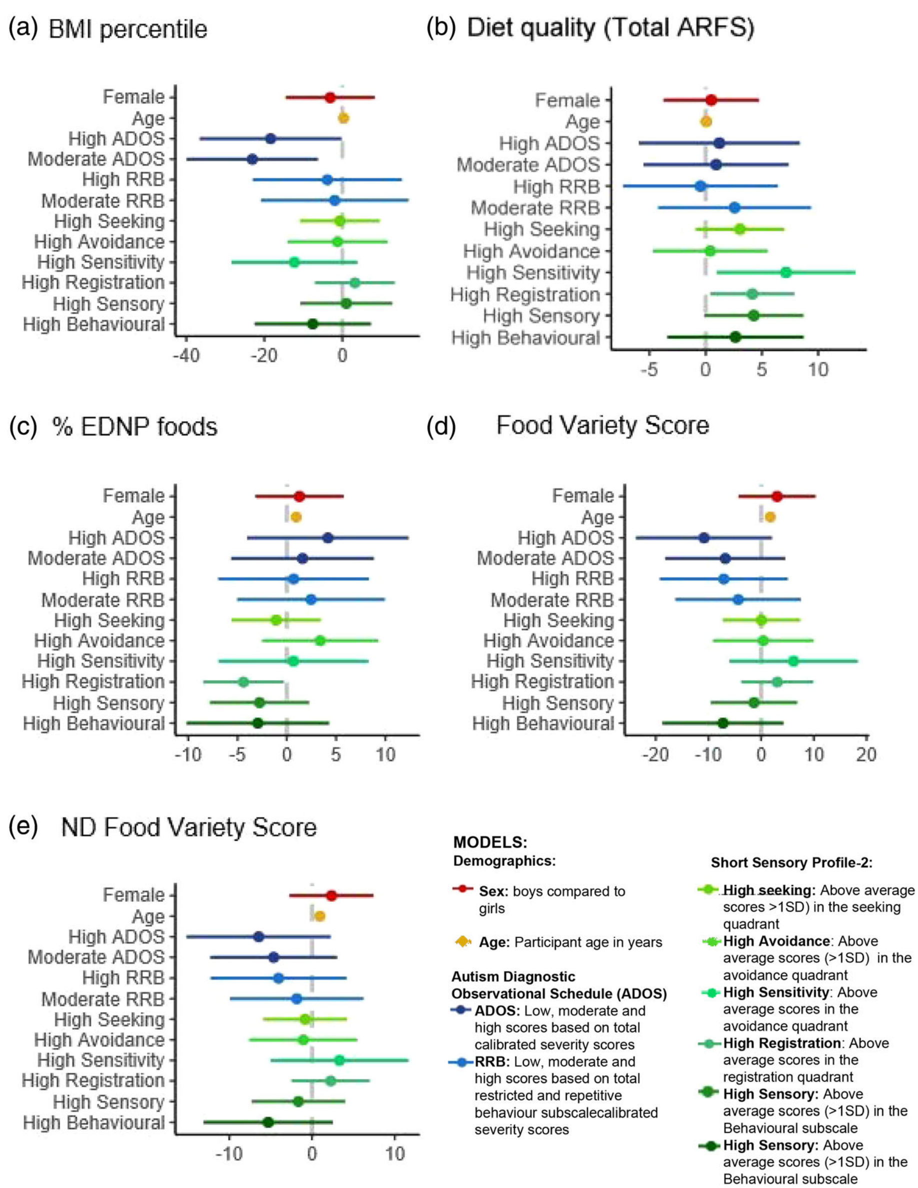

FIGURE 1 Impact of demographics, autistic traits, and sensory characteristics on BMI and markers of diet quality and variety among children and adolescents on the autism spectrum. Coefficient plots of the nested mixed effects models examining: (a) BMI percentiles, (b) diet quality as measured by total Australian Recommended Food Scores (ARFS), (c) proportion of total energy (TE) from energy dense nutrient poor (EDNP), (d) number of different foods eaten in the preceding 6 months, and (e) number of different nutrient dense (ND) foods eaten in the preceding 6 months. The circle is the mean difference associated with each variable after accounting for family relationships. The horizontal bars represent the 95% confidence interval. Bars that cross 0 are not significant at $p < 0.05$.

quadrant, consumed a higher quality diet (Figure 1b: $p = 0.021$) with more fruit (Figure 3a: $p = 0.004$) and fewer grains (Figure 3c: $p = 0.049$) but more fiber (Figure 2c: $p = 0.017$) suggesting the consumption of more complex carbohydrates. A tendency to miss sensory input reflected by above average scores on the Registration quadrant was also associated with a smaller improvement in diet quality (Figure 1b: $p = 0.0377$).

Children who had above average scores on the Sensory subscale, reflecting a high threshold for the detection of sensory stimuli, were more likely to consume high levels of fiber (Figure 2b: $p = 0.017$), relative to those who had average scores. Above average scores on the Behavioral subscale, indicating hyperreactivity to sensory stimuli, was not associated with BMIs or the markers of dietary intake examined by this study.

Demographic characteristics

We also analyzed the impact of age and sex on the diets of children on the spectrum. Girls on the spectrum ate more vegetables as a proportion of their total intake than boys (Figure 3b: $p = 0.009$). Over the preceding 6 months, older autistic children consumed a greater variety of nutrient dense foods (Figure 1f: $p = 0.005$) and a greater variety of foods overall (Figure 1e: $p = <0.001$). Older children consumed a higher proportion of their daily intake from EDNP foods (Figure 1c: $p = 0.\ 0.001$), saturated fats (Figure 2f: $p = 0.011$) and unprocessed meat (Figure 3d: $p = 0.032$). They also consumed less energy from fruits (Figure 3a: $p = 0.050$), vegetarian proteins (Figure 2c: $p = 0.0473$) and dairy products (Figure 3f: $p = 0.001$).

DISCUSSION

This study explored differences in dietary composition, including macro and micronutrient intake, dietary quality and food variety among children on the spectrum, non-autistic siblings and unrelated children. Furthermore, we examined whether autistic traits and

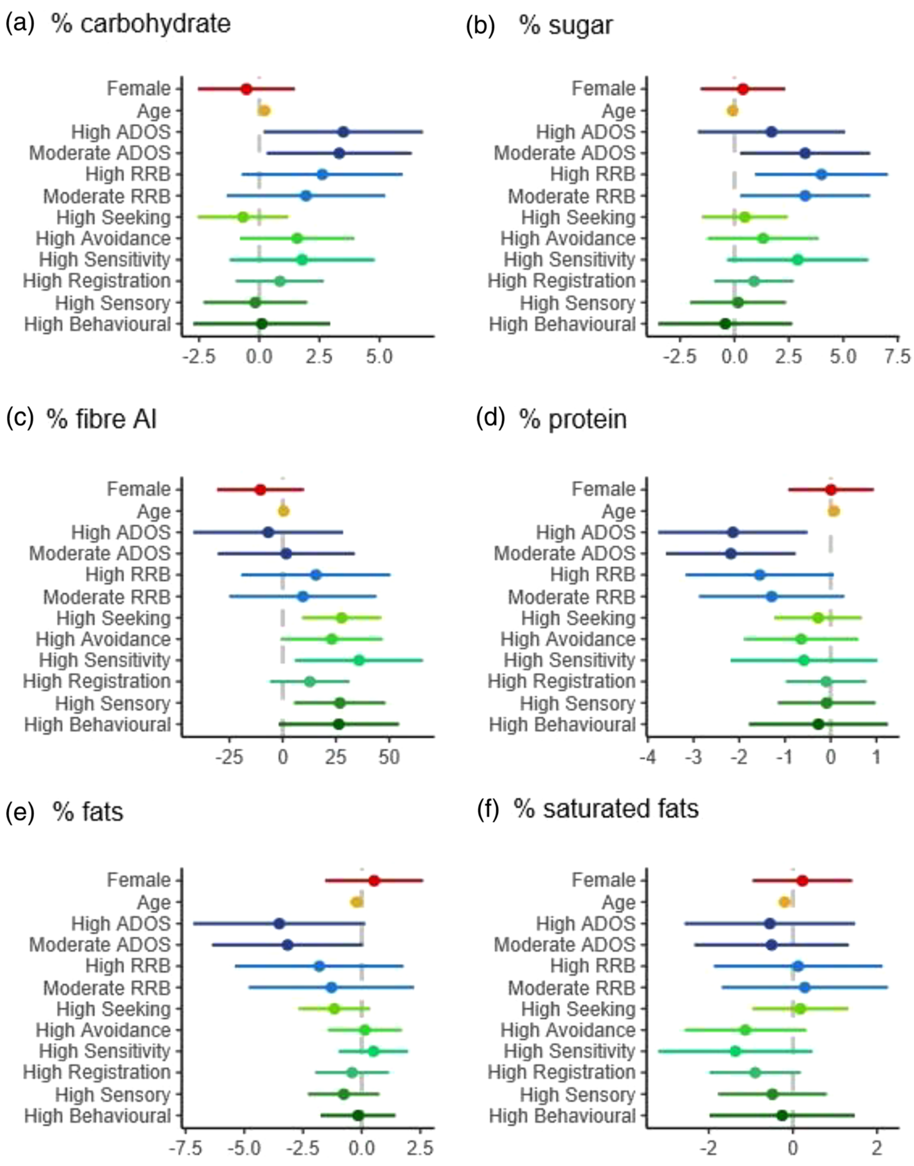

FIGURE 2 Impact of demographics, autistic traits, and sensory characteristics on macronutrient intake as a proportion of TE or average intake (AI) among children and adolescents on the autism spectrum. Coefficient plots of the nested mixed effects models examining the intake of the following macronutrients: (a) carbohydrates relative to TE, (b) sugar relative to TE, (c) fiber relative to AI, (d) protein relative to TE, (e) fat relative to TE, and (f) saturated fat relative to TE

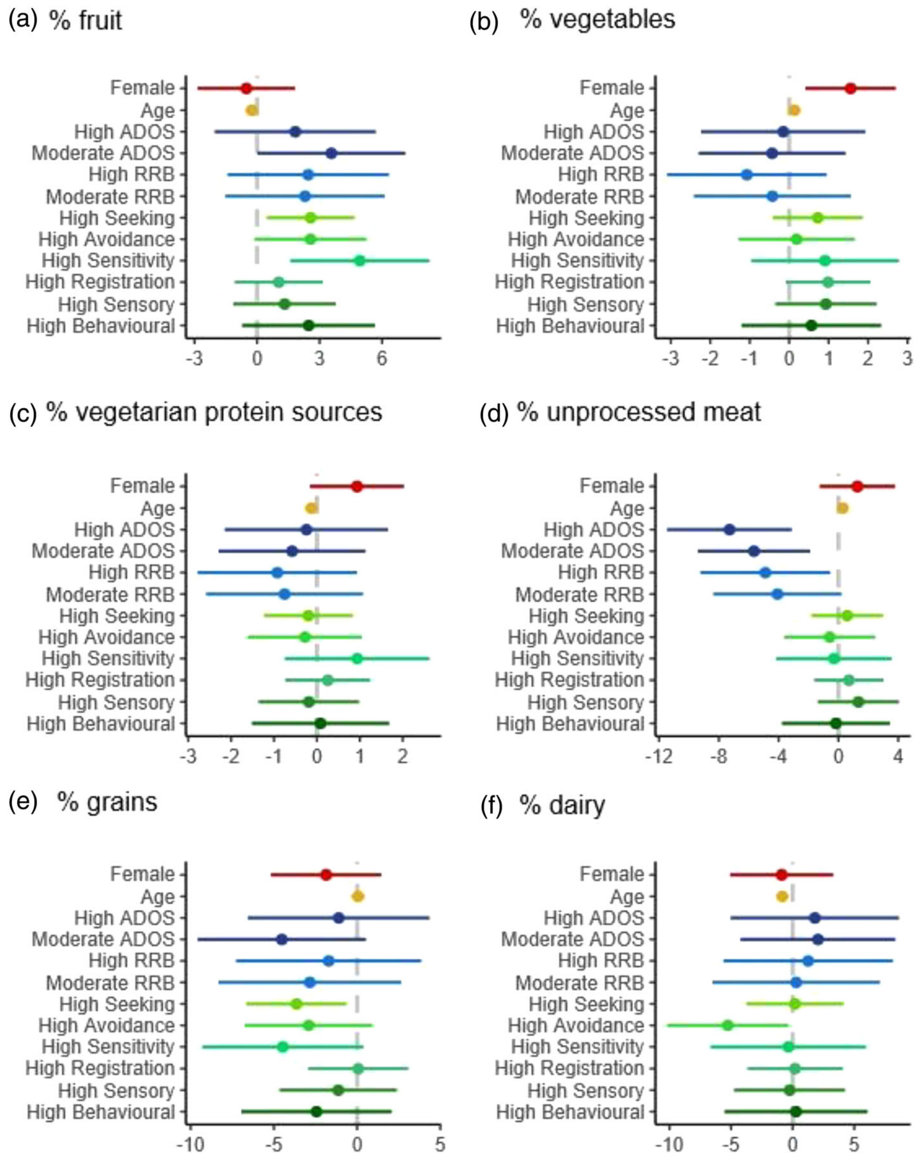

FIGURE 3 Impact of demographic and clinical characteristics on the intakes of nutrient dense food types among children on the autism spectrum. Coefficient plots of the nested mixed effects models examining the intake nutrient dense food types relative to TE: (a) fruit, (b) vegetables, (c) vegetarian proteins, (d) unprocessed meat, (e) grains, and (f) dairy

sensory processing styles impact the diets of children on the spectrum. In doing so, this is the first study of diet that includes between-group comparisons with non-autistic peers (siblings and an unrelated comparison group) as well as within-group comparisons among children on the spectrum. Overall, those on the spectrum consumed a less healthy diet with lower diet quality scores, and lower food variety scores, compared to both comparison groups. Higher EDNP and lower dairy intakes in children on the spectrum was also found among non-autistic siblings and may be influenced by shared genetic backgrounds, socioeconomic status, family environments or parental approaches. Among children on the autism spectrum, higher levels of autism traits were associated with shifts in macronutrient intake, hypersensitivity to sensory stimuli was associated with improved dietary quality and the diets of older children had greater food variety but reduced dietary quality.

Consistent with previous studies, there was less food variety (Bandini et al., 2010; Emond et al., 2010), lower overall diet quality and lower fruit and vegetable diversity in the diets of children on the spectrum (Bandini et al., 2010; Emond et al., 2010; Johnson et al., 2008; Lukens & Linscheid, 2008; Martins et al., 2008). Within families, as previously found by a smaller study (Shmaya et al., 2015), there was less variety in the diets of children on the spectrum relative to their non-autistic siblings. For the first time, children on the spectrum have been found to eat a less diverse range of fruit and vegetables when compared to siblings from the same household. Despite the lower food variety and differences in the quality of fruit and vegetable intakes, there were no differences in BMI or in the micronutrient or mineral intakes of children on the spectrum and the comparison groups. A caveat to the comparable intakes across most major food groups is that the average Australian child consumes a poor-quality diet (Australian Institute of Health and

Welfare, 2019). Examining nutritional adequacy in clinical practice would likely benefit most children on the spectrum as many participants did not meet recommended intakes of a number of essential vitamins and minerals.

Previous research has consistently shown that increased EDNP and lower dairy consumption is common among children on the spectrum (Ahearn et al., 2001; Evans et al., 2012; Malhi et al., 2017; Schreck et al., 2004; Siddiqi et al., 2019). The findings that these patterns are present in the diets of non-autistic siblings suggest they too might benefit from dietary interventions designed to reduce the intake of discretionary foods. These similarities may be influenced by family members sharing traits such as a propensity towards atypical avoidance of sensory input, which in this study was associated with lower dairy consumption. In line with this notion, higher self-reported autistic traits in the general population have been associated with the consumption of a less diverse diet featuring fewer nutrient dense foods and dairy products (Hirokawa et al., 2020; Panossian et al., 2021). Another influence on these shifts in diets among siblings may be adaptations made by families in response to the preferences of children on the spectrum. Our study design did not allow us to explore the drivers of these dietary patterns and the extent to which children on the spectrum shift their families' diets as opposed to subclinical autism-linked traits driving differences in family diets remains an important gap.

There were also several differences in diet associated with demographic characteristics in this study. Consistent with gender-linked dietary patterns found in broader pediatric studies (Bere et al., 2008; Brug et al., 2008), girls on the spectrum ate more vegetables than boys did. In line with other published studies (Bandini et al., 2017; Beighley et al., 2013), we also found evidence of an age-linked increase in the variety of foods eaten. This potential association between older age and increased food variety may have significant implications in adolescence and adulthood with research highlighting that such increases in food variety with age is adaptive for some autistic youth (Folta et al., 2020) whereas for others the persistence of limited food variety is linked with adaptive difficulties (Kuschner et al., 2015). In addition to the increase in dietary variety, we found older children ate lower diet quality diets that were higher in energy from EDNP sources and saturated fats. These results may reflect older children and adolescents asserting greater control over the food they eat in line with their personal preferences.

While atypical taste sensitivity has been linked to the consumption of fewer healthy foods and diets limited in variety (Chistol et al., 2018; Lane et al., 2014), hypersensitivity and sensory seeking across modalities may be associated with higher quality diets in children on the spectrum. In this study, children who were hypersensitive to sensory stimuli across broader sensory modalities ate a healthier diet with more fruit, complex carbohydrates and vegetarian proteins and high sensory seeking was associated with higher quality diets featuring more complex carbohydrates. These sensory patterns may drive better diets through a greater willingness to experiment with a variety of tastes and textures. Recent research has also highlighted associations between emotionally-linked overeating in autism and higher intakes of sugary foods and lower vegetable intakes (Wallace et al., 2021). Among non-autistic children, greater sensation seeking has been associated with lower levels of food neophobia and consequently a more diverse diet (Alley & Potter, 2011). The present findings suggest similar associations in the autistic population which merit further study.

The level of autistic traits was associated with a shift in macronutrient consumption in this study. Moderate and high levels of autistic traits were associated with the consumption of more simple carbohydrates but less protein and unprocessed meat. Increased levels of restricted and repetitive behaviors were associated with intakes higher in sugar and lower in unprocessed meat. The taste and texture of unprocessed meat may be particularly aversive to these subgroups and thus be replaced by more palatable simple carbohydrates or sugary foods. A number of studies have demonstrated texturally driven food intake among children and adolescents on the spectrum including preferences for low-textured foods, such as pureed foods (Padmanabhan & Shroff, 2020; Schreck et al., 2004) or "crispy" textures (Schmitt et al., 2008).

These differences in intake likely influenced the associations between greater levels of autistic traits and lower BMIs found in this sample. Pham et al. (2020) similarly found lower BMIs among children on the spectrum with taste aversions. Other studies examining the link between autism-linked traits as measured by the ADOS and obesity however have either not found a relationship with weight (Hill et al., 2015; Zuckerman et al., 2014) or contrary to our findings found autistic traits were associated with greater obesity (Rahaman et al., 2021). These contradictory results suggest that previously identified associations between obesity and autistic traits may be mediated by sample specific differences in sensory sensitivities which influence dietary intakes or other factors such as the use of medications associated with weight gain as a side effect.

While these differences in dietary patterns are likely influenced by factors such as genetic contributions to restricted, repetitive behaviors (Yap et al., 2021), these shifts in diet may also influence behavior. Previous studies have identified that high levels of sugar and simple carbohydrates, as found in subgroups of children in our study, is associated with systemic and central inflammation (Minihane et al., 2015). Diet-induced inflammation has also been linked with changes in cognition and differences in gastrointestinal function including changes in the microbiome and increases in blood–brain barrier permeability (Leigh & Morris, 2020). This has not been previously examined in clinical populations, but preclinical evidence suggests that foods high in simple carbohydrates might influence autism symptomology through inflammatory processes. In this regard, Currais et al. (2016) found that diets high in simple carbohydrates worsened restricted and repetitive behaviors and social interaction deficits and were associated with higher systemic inflammation and elevated neuroinflammation.

Strengths and limitations

The present study comprises of a larger sample size than in most previous studies of nutritional intake in autism and only one small study has previously examined the nutritional intake of non-autistic siblings (Shmaya et al., 2015). Whereas many previous studies relied on ad-hoc measures of food selectivity, this study used a well validated measure of dietary intake, the ACAES. Other methodological strengths include measures of dietary quality, food variety and the comprehensive examination of clinical and behavioral characteristics in the autism spectrum group. Unlike previous studies where parents may have biased recruitment based on their interest in nutrition, this study benefited from data collected for autism research more broadly (Alvares et al., 2018).

While we could not examine the impact of cultural factors in our cohort, many of our findings, parallel those found by international studies of diet in autism. For instance, greater consumption of simple carbohydrates and lower dietary fiber have been found in studies carried out in Turkey, the United States, Spain, India, and China (Bicer & Alsaffar, 2013; Evans et al., 2012; Marí-Bauset et al., 2015; Siddiqi et al., 2019; Yeung et al., 2021). There were no differences in the total fruit and vegetable intake of the children in this study, however contrasting findings of high fruit and vegetable consumption, relative to non-autistic peers, were identified in a Mediterranean sample (Marí-Bauset et al., 2017). These differences suggest that cultural factors may influence the diets of children on the autism spectrum. This is noteworthy as previous research has highlighted the transmission of dietary patterns as an important consideration in multicultural populations (Rhodes et al., 2016). The intersection of the influence of autistic traits and the role of culture on dietary intakes and other important demographic considerations such as the influence of socio-economic status would be a beneficial target for future research.

The main disadvantage of food frequency questionnaires is the propensity to overestimate nutrient intakes; however, low respondent burden makes them an easy and effective data collection tool (Watson et al., 2009). While food frequency questionnaires generally overestimate intakes, the ACAES uses 1995 portion size estimates and modern portion sizes are likely larger than they were 25 years ago. An additional limitation is that any substantial changes in participants diets over the previous 6 months covered by the survey may lead to inaccuracies in the estimated intake. In particular, the dietary intakes of the toddlers and young children may have shifted between the beginning and end of the surveyed time period. While we found sex-linked differences in diet, the ratio of participating autistic boys to girls in this study reflects diagnostic gender imbalances in autism. There may be important differences that this study could not capture. Our quantitative approach and cross-sectional data further limit the conclusions we can make regarding the causality underlying the dietary patterns identified. Nevertheless, these findings have significant implications for dietary assessment and nutritional advice to families and in clinical practice. Future studies could extend our findings using mixed methods analyses that integrate validated dietary measures, as included in this study, with qualitative measures such as interviews of parents and siblings (Page et al., 2021).

Summary

Children and adolescents on the spectrum in this study ate less healthy diets than their non-autistic siblings and unrelated children. Notably, some differences were also present in sibling diets highlighting the need for dietary interventions to consider the impact of the potentially bidirectional relationships between children on the spectrum and other members of the family. Hypersensitivity and sensory seeking among children and adolescents on the spectrum may be protective in relation to nutritional intake as these factors were associated with healthier diets. While dietary variety improved with age in autism, the intake of older children was still unhealthy and consisted of more energy from EDNP foods and saturated fats. The association between dietary patterns characterized by high carbohydrate and low protein intakes and more profound autism-related symptomology deserves further examination in future studies. Experiences of autism are highly variable, and these findings suggest the need to implement personalized consideration of diets that integrate information about family dynamics, autism symptom severity and sensory processing styles in clinical practice.

ACKNOWLEDGMENTS

The authors are indebted to all the children, parents and carers who participated in the Australian Autism Biobank and the Dietary Intake Study in cHildren (DISH). The data used in this project were provided by the Cooperative Research Centre for Living with Autism (Autism CRC) with appropriate ethics approval. The Australian Autism Biobank is an initiative of Autism CRC established with funding received from the Australian Government and CRC partners. The authors acknowledge the Australian Autism Biobank Team (in alphabetical order): Jolene Berry (Institute for Molecular

Biosciences, The University of Queensland), Vandhana Bharti (Institute for Molecular Biosciences, The University of Queensland), Dominique Cleary (Telethon Kids Institute, University of Western Australia; Autism CRC), Melanie De Jong (Wesley Medical Research; Autism CRC), Mira Frenk (Mater Medical Research Institute; Autism CRC), Maryam Haghiran (Olga Tennison Autism Research Centre, La Trobe University; Autism CRC), Alexis Harun (Telethon Kids Institute, University of Western Australia; Autism CRC), Helen Holdsworth (Mater Medical Research Institute; Autism CRC), Anna Hunt, (Telethon Kids Institute, University of Western Australia; Autism CRC), Rachel Jellett (Olga Tennison Autism Research Centre, La Trobe University; Autism CRC), Feroza Khan (University of New South Wales; Autism CRC), Deborah Lennon (Wesley Medical Research), Jodie Leslie (Telethon Kids Institute, University of Western Australia; Autism CRC), Tiana McLaren (Institute for Molecular Biosciences, The University of Queensland), Candice Michael (University of New South Wales; Autism CRC), Melanie Muniandy (Olga Tennison Autism Research Centre, La Trobe University; Autism CRC), Melissa Neylan (Mater Medical Research Institute), Michaela Nothard (Mater Medical Research Institute; Autism CRC). Open access publishing facilitated by University of New South Wales, as part of the Wiley - University of New South Wales agreement via the Council of Australian University Librarians. [Correction added on 07 September 2022, after first online publication: The Acknowledgments section has been updated.]

FUNDING INFORMATION

This work is supported by Sydney Partnership for Health Education Research and Enterprise funding to Nisha E. Mathew, Anne Masi, Adam K. Walker, Margaret J. Morris, and Chee Y. Ooi (Grants#: PS56837; O200005). Nisha E. Mathew is funded by the Australian Government Department of Education, Skills and Employment Research Training Program and a NeuRA top up award. Adam K. Walker is supported by the Schizophrenia Research Institute and Neuroscience Research Australia (Grant#: GXX0049). Chee Y. Ooi is supported by a National Health and Medical Research Council Investigator Grant (Grant#: APP1194358) funded by the Australian government.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Nisha E. Mathew https://orcid.org/0000-0002-0634-730X
Kylie-Ann Mallitt https://orcid.org/0000-0002-5722-7287
Anne Masi https://orcid.org/0000-0002-3135-6961
Adam K. Walker https://orcid.org/0000-0003-3772-5745
Margaret J. Morris https://orcid.org/0000-0003-2285-5117
Chee Y. Ooi https://orcid.org/0000-0001-7111-0926

REFERENCES

Ahearn, W. H., Castine, T., Nault, K., & Green, G. (2001). An assessment of food acceptance in children with autism or pervasive developmental disorder-not otherwise specified. *Journal of Autism and Developmental Disorders*, *31*(5), 505–511. https://doi.org/10.1023/a:1012221026124

Alley, T. R., & Potter, K. A. (2011). Food neophobia and sensation seeking. In R. W. Colin, R. Martin, & P. Y. Victor (Eds.), *Handbook of behavior, food and nutrition* (pp. 707–724). Springer. https://doi.org/10.1007/978-0-387-92271-3

Alvares, G. A., Dawson, P. A., Dissanayake, C., Eapen, V., Gratten, J., Grove, R., Henders, A., Heussler, H., Lawson, L., Masi, A., Raymond, E., Rose, F., Wallace, L., Wray, N. R., Whitehouse, A. J. O., & Australian Autism Biobank team. (2018). Study protocol for the Australian autism biobank: An international resource to advance autism discovery research. *BMC Pediatrics*, *18*(1), 1–9. https://doi.org/10.1186/s12887-018-1255-z

Aponte, C. A., & Romanczyk, R. G. (2016). Assessment of feeding problems in children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *21*, 61–72. https://doi.org/10.1016/j.rasd.2015.09.007

Australian Institute of Health and Welfare. (2019). *Poor diet in children* (PHE 249). Canberra. https://www.aihw.gov.au/reports/food-nutrition/poor-diet/contents/poor-diet-in-children

Bandini, L. G., Anderson, S. E., Curtin, C., Cermak, S., Evans, E. W., Scampini, R., Maslin, M., & Must, A. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *The Journal of Pediatrics*, *157*(2), 259–264. https://doi.org/10.1016/j.jpeds.2010.02.013

Bandini, L. G., Curtin, C., Phillips, S., Anderson, S. E., Maslin, M., & Must, A. (2017). Changes in food selectivity in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *47*(2), 439–446. https://doi.org/10.1007/s10803-016-2963-6

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Beighley, J. S., Matson, J. L., Rieske, R. D., & Adams, H. L. (2013). Food selectivity in children with and without an autism spectrum disorder: Investigation of diagnosis and age. *Research in Developmental Disabilities*, *34*(10), 3497–3503. https://doi.org/10.1016/j.ridd.2013.07.026

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal statistical Society: Series B – Methodological*, *57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Bere, E., Brug, J., & Klepp, K. I. (2008). Why do boys eat less fruit and vegetables than girls? *Public Health Nutrition*, *11*(3), 321–325. https://doi.org/10.1017/s1368980007000729

Bicer, A. H., & Alsaffar, A. A. (2013). Body mass index, dietary intake and feeding problems of Turkish children with autism spectrum disorder (ASD). *Research in Developmental Disabilities*, *34*(11), 3978–3987. https://doi.org/10.1016/j.ridd.2013.08.024

Brug, J., Tak, N. I., Te Velde, S. J., Bere, E., & De Bourdeaudhuij, I. (2008). Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: Results from observational studies. *British Journal of Nutrition*, *99*(S1), S7–S14. https://doi.org/10.1017/S0007114508892458

Burrows, T. L., Collins, K., Watson, J., Guest, M., Boggess, M. M., Neve, M., Rollo, M., Duncanson, K., & Collins, C. E. (2014). Validity of the Australian recommended food score as a diet quality index for pre-schoolers. *Nutrition Journal*, *13*, 87. https://doi.org/10.1186/1475-2891-13-87

Burrows, T. L., Truby, H., Morgan, P. J., Callister, R., Davies, P. S. W., & Collins, C. E.(2013). A comparison and validation of child versus parent reporting of children's energy intake using food frequency questionnaires versus food records: Who's an accurate reporter?*Clinical Nutrition*, *32*(4), 613–618. https://doi.org/10.1016/j.clnu.2012.11.006

Canals-Sans, J., Esteban-Figuerola, P., Morales-Hidalgo, P., & Arija, V. (2021). Do children with autism Spectrum disorders eat differently and less adequately than those with subclinical ASD and typical development? EPINED epidemiological study. *Journal of Autism and Developmental Disorders*, *52*, 361–375. https://doi.org/10.1007/s10803-021-04928-7

Centers for Disease Control and Prevention. (2000). *Modified z-scores in the CDC growthcharts*. http://www.cdc.gov/nccdphp/dnpa/growthcharts/resources/BIV-cutoffs.pdf

Chistol, L. T., Bandini, L. G., Must, A., Phillips, S., Cermak, S. A., & Curtin, C. (2018). Sensory sensitivity and food selectivity in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *48*(2), 583–591. https://doi.org/10.1007/s10803-017-3340-9

Collins, C. E., Burrows, T. L., Truby, H., Morgan, P. J., Wright, I. M. R., Davies, P. S. W., & Callister, R. (2013). Comparison of energy intake in toddlers assessed by food frequency questionnaire and total energy expenditure measured by the doubly labeled water method. *Journal of the Academy of Nutrition and Dietetics*, *113*(3), 459–463. https://doi.org/10.1016/j.jand.2012.09.021

Collins, M. S., Kyle, R., Smith, S., Laverty, A., Roberts, S., & Eaton-Evans, J. (2003). Coping with the usual family diet: Eating behaviour and food choices of children with Down's syndrome, autistic spectrum disorders or cri du chat syndrome and comparison groups of siblings. *Journal of Learning Disabilities*, *7*(2), 137–155. https://doi.org/10.1177/1469004704047504

Currais, A., Farrokhi, C., Dargusch, R., Goujon-Svrzic, M., & Maher, P. (2016). Dietary glycemic index modulates the behavioral and biochemical abnormalities associated with autism spectrum disorder. *Molecular Psychiatry*, *21*(3), 426–436. https://doi.org/10.1038/mp.2015.64

Dunn, W. (2014). *Sensory profile 2*. Psych Corporation.

Emond, A., Emmett, P., Steer, C., & Golding, J. (2010). Feeding symptoms, dietary patterns, and growth in young children with autism spectrum disorders. *Pediatrics*, *126*(2), e337–e342. https://doi.org/10.1542/peds.2009-2391

Evans, E. W., Must, A., Anderson, S. E., Curtin, C., Scampini, R., Maslin, M., & Bandini, L. (2012). Dietary patterns and body mass index in children with autism and typically developing children. *Research in Autism Spectrum Disorders*, *6*(1), 399–405. https://doi.org/10.1016/j.rasd.2011.06.014

Flegal, K. M., & Cole, T. J. (2013). Construction of LMS parameters for the Centers for Disease Control and Prevention 2000 growth charts. *National Health Statistics Report*, *63*, 1–3.

Folta, S. C., Curtin, C., Must, A., Pehrson, A., Ryan, K., & Bandini, L. (2020). Impact of selective eating on social domains among transition-age youth with autism spectrum disorder: A qualitative study. *Journal of Autism and Developmental Disorders*, *50*(8), 2902–2912. https://doi.org/10.1007/s10803-020-04397-4

Hill, A. P., Zuckerman, K. E., & Fombonne, E. (2015). Obesity and autism. *Pediatrics*, *136*(6), 1051–1061. https://doi.org/10.1542/peds.2015-1437

Hirokawa, K., Kimura, T., Ikehara, S., Honjo, K., Ueda, K., Sato, T., & Iso, H. (2020). Associations between broader autism phenotype and dietary intake: A cross-sectional study (Japan Environment & Children's study). *Journal of Autism and Developmental Disorders*, *50*(8), 2698–2709. https://doi.org/10.1007/s10803-020-04380-z

Ho, H. H., Eaves, L. C., & Peabody, D. (1997). Nutrient intake and obesity in children with autism. *Focus on Autism and Other Developmental Disabilities*, *12*(3), 187–192. https://doi.org/10.1177/108835769701200308

Hopper, J. L., Bishop, D. T., & Easton, D. F. (2005). Population-based family studies in genetic epidemiology. *The Lancet*, *366*(9494), 1397–1406. https://doi.org/10.1016/S0140-6736(05)67570-8

Hus, V., Gotham, K., & Lord, C. (2014). Standardizing ADOS domain scores: Separating severity of social affect and restricted and repetitive behaviors. *Journal of Autism and Developmental Disorders*, *44*(10), 2400–2412. https://doi.org/10.1007/s10803-012-1719-1

Hyman, S. L., Stewart, P. A., Schmidt, B., Cain, U., Lemcke, N., Foley, J. T., Peck, R., Clemons, T., Reynolds, A., Johnson, C., Handen, B., James, S. J., Courtney, P. M., Molloy, C., & Ng, P. K. (2012). Nutrient intake from food in children with autism. *Pediatrics*, *130*(Suppl 2), S145–S153. https://doi.org/10.1542/peds.2012-0900L

Johnson, C. R., Handen, B. L., Mayer-Costa, M., & Sacco, K. (2008). Eating habits and dietary status in young children with autism. *Journal of Developmental and Physical Disabilities*, *20*(5), 437–448. https://doi.org/10.1007/s10882-008-9111-y

Johnson, C. R., Turner, K., Stewart, P. A., Schmidt, B., Shui, A., Macklin, E., Reynolds, A., James, J., Johnson, S. L., & Courtney, P. M. (2014). Relationships between feeding problems, behavioral characteristics and nutritional quality in children with ASD. *Journal of Autism and Developmental Disorders*, *44*(9), 2175–2184. https://doi.org/10.1007/s10803-014-2095-9

Kuschner, E. S., Eisenberg, I. W., Orionzi, B., Simmons, W. K., Kenworthy, L., Martin, A., & Wallace, G. L. (2015). A preliminary study of self-reported food selectivity in adolescents and young adults with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *15*, 53–59. https://doi.org/10.1016/j.rasd.2015.04.005

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(1), 1–26. https://doi.org/10.18637/jss.v082.i13

Lane, A. E., Geraghty, M. E., Young, G. S., & Rostorfer, J. L. (2014). Problem eating behaviors in autism spectrum disorder are associated with suboptimal daily nutrient intake and taste/smell sensitivity. *ICAN: Infant, Child, & Adolescent Nutrition*, *6*(3), 172–180. https://doi.org/10.1177/1941406414523981

Leigh, S.-J., & Morris, M. J. (2020). Diet, inflammation and the gut microbiome: Mechanisms for obesity-associated cognitive impairment. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, *1866*(6), 165767. https://doi.org/10.1016/j.bbadis.2020.165767

Li, Y. J., Xie, X. N., Lei, X., Li, Y. M., & Lei, X. (2020). Global prevalence of obesity, overweight and underweight in children, adolescents and adults with autism spectrum disorder, attention-deficit hyperactivity disorder: A systematic review and meta-analysis. *Obesity Reviews*, *21*(12), e13123. https://doi.org/10.1111/obr.13123

Lombardo, M. V., Lai, M.-C., & Baron-Cohen, S. (2019). Big data approaches to decomposing heterogeneity across the autism spectrum. *Molecular Psychiatry*, *24*(10), 1435–1450. https://doi.org/10.1038/s41380-018-0321-0

Lord, C., Rutter, M., DiLavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism diagnostic observation schedule, (ADOS-2) modules 1–4*. Western Psychological Services.

Lukens, C. T., & Linscheid, T. R. (2008). Development and validation of an inventory to assess mealtime behavior problems in children with autism. *Journal of Autism and Developmental Disorders*, *38*(2), 342–352. https://doi.org/10.1007/s10803-007-0401-5

Malhi, P., Venkatesh, L., Bharti, B., & Singhi, P. (2017). Feeding problems and nutrient intake in children with and without autism: A comparative study. *The Indian Journal of Pediatrics*, *84*(4), 283–288. https://doi.org/10.1007/s12098-016-2285-x

Marí-Bauset, S., Llopis-González, A., Zazpe-García, I., Marí-Sanchis, A., & Morales-Suárez-Varela, M. (2015). Nutritional Status of Children with Autism Spectrum Disorders (ASDs): A Case–Control Study. *Journal of Autism and Developmental Disorders*, *45*(1), 203–212. https://doi.org/10.1007/s10803-014-2205-8

Marí-Bauset, S., Llopis-González, A., Zazpe, I., Marí-Sanchis, A., & Morales Suárez-Varela, M. (2017). Comparison of nutritional status between children with autism spectrum disorder and typically developing children in the Mediterranean Region (Valencia, Spain). *Autism*, *21*(3), 310–322. https://doi.org/10.1177/1362361316636976

Marshall, S., Burrows, T., & Collins, C. E. (2014). Systematic review of diet quality indices and their associations with health-related outcomes in children and adolescents. *Journal of Human Nutrition and Dietetics*, *27*(6), 577–598. https://doi.org/10.1111/jhn.12208

Marshall, S., Watson, J., Burrows, T., Guest, M., & Collins, C. E. (2012). The development and evaluation of the Australian child and adolescent recommended food score: A cross-sectional study. *Nutrition Journal*, *11*(1), 96. https://doi.org/10.1186/1475-2891-11-96

Martins, Y., Young, R. L., & Robson, D. C. (2008). Feeding and eating behaviors in children with autism and typically developing children. *Journal of Autism and Developmental Disorders*, *38*(10), 1878–1887. https://doi.org/10.1007/s10803-008-0583-5

Minihane, A. M., Vinoy, S., Russell, W. R., Baka, A., Roche, H. M., Tuohy, K. M., Teeling, J. L., Blaak, E. E., Fenech, M., Vauzour, D., HJ, M. A., Kremer, B. H., Sterkman, L., Vafeiadou, K., Benedetti, M. M., Williams, C. M., & Calder, P. C. (2015). Low-grade inflammation, diet composition and health: Current research evidence and its translation. *British Journal of Nutrition*, *114*(7), 999–1012. https://doi.org/10.1017/S0007114515002093

Nadon, G., Feldman, D. E., Dunn, W., & Gisel, E. (2011). Mealtime problems in children with autism spectrum disorder and their typically developing siblings: A comparison study. *Autism*, *15*(1), 98–113. https://doi.org/10.1177/1362361309348943

National Health and Medical Research Council (NHMRC) (2006). Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes. Canberra, Australia: National Health and Medical Research Council.

National Health and Medical Research Council (2013). Australian dietary guidelines. Canberra, Australia: National Health and Medical Research Council. Australia

Nishida, C., Shetty, P., & Uauy, R. (2004). Diet, nutrition and the prevention of chronic diseases: Scientific background papers of the joint WHO/FAO expert consultation (Geneva, 28 January-1 February 2002)-Introduction. *Public Health Nutrition*, *7*(1), 99–100. https://doi.org/10.1079/PHN2003592

Padmanabhan, P., & Shroff, H. (2020). The relationship between sensory integration challenges and the dietary intake and nutritional status of children with autism spectrum disorders in Mumbai, India. *International Journal of Developmental Disabilities*, *66*(2), 142–152. https://doi.org/10.1080/20473869.2018.1522816

Page, S. D., Souders, M. C., Kral, T. V. E., Chao, A. M., & Pinto-Martin, J. (2021). Correlates of feeding difficulties among children with autism Spectrum disorder: A systematic review. *Journal of Autism and Developmental Disorders*, *52*, 255–274. https://doi.org/10.1007/s10803-021-04947-4

Panerai, S., Ferri, R., Catania, V., Zingale, M., Ruccella, D., Gelardi, D., Fasciana, D., & Elia, M. (2020). Sensory profiles of children with autism spectrum disorder with and without feeding problems: A comparative study in sicilian subjects. *Brain Sciences*, *10*(6), 336. https://doi.org/10.3390/brainsci10060336

Panossian, C., Lyons-Wall, P., Whitehouse, A., Oddy, W. H., Lo, J., Scott, J., & O'Sullivan, T. A. (2021). Young adults with high autistic-like traits displayed lower food variety and diet quality in childhood. *Journal of Autism and Developmental Disorders*, *51*(2), 685–696. https://doi.org/10.1007/s10803-020-04567-4

Pham, D., Silver, S., Haq, S., Hashmi, S. S., & Eissa, M. (2020). Obesity and severe obesity in children with autism spectrum disorder: Prevalence and risk factors. *Southern Medical Journal*, *113*(4), 168–175. https://doi.org/10.14423/smj.0000000000001068

Rahaman, M. A., Lopa, M., Uddin, K. F., Baqui, M. A., Keya, S. P., Faruk, M. O., Sarker, S., Basiruzzaman, M., Islam, M., Al Banna, A., Jahan, N., Chowdhury, M. A. K. A., Saha, N., Hussain, M., Colombi, C., O'Rielly, D., Woodbury-Smith, M., Ghaziuddin, M., Rahman, M. M., & Uddin, M. (2021). An exploration of physical and phenotypic characteristics of Bangladeshi children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *51*(7), 2392–2401. https://doi.org/10.1007/s10803-020-04703-0

Rhodes, K., Chan, F., Prichard, I., Coveney, J., Ward, P., & Wilson, C. (2016). Intergenerational transmission of dietary behaviours: A qualitative study of Anglo-Australian, Chinese-Australian and Italian-Australian three-generation families. *Appetite*, *103*, 309–317. https://doi.org/10.1016/j.appet.2016.04.036

Schmitt, L., Heiss, C. J., & Campbell, E. E. (2008). A comparison of nutrient intake and eating behaviors of boys with and without autism. *Topics in Clinical Nutrition*, *23*(1), 23–31. https://doi.org/10.1097/01.TIN.0000312077.45953.6c

Schofield, W. N. (1985). Predicting basal metabolic rate, new standards and review of previous work. *Human Nutrition. Clinical Nutrition*, *39*, 5–41.

Schreck, K. A., & Williams, K. (2006). Food preferences and factors influencing food selectivity for children with autism spectrum disorders. *Research in Developmental Disabilities*, *27*(4), 353–363.

Schreck, K. A., Williams, K., & Smith, A. F. (2004). A comparison of eating behaviors between children with and without autism. *Journal of Autism and Developmental Disorders*, *34*(4), 433–438. https://doi.org/10.1023/b:jadd.0000037419.78531.86

Sharp, W. G., Berry, R. C., McCracken, C., Nuhu, N. N., Marvel, E., Saulnier, C. A., Klin, A., Jones, W., & Jaquess, D. L. (2013). Feeding problems and nutrient intake in children with autism spectrum disorders: A meta-analysis and comprehensive review of the literature. *Journal of Autism and Developmental Disorders*, *43*(9), 2159–2173. https://doi.org/10.1007/s10803-013-1771-5

Shmaya, Y., Eilat-Adar, S., Leitner, Y., Reif, S., & Gabis, L. (2015). Nutritional deficiencies and overweight prevalence among children with autism spectrum disorder. *Research in Developmental Disabilities*, *38*, 1–6. https://doi.org/10.1016/j.ridd.2014.11.020

Siddiqi S., Urooj A., D'Souza M. J. (2019). Dietary Patterns and Anthropometric Measures of Indian Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders* *49*(4), 1586–1598. https://10.1007/s10803-018-3850-0.

Sutherland, R., Katz, T., Liu, V., Quintano, J., Brunner, R., Tong, C. W., Collins, C. E., & Ooi, C. Y. (2018). Dietary intake of energy-dense, nutrient-poor and nutrient-dense food sources in children with cystic fibrosis. *Journal of Cystic Fibrosis*, *17*(6), 804–810. https://doi.org/10.1016/j.jcf.2018.03.011

Wallace, G. L., Richard, E., Wolff, A., Nadeau, M., & Zucker, N. (2021). Increased emotional eating behaviors in children with autism: Sex differences and links with dietary variety. *Autism*, *25*(3), 603–612. https://doi.org/10.1177/1362361320942087

Watson, J. F., Collins, C. E., Sibbritt, D. W., Dibley, M. J., & Garg, M. L. (2009). Reproducibility and comparative validity of a food frequency questionnaire for Australian children and adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, *6*(1), 1–17. https://doi.org/10.1186/1479-5868-6-62

Weinberg, C., & Umbach, D. M. (2000). Choosing a retrospective design to assess joint genetic and environmental contributions to risk. *American Journal of Epidemiology*, *152*(3), 197–203. https://doi.org/10.1093/aje/152.3.197

Williams, Z. J., Failla, M. D., Gotham, K. O., Woynaroski, T. G., & Cascio, C. (2018). Psychometric evaluation of the short sensory profile in youth with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *48*(12), 4231–4249. https://doi.org/10.1007/s10803-018-3678-7

Yap, C. X., Henders, A. K., Alvares, G. A., Wood, D. L. A., Krause, L., Tyson, G. W., Restuadi, R., Wallace, L., McLaren, T., Hansell, N. K., Cleary, D., Grove, R., Hafekost, C., Harun, A., Holdsworth, H., Jellett, R., Khan, F., Lawson, L. P., Leslie, J., … Gratten, J. (2021). Autism-related dietary preferences mediate autism-gut microbiome associations. *Cell*, *184*, 5916–5931.e17. https://doi.org/10.1016/j.cell.2021.10.015

Yeung, S. S., Chan, R., Li, L., Chan, D., Leung, J., & Leung, T.-F. (2021). Eating behaviors and diet quality in chinese preschoolers with and without autism spectrum disorder: A case-control study. *The Journal of Pediatrics*, *237*, 258–266.e255. https://doi.org/10.1016/j.jpeds.2021.06.017

Zimmer, M. H., Hart, L. C., Manning-Courtney, P., Murray, D. S., Bing, N. M., & Summer, S. (2012). Food variety as a predictor of nutritional status among children with autism. *Journal of Autism and Developmental Disorders*, *42*(4), 549–556. https://doi.org/10.1007/s10803-011-1268-z

Zuckerman, K. E., Hill, A. P., Guion, K., Voltolina, L., & Fombonne, E. (2014). Overweight and obesity: Prevalence and correlates in a large clinical sample of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *44*(7), 1708–1719. https://doi.org/10.1007/s10803-014-2050-9

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Mathew, N. E., Mallitt, K.-A., Masi, A., Katz, T., Walker, A. K., Morris, M. J., & Ooi, C. Y. (2022). Dietary intake in children on the autism spectrum is altered and linked to differences in autistic traits and sensory processing styles. *Autism Research*, *15*(10), 1824–1839. https://doi.org/10.1002/aur.2798