

Sensory Processing Dysfunction and Mealtime Behavior Problems in Children With Autism

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Objectives: To compare sensory processing and mealtime problem behaviors among children with autism spectrum disorder (ASD) and typically developing controls, and to examine the relationship between atypical sensory processing and eating problems in children with ASD. **Methods:** 50 children (4-10 years) with a diagnosis of ASD as per DSM-5 were recruited from the pediatric psychology clinic of a tertiary care center in India. The Brief Assessment of Mealtime Behavior in Children (BAMBIC) and the Short Sensory Profile (SSP) were administered to measure feeding and sensory processing problems, respectively. Parents were interviewed about their child's dietary intake using a 3-day dietary recall. **Results:** The ASD group showed greater mealtime behavior problems than the control group and had significantly higher total scores on the BAMBIC ($P<0.001$), and on two of the three subscales including food refusal ($P<0.001$) and disruptive behavior ($P<0.001$). The ASD group, relative to the neurotypical children, showed atypical response on majority of the subscales of the short sensory profile including tactile sensitivity ($P<0.001$), taste sensitivity ($P<0.001$), movement sensitivity ($P<0.001$), under responsiveness ($P<0.001$), auditory filtering ($P<0.001$), low weak/energy ($P=0.02$), and visual/auditory sensitivity ($P<0.001$). **Conclusions:** The study underscores the need for detailed evaluation of sensory processing and feeding problems of children with ASD so that the interventions can be tailored to address their unique sensory characteristics.

Keywords: Feeding problems, Nutritional inadequacies, Sensory dysfunction.

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Children with autism spectrum disorder (ASD) have many aberrant behaviors including limited food preferences, avoidance of certain foods, non-functional mealtime rituals, pica, hypersensitivity to food textures or temperatures, eating only specific brands of foods, and smelling food items before consuming [1-3]. In a recent study, Mayes, et al. [4] assessed the aberrant eating behaviors of 1462 children with ASD. They found that 70% of children with ASD had feeding difficulties compared to only 5% of the typically developing children. The authors argued that early unusual feeding patterns of behavior in children might help distinguish autism from other disorders and should be considered a red flag for autism by clinicians [4]. Indeed, research indicates that atypical food preferences may be prevalent as early as 15 months of age, and this may increase the risk for nutritional deficiencies and malnutrition among children with ASD [5-7]. Mealtimes are especially challenging for parents, and studies show greater parental stress associated with the feeding of their autistic children and increased caregiver burden [7-9].

Research suggests an association between sensory processing problems, food refusal, and nutritional adequacy in children with ASD [7,10,11]. For instance, Nadon, et al. [10] examined the relationship between sensory processing problems and the number of eating difficulties reported by parents in 95 children aged 3-10 years with ASD. They found that children with tactile, visual or auditory sensitivities were more likely to have a more restricted food repertoire than children with typical sensory processing profile [10]. Thus, there is a need to understand the complexity of sensory sensitivity issues leading to a narrower range of diets, and design specific strategies to decrease challenging mealtime behaviors. Despite a growing body of literature on feeding selectivity in children with ASD, limited research has been done regarding sensory processing dysfunction and food selectivity issues in children with ASD, particularly in developing countries. There is a need to address some of the factors associated with challenging mealtime behaviors among children with ASD to address the nutritional inadequacies found in these children. This study aims to compare sensory dysfunction and the

number of mealtime behavior problems among ASD and typically developing controls, and to examine the relationship between atypical sensory processing and atypical eating in children with ASD.

METHODS

Fifty children with ASD (DSM-5 criteria), aged 4 to 10 years, were consecutively enrolled from the pediatric psychology clinic and neurodevelopment clinic of a pediatrics department in an advanced pediatric center. All children with any chronic medical condition, on any exclusion diet, and any medications that could alter feeding were excluded. A total of 28 age-matched (within four months) typically developing children were recruited as controls. The study was approved by the Institute review board, and informed signed consent was obtained from the caregivers.

Tools: Brief assessment of mealtime behavior in children (BAMBIC) consists of 10 items and these assess three domains of mealtime behaviors including food refusal, limited variety of food intake, and disruptive mealtime behaviors [12]. The parent has to respond to each item of the scale using a 5-point scale ranging from always to never. The responses to each item were summed to yield a total score. Higher scores indicated more problem feeding behaviors. Short sensory profile (SSP) is a 38-item questionnaire that assesses seven sensory domains: tactile, taste/smell, movement, under-responsive/seeks sensation, auditory filtering, low energy/weak, and visual/auditory [13]. Each item is answered on a 5-point scale with responses ranging from always to never, with higher scores indicating more typical performance while low scores indicate heightened sensitivity in that area.

Parents were interviewed about their child's dietary intake using a 3-day dietary recall. Parents were asked to list the food items and the quantity which their child consumed during breakfast, lunch, snack, and dinner time. The three-day recall of macro- and micro-nutrient consumption was calculated and compared with the recommended dietary allowances (RDA) as per age requirements provided by the ICMR 2017 using the Diet Software. For food selectivity, parents were asked to report whether their children would eat commonly consumed foods present in an Indian diet (vegetables, proteins, fruits, dairy products, starches) and the responses were recorded as: almost never/rarely, sometimes and frequently/always. Based on the caregivers' responses, the two groups were compared on food selectivity as defined by the percentage of children who almost never or rarely consumed various foods. The height and weight of all participants was taken, and body mass index (BMI) was calculated.

Statistical analysis: The two groups were compared using the *t* test for continuous variables and chi-square test for categorical variables. Multivariate stepwise regression analysis was performed to identify the predictors of the total score on the BAMBIC scale among the ASD children. The predictors used in the analysis were the seven subscale scores of the SSP.

RESULTS

We enrolled 50 children with ASD and 28 typically developing children. There were no significant differences among the groups for baseline characteristics (**Table I**). Severe autism, as assessed by the Childhood Autism Rating Scale (CARS), was seen in 38 (76.7%) children.

The ASD group showed greater mealtime behavior problems than the typically developing group and had significantly higher total scores on the BAMBIC ($P<0.001$), and on two of the three subscales of BAMBIC including food refusal ($P<0.001$) and disruptive behavior ($P<0.001$). **Web Table I** presents comparative group responses on each of the BAMBIC items. Children with ASD were more likely to scream or cry at mealtimes ($P=0.04$), turn their face or body away from food ($P=0.03$), close the mouth tightly when food was presented ($P=0.04$), and show aggressive behavior ($P=0.04$) and disruptive behavior ($P=0.006$) than typically developing children.

Comparison of the groups on food preferences revealed that a significantly higher proportion of children with ASD refused to eat commonly consumed fruits like apple ($P=0.004$), pomegranate ($P<0.001$), and guava ($P=0.04$); and vegetables like bitter melon ($P=0.004$), ladyfinger ($P=0.009$), potato ($P=0.06$), and cauliflower ($P=0.002$), and proteins like red kidney beans (*rajma*) ($P=0.004$), chick peas (*chana*) ($P=0.02$), and snacks like cold drinks ($P=0.02$) and chips ($P=0.003$). Despite

Table I Comparison of Groups on Socioeconomic and Demographic Variables

Characteristics	ASD (n=50)	TD (n=28)
Age (y), mean (SD)	5.3 (1.38)	5.96 (1.38)
Boys, n (%)	72.0	67.9
Urban residence, n (%)	70.0	51.1
<i>Socioeconomic status, n (%)</i>		
Lower	12.0	25.0
Middle	64.0	57.1
Upper	24.0	17.9
Nuclear family, n (%)	56.0	53.6

ASD: autism spectrum disorder; TD: typically developing children. All *P* values >0.05.

limited food diversity, no significant group differences on the mean daily intake of calories ($P=0.9$) and fats were found. However, children with ASD had lower consumption of proteins ($P=0.04$), vitamin D ($P=0.04$) and folic acid ($P<0.001$) when compared to typically developing children. Among the micronutrients, the mean intake of sodium was also significantly low ($P=0.002$). The intake of vitamin C, copper, zinc, and calcium were comparable.

Significantly higher proportion of children with ASD showed atypical response on all the subscales on the short sensory profile as compared to typically developing children (**Table II**). The mean total score on the SSP score ($P<0.001$) and all the subscales of the SSP profile were significantly lower as compared to control group suggesting atypical sensory processing in children with autism. Specifically, ASD children had lower scores than the control group on the subscales of tactile sensitivity ($P<0.001$), taste sensitivity ($P<0.001$), movement sensitivity ($P<0.001$), under responsiveness ($P<0.001$), auditory filtering ($P<0.001$), low weak/energy ($P=0.02$), and visual/auditory sensitivity ($P<0.001$). Anthropometric parameters were comparable in terms of weight ($P=0.02$) and BMI ($P=0.55$); however, ASD children had significantly lower height as compared to the typically developing group ($P=0.04$).

Multivariate stepwise regression analysis revealed that 31% of the total score variance on the BAMBIC scale was explained by two of the SSP subscales, namely the taste sensitivity and the auditory-visual sensitivity. Parents of ASD children with more atypical scores on the taste/smell and auditory/visual subdomains of the SSP were significantly more likely to report mealtime behavior difficulties ($P=0.01$).

Table II Performance on Short Sensory Profile (SSP) for Children With Autism Spectrum Disorder and Typically Developing Children

<i>Subscales of SSP</i>	<i>Autism spectrum disorder, n=50</i>	<i>Typically developing children, n=28</i>
Tactile sensitivity	23.63(55)	30.1 (2.99)
Taste sensitivity	11.7 (3.57)	15.9 (2.78)
Movement sensitivity	9.9 (2.73)	12.9 (1.72)
Under responsive	21.4 (4.28)	28.8 (3.92)
Auditory filtering	16.7 (3.93)	24.4 (4.68)
Low/weak energy ^a	22.4 (4.75)	25.0 (4.13)
Visual/auditory sensitivity	17.3 (3.75)	21.3 (2.47)
Total score	123.06 (13.83)	158.32 (15.49)

All values in mean (SD). $P<0.001$ for all comparisons except ^a $P=0.02$.

DISCUSSION

We examined sensory sensitivities, mealtime behaviors, and nutritional insufficiencies of children with ASD and compared it to a group of typically developing children matched on age. Parents of children with ASD reported significantly greater number of problem behaviors during feeding, food refusal, higher sensory sensitivities, and nutritional deficiencies as compared to controls. Indeed, the prevalence of a restricted variety of foods consumed by children with autism is 30-84% and these rates are significantly higher than those reported in typically developing children [2,4,14-15]. Moreover, atypical eating behaviors among ASD children are also related to increased problem behaviors in children including heightened irritability, anxiety, emotional lability, and oppositional behavior [3,7].

Previous studies have found a significant association between oral, visual and auditory sensitivities and a number of feeding problems [9-11,16-18]. Evidence indicates that the ASD children with atypical oral sensory processing refuse more foods and eat fewer vegetables and it has been suggested that addressing the oral sensory processing problems may help in mitigating selective and picky eating [7,18,19]. Current findings extend previous research by documenting that the auditory and visual sensitivities may also be associated with limited food repertoire in children with ASD. Possibly, the noise during mealtimes, ongoing conversations, sound of the spoon against utensils and the like may cause the hypersensitive ASD children to overreact, and this may reflect in lower quality of diet, rejection of nutritious foods, and disruptive behaviors at mealtimes. Children with visual sensory dysfunction may also be overly sensitive to the presentation of meals as this may be associated with food aversions, unpleasant food textures, picky eating, and behavioral disturbances.

Previous studies have reported that feeding problems may not translate into non-optimal growth in the short run, and caution should be exercised on anthropometric measures' reliability as measures of dietary adequacy in children with ASD [2,14,20]. Our results further extend these findings that consumption of a limited food variety may put young children with autism at higher risk for nutritional insufficiencies and compromised growth. However, these findings need further corroboration as they are based on a small size of ASD children.

The study has a few limitations including the small sample size, which may have resulted in decreased power for analyzing differences between groups. Moreover, obtaining a reliable three-day dietary record of the child was often challenging as parents had difficulty in

WHAT THE STUDY ADDS?

- Feeding problems in children with autism spectrum disorder are associated with sensory processing sensitivities.

recalling and estimating quantities of various foods consumed by the child. Perhaps maintaining a detailed behavioral mealtime log may help get more valid information on the child's food intake. Future extension of the work needs to incorporate more objective measures along with parent reported questionnaires.

Children with ASD have marked feeding problems along with sensory processing sensitivities, nutritional inadequacies, and compromised growth. The study underscores the need for a detailed evaluation of mealtime behaviors and sensory processing dysfunction of children with ASD, so that interventions can be initiated at the earliest to increase food intake variety and encourage healthy eating habits. Intervention strategies need to be personalized to address each child's unique sensory characteristics, and a sensory integration approach may be used to alleviate mealtime challenging behaviors and caregiver burden.

Note: Additional material related to this study is available with the online version at www.indianpediatrics.net

Ethics clearance: Institute ethics committee; No.11115/PG-2Trg/2016/7695-96, dated May 18, 2017.

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Web Table I Comparison of Children With Autism Spectrum Disorder and Typically Developing Children on Brief Assessment of Mealtime Behavior in Children

<i>Subscale/items of BAMBIC</i>	<i>Group</i>	<i>Never/seldom</i>	<i>Occasionally</i>	<i>Often/always</i>	<i>P value</i>
<i>Food refusal subscale</i>					
Screams during mealtimes	ASD TD	52.0 75.0	24.0 21.4	24.0 3.6	0.047
Turns face away from food	ASD TD	36.0 67.9	28.0 14.3	36.0 17.9	0.03
Closes mouth when food presented	ASD TD	40.0 67.9	16.0 14.3	44.0 17.9	0.04
<i>Limited variety subscale</i>					
Tries new foods	ASD TD	36.0 42.9	30.0 14.3	34.0 42.9	0.29
Dislikes certain foods	ASD TD	40.0 57.1	26.0 21.4	34.0 21.4	0.32
.Prefers same food	ASD TD	38.0 71.4	34.0 10.7	28.0 17.9	0.01
Accepts variety of foods	ASD TD	30.0 39.3	24.0 7.1	46.0 35.9	0.17
<i>Disruptive behavior subscale</i>					
Aggressive during mealtimes	ASD TD	50.0 78.6	22.0 10.7	28.0 10.7	0.04
Self-injurious at mealtimes	ASD TD	72.0 92.9	18.0 7.1	10.0 0.0	0.07
Disruptive during mealtimes	ASD TD	46.0 82.1	32.0 14.3	22.0 3.6	0.006

Values in percentages. BAMBIC-Brief assessment of mealtime behavior in children; TD-typically developing children ; ASD-autism spectrum disorder.