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Parent-reported feeding characteristics in children with ASD vs. children who are typically developing

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Abstract

Background: Parents of children with autism spectrum disorders (ASDs) often report that their children have multiple dietary behavior problems than parents of typically developing (TD) children do. This may affect proper nutrition and subsequently adequate growth and development in children with ASD. The current study aimed to assess the feeding behavior in recently diagnosed children with autism spectrum disorders (ASD) ranged in age from 2 to 4 years and compare it with typically developing (TD) children and to explore the relationship between feeding behaviors and autism severity using the Montreal Children's Hospital Feeding Scale (MCH) and Childhood Autism Rating Scale (CARS), respectively. Parents of 35 preschool children (2–4 years) with ASD completed reports of physical measurements, feeding interview, Childhood Autism Rating Scale (CARS), and Montreal Children's Hospital Feeding Scale (MCH Feeding-Scale). The collected data from parents of children with ASD were analyzed and compared with 70 typically developed children matched with age and sex.

Results: ASD children showed statistically significantly more problematic feeding behaviors in most of the assessed eating characters compared with TD children, e.g., food neophobia, eating non-food items instead of food, requiring assistance during eating, and feeding avoidance to particular textures and taste. The mean total score of the MCH feeding scale differed significantly between children with ASD and TD children. No correlation was found between the mean total score of the MCH feeding scale and CARS scores.

Conclusion: Our findings revealed a high rate of behavioral feeding problems in children with ASD. Future work will be needed to follow up the feeding behaviors and to develop practical feeding approaches for ASD children to maintain nutritional adequacy.

Keywords: Parents, Feeding, Children, Autism

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Background

Parents of children with autism spectrum disorders (ASDs) often report that their children have multiple dietary behavior problems than parents of typically developing (TD) children do [1–3]. This may affect proper nutrition and subsequently adequate growth and development in children with ASD.

Earlier studies demonstrated a wide prevalence range of feeding problems in ASD children extending from 13 to 80% [4]. More recently, Nadon et al. [5] stated that 80% of children with ASD experience feeding problems. Results by Seiverling et al. [6] supported that children with ASD in early age have significantly more feeding problems with special concern to food selectivity than typically developed ones.

Food selectivity, as described by parents of children with ASD, includes picky eating, frequent food refusals, mealtimes' rituals, limited repertoires of foods [4], and selective intake of certain food categories, such as carbohydrates [7], uniform food preferences, and unusual feeding behaviors [8, 9]. The prevalence estimates of selective food acceptance in children with ASD vary, but researchers have consistently found that more than half of children with ASD exhibit limited food acceptance [4, 10, 11].

Food refusal may be caused by a variety of reasons, including smell, texture, and color [4]. Aversions to certain textures as well as eating inedible objects have been reported [12]. Behaviors such as consuming more salty and sugary foods, refusal of fruits, and vegetables are considered the most important factors that reduce the nutritional value [13].

The unclear nomenclature of feeding and eating problems in children with ASD makes it difficult to determine whether such problems are attributed to autism traits or a separate diagnosis. Several factors may contribute to the development and persistence of eating problems. These factors included the autism traits attribution, the underlying genetic vulnerability that interacted with environmental factors, or underlying difficulties in cognitive, social, and/or emotional functioning [14–16]. Brede et al. (2020) [17] linked sensory sensitivities, social difficulties, and emotional difficulties to restrictive food intake in children with ASD.

It was hypothesized that feeding difficulties are common in children with autism [6], but a vast majority of studies investigated this issue in older children [3, 4, 7, 8]. Few recent studies have urged that feeding problems begin early at a young age in children with ASD [6, 18–20].

Recent guidelines recommend starting an integrated behavioral and developmental behavioral intervention as soon as ASD diagnosis is settled [19]. As early as 2 or 3 years of age, a child's brain is still forming [20], and

more "plastic" than at older ages. Early identification of and intervention for feeding problems in autism could be advantageous because of the brain's plasticity in this age range.

Additionally, the first required step to initiate a positive change in children's eating behavior lies in communicating the knowledge between professionals and parents [21]. The use of parental reports of foods eaten and behaviors related to eating in the chosen target age may guide professionals to create an alternative feeding strategy for early intervention that goes hand in hand with other core autism behavior rehabilitation.

In summary, there is a lack of research on feeding behavior problems in children recently diagnosed with ASD and hardly any research work has been reported from Egypt. This has important implications not only for diagnostic purposes but also for the potential intervention. Therefore, the first purpose of this study was to compare the general problematic feeding behaviors of children with ASD and TD children such as food selectivity, food neophobia, eating non-food items instead of food, and ritualistic feeding behaviors, that are experienced by these two groups using a sample of recently diagnosed children with ASD who were not referred to nutritional clinics before, and using a matched control group of TD children with restricted age range (2–4 years). The second purpose was to explore the relationship between feeding behavior and autism severity using the Montreal Children's Hospital Feeding Scale (MCH) and Childhood Autism Rating Scale (CARS) scores as an indicator of feeding behaviors difficulties and autism severity in children with ASD, respectively.

Methods

Ethics

Before starting the study, all parents were informed of the study protocol by the nurse coordinator, and written informed consent was obtained. The study was approved by the Ethics Committee No: FMBSUREC/03112019/ Abdelhameed.

Participants

A cross-sectional, case-control observational study was conducted between January 2020 and April 2020. At first, 150 children agreed to take part in the study: 50 in the case group (children with ASD) and 100 controls (typically developing, TD). The selection criteria of the case group: (1) All the children in the case group were 2–4 years of age and were recruited to the outpatient clinic of Phoniatics Unit. (2) The diagnosis of ASD was performed by a multidisciplinary team (composed of a senior child psychiatrist, a phoniatician, and an experienced child psychologist), which was confirmed by evaluation of DSM-V criteria [22], and administration of

the Childhood Autism Rating Scale (CARS) (Arabic version) [23]. (3) Children with ASD performed also some recommended laboratory tests and assessments to rule out any other medical conditions, including audiometry, assessment of thyroid function, cerebral palsy or other neurological disorder, known genetic or chromosomal abnormality, and severe visual or hearing impairment. In addition, children with food allergies or on medications which may modify dietary intake were excluded from the study. (4) All children with ASD were recently diagnosed with autism by previous measures (DSM-V & CARS) within 2 weeks before they were invited to participate in the study.

The control group was recruited from preschool nurseries. They were matched to the ASD group for age and gender. In addition to the previously mentioned above exclusion criteria for the ASD group, exclusion criteria for TD children were (a) no parental concern about their children motoric development, no complaints of language or speech disorders, no prior speech therapy, and adequate performance in the Modified Preschool Language Scale [24]. (b) TD children did not demonstrate significant difficulties with social (eye contact, lack of social interaction) or repetitive behaviors.

Finally, due to failure to receive or complete the questionnaires, 15 and 30 children were excluded from the case and control groups, respectively. The final sample consisted of 105 children: 35 with ASD (case group) and 70 with TD (control group).

All participants completed one study visit during which demographic information was collected (Vineland Adaptive Behavior Scales score, CARS, birth weight, number of children in family, mother's average age), body mass index (BMI) was measured, and the parents/mothers from both groups were asked to complete a feeding interview questionnaire and the Montreal Children's Hospital Feeding Scale (MCH-Feeding Scale) [25] after a brief explanation for describing their children feeding behavior over the previous 6 months before the study.

Procedures

Childhood Autism Rating Scale (CARS) (Arabic version) [23]

CARS is the most widely used standardized behavioral rating scale of autistic characteristics in children over the age of two. The CARS includes 14 domains for assessing autism-related behaviors, such as imitation, verbal and nonverbal communication, emotional responsiveness, body and object use, and intellectual and activity levels. The 15th domain rates the general impression of autism. Each domain is scored on a scale ranging from one to four, with higher scores indicating a higher level of impairment. Total scores can range from a low of 15 to a high of 60; scores less than 30 indicate that

the individual is not autistic, scores between 30 and 36.5 indicate mild to moderate autism, and scores from 37 to 60 indicate severe autism [26].

Semi-structured feeding interview

Participants completed an open-ended and closed-ended feeding interview (yes or no). For answering questions related to types of food preference, parents were given a choice of three descriptions: no, some, or all. The physician defined the previous answers to provide parents with a reliable way to describe their child's food preference (no defined as no item selected in this food category), some (one or two items selected), and all (three or more items selected). The interview questions investigated general eating, chewing, choking, and swallowing behaviors as well as feeding therapy, and included questions, e.g., about food neophobia, eating non-food items, use of special diets, and whether their child currently or in the past year refused foods based on different characteristics, such as texture, color, and taste. The feeding interview was developed and is based on previous research on behavioral feeding difficulties experienced in children [27, 28, 29].

Montreal Children's Hospital Feeding Scale (MCH-Feeding Scale) [25]

Items for MCH-Feeding Scale targeted at children aged 6 months to 6 years. The scale included 14 items that covered various feeding domains, with some items that were common overlap, including oral motor (items 8 and 11), oral sensory (items 7 and 8), and appetite (items 3 and 4). Other items addressed maternal concerns about feeding (items 1, 2, and 12), mealtime behaviors (items 6 and 8), maternal strategies used (items 5, 9, and 10), and family reactions to their child's feeding (items 13 and 14). Each item is rated on a seven-point Likert scale with the anchor points at either end. Seven items are scored from negative to positive direction, and the remaining seven from positive to negative direction. The parent/caregiver marks each item according to the frequency of a feeding behavior. After reversing the scores of seven items from negative to positive, the total feeding problem score is calculated by adding the scores for each item.

Statistical analysis

Statistical Package for Social Science (SPSS v. 25) was used to analyze interview questions and questionnaire scores. The quantitative variables were described using the form of the mean and standard deviation (SD). The description of qualitative variables was in the form of numbers (No.) and percentage (%). Data were explored for normality using the Kolmogorov-Smirnov test. A chi-squared test was used to compare cases and controls

regarding the categorical variables. *T* test was used to compare cases and controls regarding the normally distributed scale variables, and Mann-Whitney test was used for non-normally distributed data. The significance of the results was determined in the form of a *P* value that was classified into non-significant when *P* value > 0.05 and significant when a *P* value ≤ 0.05.

The power of sample size was estimated using g*power software based on the effect size of 0.5, overall type I error rate (α) ≤ 0.05. One hundred five subjects (35-case, 70-control) are expected to achieve a power of more than 80%.

Results

Demographic information of the children that participated in the study

Records of 105 subjects who participated in the current study were analyzed. All subjects had growth parameters and completed the feeding interview and MCH feeding scale. Subjects ranged from 2 to 4 years. The sample included 35 children with ASD (26 boys (74.3%), 9 girls (25.7%)), 70 TD children (39 boys (55.7%), and 31 girls (44.3%)). Table 1 presented the participants' characteristics. The age and sex of the two groups showed no statistically significant difference. No statistically significant difference was found between both groups in the following variables: birth weight, number of children in a family, and mother's mean age. Regarding children with ASD, the majority (85%) of parents reported that their children with ASD were born at full term with no significant differences between the groups. Birth weight and mother's average age at the child's birth were comparable for the two groups with no significance between the groups. The median number of children in the families was similar across both groups (3 and 4 children per family of children with ASD, family of TD children,

respectively). The vast majority of the questionnaires were completed by the mother (mother: 97.5%; father: 2.5%) of the child in question, and 60% had a university degree or higher qualification. Children with ASD had a statistically significant higher BMI than TD children (*P* value<0.001). According to the data obtained from autism severity measured by total CARS scores, it revealed 30 children with ASD in mild/moderate, and 5 children were rated as a severe degree.

Group differences in eating behavior obtained from parents' interview

Regarding feeding interviews, parents' reports of their children's most common eating and swallowing characteristics were presented in Tables 2 and 3, which revealed that children with ASD differed significantly in almost all variables compared with TD children. Children with ASD had significantly special types of food selectivity than the TD children. All children in both groups preferred juice and starch at similar rates. Children with ASD were exhibiting neophobic eating behaviors more than the TD children. Children with ASD significantly preferred to eat non-food items instead of food rather than the TD children did. ASD experienced a significantly greater percentage of problems in self-feeding skills (71.4%) than the TD children. Parents of TD children had a greater ability to control their child's feeding behaviors over their feeding situation than parents of children with ASD do.

Also, children with ASD showed insignificantly higher rates of ritualistic feeding behaviors than TD children. Children with ASD were more likely to avoid particular textures or tastes than the TD children. 94.3% of children with ASD significantly showed an aversion to strong textures (i.e., hard, solid consistency) and strong tastes (i.e., concentrated flavor, hot, and spicy) and

Table 1 Demographic characteristic of children with autism ASD and TD children

	Children with ASD (n=35)	TD children (n=70)	P value
Age (years) (M ± SD)	3.3±0.64	3.2±0.76	0.595
Age range (years)	2–4	2–4	
Sex, n (%)			0.069
Males	26 (74.3%)	39 (55.7%)	
Females	9 (25.7 %)	31 (44.3%)	
BMI (M ± SD)	22.2± 2.3	20.1±1.6	<0.001
Vineland Adaptive Behavior Scales score (M ± SD)	100.68±16.52	N/A	
CARS (M ± SD)	33.24±2.24	N/A	
Birth weight	3.25±1.1	3.43±1.2	0.445
Number of children in family (median)	3	4	0.166
Mother's average age	35.5±5.9	36.2±6.5	0.593

N/A not applicable
M mean, SD standard deviation

Table 2 Eating characteristics of children with ASD and TD children

	Children with ASD Count (%) (n = 35)		TD children Count (%) (n = 70)		P value	
	Yes	No	Yes	No		
Q1a: Does your child prefer special types of food?	33 (94.3%)	2 (5.7%)	32 (45.7%)	38 (54.3%)	<0.001	
Q1b: Does your child feel food neophobia?	32 (91.4%)	3 (8.6%)	4 (5.7%)	66 (94.3%)	<0.001	
Q1c: Does your child ever prefer to eat non-food items instead of food?	15 (42.9%)	20 (57.1%)	2 (2.9%)	68 (97.1%)	<0.001	
Q1d: Does your child require any assistance during the eating process?	25 (71.4%)	10 (28.6%)	36 (51.4%)	34 (48.6%)	0.047	
Q1e: Do you report any ritualistic feeding behaviors in your child (e.g., person, place, and utensil)?	11 (31.4%)	24 (68.6%)	14 (20%)	34 (48.6%)	0.195	
Q1f: Does your child display any oral aversion to oral feeding (i.e., not accepting the bottle, cup or spoon), avoiding particular textures or taste, color?	Oral feeding	8 (22.9%)	27 (77.1%)	18 (25.7%)	52 (74.3%)	0.749
	Strong Texture	33 (94.3%)	2 (5.7%)	5 (7.1%)	65 (92.9%)	<0.001
	Strong Taste	33 (94.3%)	2 (5.7%)	16 (22.9%)	54 (77.1%)	<0.001
	color	8 (22.9%)	27 (77.1%)	18 (25.7%)	52 (74.3%)	0.749

similarly, 94.3% of children with ASD showed eating challenges with solid texture (Table 2).

Table 3 illustrated that on comparison of special types of food preference between children with ASD and TD children, no statistical significant difference was found.

Next, the data obtained from the subsequent subscales of the feeding interview: chewing, choking, swallowing, and feeding therapy characteristics of children with ASD and TD children were analyzed and no statistically significant difference was found between both groups under the study in each subscale as illustrated in Table 4.

Comparison of ASD and TD by MCH-scale

Further examination of the data obtained from different domains of the MCH-scale revealed a statistically significant difference between both groups in the mealtime domain and maternal strategies used; otherwise, no statistical significant differences were found in other domains as shown in Table 5.

As far as the severity of ASD is concerned, no statistical significant correlation was found between the total score of MCH feeding scale and total CARS scores as shown in Table 6.

Table 3 Comparison of special types of food preference (selectivity) (fruits/vegetables/meat/milk product/juice/starch) among ASD children and TD children

Food type		Children with ASD count (%) (n = 35)	TD children count (%) (n = 70)	P value
Fruits	No	4 (12.1%)	0(0.0 %)	0.034
	some	15 (45.5%)	23 (71.9%)	
	All	14 (42.4%)	9 (28.1%)	
Vegetables	No	2 (6.1%)	2 (6.3%)	0.995
	some	20 (60.6%)	19 (59.4%)	
	All	11 (33.3%)	11 (33.4%)	
Meat	No	8 (24.2 %)	1 (3.1 %)	0.038
	some	19 (57.6 %)	21 (65.6 %)	
	All	6 (18.2 %)	10 (31.3%)	
Milk products	No	3 (9.1%)	1 (3.1%)	0.488
	some	18 (54.5%)	16 (50.0%)	
	All	12 (36.4%)	15 (46.9%)	
Juice	No	0 (0.0%)	0 (0.0%)	0.316
	some	15 (46.9%)	19 (59.4%)	
	All	17 (53.1%)	13 (40.6%)	
Starch	No	0 (0.0%)	0 (0.0%)	0.244
	some	11 (35.5%)	16 (50.0%)	
	All	20(64.5%)	16 (50.0%)	

Table 4 Chewing, choking, swallowing, and feeding therapy characteristics of children with ASD and TD children

	Children with ASD Count (%) (n = 35)		TD children count (%) (n = 70)	
	Yes	No	Yes	No
Q2: Does your child have any eating challenges with food textures?	33 (94.3%)	2 (5.7%)	5 (7.1%)	65 (92.9%)
Q3: Has your child ever experienced choking while feeding?	0(0%)	35 (100%)	0(0%)	70 (100%)
Q4: Has your child ever experienced any swallowing difficulties during eating throughout your child's life?	0(0%)	35 (100%)	0(0%)	70 (100%)
Q5a: Has your child received any therapy from a speech-language pathologist for eating issues?	0(0%)	35 (100%)	0(0%)	70 (100%)
Q5b: Has your child received any therapy from a psychologist for eating issues?	0(0%)	35 (100%)	0(0%)	70 (100%)
Q5c: Has your child undergone any surgeries to better manage his/ her swallowing or eating?	0(0%)	35 (100%)	0(0%)	70 (100%)

Discussion

Most of the previous studies examined behavioral feeding problems in children with ASD considering across a wide age range, whereas our study paid attention to recently diagnosed children with ASD aged from 2 to 4 years to enhance early detection and intervention of feeding problems in this particular group of children to improve their outcomes. This study tried expanding the research in this particular age of this population in three important ways: First, it compared the general eating and feeding behaviors of children with ASD and TD children who were matched in age and sex. Second, it provided an in-depth description of the food selectivity of children with ASD to that of TD children. Third, it tried to find a correlation between autism severity (total CARS scores) with the severity of feeding problems (MCH feeding scores).

Our findings implied that parents of children with ASD reported that their children exhibited more general feeding problems including food neophobia and eating strong texture and taste foods. These data are demonstrated in the following order, the most frequently reported eating behavior problems in children with ASD were food selectivity (94.3%), food neophobia (91.4%), requiring any assistance during the eating process (71.4%), eating non-food items instead of food (42.9%), and ritualistic feeding behaviors (31.4%).

Definition of atypical eating behavior remained broad. It was defined as food refusal, selectivity, or mealtime rituals [9]. We concluded that children with ASD had a significantly higher degree of food selectivity than TD children. Across all food groups we examined, children with ASD ate fewer types of foods than did TD children. In this study, food acceptance was determined and categorized as no (zero food selected), some (one or two), or all (three or more), depending upon the number of types of food the child chose. Our results revealed that meat is the least preferable type of food. Shmaya et al. [30] referred to the poor intake of calcium, and protein in children with ASD is less than TD children which affects later the nutrient required for growing and development.

Pica is also referred to atypical food behavior as children with ASD prefer to eat non-food items instead of food (i.e., objects, rocks, or dirt). Parents of children with ASD frequently describe their children as “picky eaters,” refusing to try or eat a variety of foods. Pica in children with ASD may be even more restrictive and may extend beyond the early childhood period [31–33].

We reported some of the factors, which influence food selectivity: texture (94.3%), taste (94.3%), and color (22.9%). Several studies have consistently identified food texture as a related aspect of food acceptance [34–36].

Food selectivity may result in inadequate weight gain, simply because children with ASD consume more

Table 5 The feeding domains covered by MCH feeding scale in both groups understudy

Domains	Children with ASD (n = 35)	TD children (n = 70)	P value
Oral motor	7.6286±1.39507	7.5294±1.09913	0.694
Oral sensory	7.4286±1.19523	7.4118±1.44796	0.953
Appetite	9.7143±3.30393	9.8824±3.86152	0.827
Maternal concerns about feeding	14.0857±1.61558	14.0882±1.97549	0.995
Mealtime behaviors	9.5714±2.09039	8.3235±2.06926	0.005
Maternal strategies used	9.7429±2.35575	8.0294±2.87537	0.003
Family reactions to their child's feeding	7.9429±0.33806	7.9706±0.17021	0.580

Table 6 Correlation between the CARS scores and the total score of the MCH feeding scale for children with ASD

ASD group		T-score	Row score
CARS	Pearson Correlation	-.011	-.043
	Sig. (2-tailed)	.952	.808
	N	35	35

sweetened juice and starch meals and consume less meat, fruits, and vegetables than TD children. This may be a direct cause for the significant difference in BMI between the two groups since BMI is higher in children with ASD. Many studies have revealed that the frequency of overweight and obesity in children with ASD is greater [37, 38].

In fact, altered BMI could be of multifactorial origin. A recent study found that the difference in BMI between ASD and TD children may be associated to both oral health problems and food hyperselectivity [8].

In addition to the importance of food selectivity, mealtime behavior problems and maternal strategies used were frequently observed in children with ASD [9]. Our comparative analysis revealed a significant difference in evaluating mealtime behavior between both groups under the study. This is consistent with the findings of Castro et al. (2016) [39], and Malhi et al. (2017) [40], who assessed mealtime behavior and got similar results, which entailed that children with ASD had more problems at mealtimes than the controls. It is worth noting that previous studies used different assessment tools; the first study used the Behavioral Pediatric Feeding Assessment Scale (BPFA), and the second used the Children's Eating Behavior Inventory (CEBI).

It was suggested [41, 42] that poor multi-sensory processing and executive function difficulties (lack of planning, e.g., washing hands, and coordinating eating) that affects activity level, emotional, and social responses may impact functional daily activities, including mealtimes can cause behavior problems in individuals with ASD who are unable to describe their distress. This issue, which may be food selectivity-based, creates stress and negatively affect family mealtimes and quality of life [43–45]. In contrast, no significant differences in mealtime behavioral problems (oral sensitivity, mild eating problems, or mild resistance to the introduction of new foods) have been reported between children with and without ASD [46].

As evidenced by our findings, children with ASD are significantly more likely to avoid foods, exhibit food neophobic behaviors, and have poorer self-feeding skills. This is consistent with previous studies in this area [4, 11].

Although parents of children with ASD in our sample reported that their children are highly significantly selective eaters of certain food categories such as

carbohydrates (starch) with limited repertoires of food acceptance and picky eating but no parent of a child with ASD expressed a concern for referral for nutritional therapy. This may be due to a lack of awareness of essential nutritional requirements as well as the previously mentioned behavioral feeding problems which may lead to certain dietary inadequacy. According to our sample, significantly higher BMI in ASD children may mislead the parents with the feeding behaviors and probability of nutritional deficiencies in their children. Also, the recent diagnosis of their siblings and therapy plan is mainly directed towards the rehabilitation of other affected areas in autism as rehabilitation of communication and social skills.

In the current study, most items in the MCH scale which showed a significant difference were related mainly to the parents and their experience toward their children such as the breakdown in mealtime behaviors and maternal strategies. Our findings were in accordance with previous studies by Malhi [40] and Johnson [47] who reported elevated stress associated with mealtime in parents of ASD children. Parents' stress may be due to children's lack of reciprocity to their parents and children's disruptive acts, especially in public areas. These behaviors may cause their lack of ability to control their children and so hinder family interactions with others.

Finally, feeding problems were unrelated to autism severity by measures of CARS scores. It was difficult to draw a conclusion about the relation of feeding problems in children with the ASD and severity of autism due to the conflicting reports. Some studies suggesting that it is related to children with autism [4] while others refute this claim [48].

However, our finding could be partly explained by differences in behavioral feeding problems definitions, as well as in ASD severity evaluation tools. We investigated this topic through the CARS scale-specific for ASD, which was found as a reliable indicator of ASD severity. A recent study by Malhi et al. [49] examined the relation between the severity of autism and various behavior feeding problems such as atypical food preferences in children with ASD. They suggested that there is variability even among the ASD group, and the clinically severe ASD cases may be at a higher risk for nutritional inadequacies and growth failure.

Limitations in our study should be considered, which included a small sample size. Our main limitation was that the collected data relied on parental reports. This may result in overestimation or underestimation of problematic behaviors. The parents frequently questioned how they should answer questions about eating fruits, vegetables, and meats. This calls into question the number of uncertainties encountered by parents completing the questionnaires without assistance.

Also, questions concerned with food refusal are based on the parent's understanding of the dominant character of the food. It is difficult for parents to report the true reason for refusal (color vs taste vs texture) because the children cannot express the reason and some foods have similar properties. For example, some parents reported that their children refused vegetables because of their color; however, other factors such as texture may play a role in the refusal. We tried to clarify this by adding a separate question in the chewing section of the feeding questionnaire asking the parents whether their children experienced eating challenges with food textures: liquids, purees, and solids.

Since our sample of children with ASD was diagnosed at a young age, this allows for a follow-up to study if the eating problems are transient or, to some extent. Future studies with a larger sample size should focus on alternative assessment methods as objective measures of food selectivity with valid dietary pattern measures including the assessment of iron deficiency, vitamin D, calcium, and zinc. More importantly, future research should focus on the relationship between dietary intake and gastrointestinal symptoms in children with ASD, as food selectivity may be significant and cause or worsen GI symptoms such as constipation. Multidisciplinary programs to overcome and follow-up on feeding difficulties need to be developed as early as the diagnosis is established to maintain nutritional adequacy since these problems are described in early childhood with the evaluation of the effects of early intervention on later development.

Conclusions

This study describes the behavior-feeding problems in children with ASD with clear differences between them and TD children. Our findings point to the importance of early investigation of feeding behaviors and the development of practical feeding approaches to maintain nutritional adequacy for children with ASD.

Abbreviations

ASD: Autism spectrum disorders; TD: Typically developed children; MCH: The Montreal Children's Hospital Feeding Scale; CARS: Childhood Autism Rating Scale; BMI: Body mass index

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None

Authors' contributions

NF provided the concept, design, manuscript preparation, and manuscript editing. RS performed the research methodology, data collection, and data analysis. SA contributed to the supervision and study design. AA contributed to the supervision and methodology. DM contributed to the interpretation of the results. SS contributed to the supervision, study design, and methodology. All authors discussed the results and contributed to the writing and revising of the manuscript. The authors have approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Beni-Suef University (Beni-Suef, Egypt) No: FMBSUREC/03112019/Abdelhameed. Written informed consent was obtained from all parents of participants included in the study.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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