



Eating problems and patterns among toddlers and young boys with and without autism spectrum disorders



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ABSTRACT

Background: Eating and feeding problems are common comorbidities among children with autism spectrum disorders (ASD) yet the reasons for this are unclear, and relatively few studies have compared the eating problems seen in ASD to a typically developing control group.

Methods: Differences in eating problems and patterns between children with ASD and typically developing children were assessed, as well as correlations with age as well as differences between eating problems and patterns between toddlers (aged 2–3 years) and young boys (aged 3–7) with ASD. A total of 105 children with ASD and 95 typically developing children were included in the study. Of the 91 toddlers, 65 had a diagnosis of ASD and of the 112 young boys, 40 had a diagnosis of ASD.

Results: Children with ASD displayed significantly more eating problems in every domain assessed than children with typical development. The overall effect of age was found only in ritualistic behavior during eating, which older children displayed more than younger children. In addition, typically developing children ate a significantly greater variety of all food groups than children with ASD, except drinks and snacks. An overall age effect was also found. Younger children ate a greater variety than older children in the majority of food groups, except for drinks, snacks and meats.

Conclusion: This study supports previous findings regarding the greater incidence of eating problems and patterns among children with ASD and provides new findings about the role of age in eating problems. More research is needed to shed light on underlying causes of eating problems and patterns in ASD.

1. Introduction

Eating and feeding problems are common comorbidities in children with autism spectrum disorders (ASD). Parents and clinicians frequently report on the challenges of getting them to eat; texture and taste sensitivities as well as restriction and rejection of food groups often represent shared experiences among these children (Diolordi, del Balzo, Bernabei, Vitiello, & Donini, 2014; Matson & Fodstad, 2009; Schreck & Williams, 2006). Despite repeated reports that children with ASD consume a smaller variety of foods than typical children, few studies have actually compared the eating problems seen in ASD to a typically developing control group (Bandini et al., 2010; Curtin et al., 2015; Schreck, Williams, & Smith, 2004).

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Age has also been found to play a role in the manifestation of eating problems both in children with typical development and ASD. The literature has shown that younger children with typical development commonly present with more food selectivity. Williams, Gibbons, and Schreck, (2005), a study which included children with autism spectrum disorders, children with special needs without autism, and children without special needs), found that food selectivity began by the age of 18 months and lasted for over 2 years. In other research which assessed food selectivity in 18 children with ASD at two time points (mean ages = 6.8 and 13.2 years), although food refusal improved, an overall increase in food repertoire (number of unique foods eaten) was not observed (Bandini et al., 2017). A third study found individuals with ASD to have significantly more food selectivity than both atypically developing and typically developing comparison groups; the ASD group showed a decrease in food selectivity across childhood, though age was not found to be a significant predictor of food selectivity among children with ASD (Beighley, Matson, Rieske, & Adams, 2013). Beighley et al. (2013) also revealed a downward trend in food selectivity symptom severity among children with ASD across childhood.

Eating and feeding difficulties are not specific to children with ASD, as 25–45% of typically developing children also exhibit eating and feeding difficulties throughout their development (Martins, Young, & Robson, 2008). However it is estimated that 46%–89% of children with ASD have atypical eating and feeding habits (Ledford & Gast, 2006; Provost, Crowe, Osbourn, McClain, & Skipper, 2010), therefore it is important to explore the role of both diagnosis and age in eating problems in children with ASD.

In children with ASD, eating/feeding problems occur more frequently and with greater diversity than problems seen among children with other developmental disabilities and among typically developing children (Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007; Schreck et al., 2004). Though few population studies have been conducted, close to 70% of children with ASD have been reported to be selective eaters (Matson & Fodstad, 2009; Twachtman-Reilly, Amaral, & Zebrowski, 2008) and they have been repeatedly found to display food refusal, idiosyncratic mealtime behavior, and limited acceptance of a variety and texture of food items, than typically developing children (Schreck et al., 2004). Although the literature on eating problems in ASD is still sparse, many have reported the following eating problems to be common among children with ASD: food selectivity, poor appetite or food refusal, binge eating or overeating, chewing and swallowing problems, insistence on certain food presentation, pica, fast eating, vomiting and rumination, packing/pocketing and regurgitation (Matson, Hattier, Belva, & Matson, 2013; Nicholls & Bryant-Waugh, 2009; Schreck et al., 2004; Seiverling, Williams, & Sturmey, 2010; Sharp et al., 2013). Many children also display aggression and tantrums in the eating/feeding setting (Provost et al., 2010).

As previously mentioned, food selectivity is the most common feeding concern documented among children with ASD. Food selectivity may refer to frequent refusals of particular foods, a limited repertoire of foods, excessive intake of a few foods, and selective intake of certain foods, such as those rich in carbohydrates (Cermak, Curtin, & Bandini, 2010). Ledford and Gast found that all studies on children with ASD included in their 2006 review reported significant feeding difficulties, primarily in the form of food selectivity by type and/or texture, however selectivity by presentation/appearance, taste, smell and temperature was also common. Eating rituals or ritualistic or repetitive patterns of behavior are also commonly believed to contribute to food selectivity, which can include insistence on specific methods of preparation, food types, and mealtime rules (Matson & Fodstad, 2009; Zandt, Prior, & Kyrios, 2007). In addition, children with ASD accepted fewer foods across all food categories presented (fruits, vegetables, dairy, proteins, starches) than typically developing children. Schreck et al. (2004) also reported that children with ASD had more 'ritualistic eating behaviors' (i.e., required a specific utensil or food presentation to consume a food), refused more foods, rejected more foods due to texture, and in general, had more feeding problems than typically developing children (Schreck et al., 2004). A 2006 study found parents reported that their children with ASD engaged in both food restriction and refusal and accepted fewer than half of the listed foods (Schreck & Williams, 2006).

Food selective children with ASD also commonly exhibit a preference for certain food groups, including starches, snack foods, and processed foods, and may display a lack of willingness to eat fruits, vegetables, and proteins. In one study of 30 children with ASD, vegetables were the most commonly rejected food based on parental report; increased food selectivity was also found to be correlated with more problem behaviors (Sharp et al., 2013). A recent study comparing food refusal in children with ASD to typically developing children found children with ASD were significantly more likely to refuse foods based on texture/consistency, taste/smell, mixtures, brand and shape while no differences were found for refusal based on temperature, foods touching other foods or color (Hubbard, Anderson, Curtin, Must, & Bandini, 2014).

Although food selectivity is a frequent target for intervention because of concern over dietary balance, its relationship to nutritional status is still unclear. Research on the impact of food selectivity on intake of micronutrients has yielded mixed results (Lockner, Crowe, & Skipper, 2008); low levels of vitamins K and A, and greater levels of vitamin B6 and E have been noted, as have low intake of calcium, fiber, iron, and vitamins E and D (Kral, Eriksen, Souders, & Pinto-Martin, 2013). Though it appears to be less common than food selectivity, food refusal, defined as a child's refusal to eat all or most foods presented, resulting in the failure to meet caloric needs or dependency on a supplemental formula (Williams, Field, & Seiverling, 2010) is considered a more severe feeding problem with more serious health implications. While children who are food selective have a limited repertoire of foods, studies have not found the problem to be severe enough to result in malnutrition or to require intense intervention; in contrast, children with food refusal who are either unable to or refuse to eat developmentally appropriate foods may experience more serious health consequences (Laud, Girolami, Boscoe, & Gulotta, 2009). Food deprivation, for any reason, can cause physical problems including anatomical abnormalities, sensory perceptual impairment, motor dysfunction, oral motor dysfunction and respiratory, cardiac and gastrointestinal problems (Kerwin, Eicher, & Gelsinger, 2005). Co-morbidities of food refusal include gastro-esophageal reflux, cardiopulmonary conditions, neurological conditions, food allergies, anatomical anomalies, and delayed gastric emptying (Williams et al., 2010).

The aforementioned eating problems may be caused by sensory (Nadon, Feldman, Dunn, & Gisel, 2011), ritualistic or obsessive behaviors (Ahearn, Castine, Nault, & Green, 2001; Schreck & Williams, 2006) and may also be influenced by biological variables,

such as gastrointestinal health and the eating environment, which can affect health and nutritional status. Since all eating problems may have potentially serious health implications, it is imperative to further research eating problems and patterns among children with ASD.

The aim of the current study was therefore to shed further light on the eating patterns seen in ASD by assessing the differences in eating problems and patterns between children with ASD and typically developing children and to explore the influence of age on eating problems and patterns among typical children and children with ASD. More specifically, the study assessed correlations between age and eating problems and patterns, and differences between eating problems and patterns in toddlers in comparison to young children with ASD.

2. Methodology

2.1. Population

A total of 105 children with ASD (mean age 40.85 ± 15.66 (SD) months) and 95 typically developing children (mean age 50.33 ± 16.49 (SD) months) were included in this cross-sectional study. All participants were males, representing the predominant presence of males among the ASD population. The toddler age group included a total of 91 children and the young children age group included a total of 112 children (toddlers: 2–3 years [included children who had turned 3] and young children: 3–7 years [included children aged 3 and 1 day to 7 years]). Of the 91 toddlers, 65 had a diagnosis of ASD and of the 112 young children, 40 had a diagnosis of ASD. The study included children diagnosed with ASD based on DSM 5 criteria (American Psychiatric Association, 2013). Diagnosis was made by an interdisciplinary team of pediatric neurologists, psychiatrists and psychologists. Participants with known serious illnesses, injuries, physical disabilities, or developmental disability other than ASD were excluded from the study.

2.2. Procedure

Approval for the study was obtained from the Ethics Committees of the Ministry of Welfare, the Ministry of Education, and the University. Participants with ASD were recruited both through the educational system and through the medical system. Children with typical development were recruited via convenience sample using a snowball methodology; parents were reached via telephone to enroll in the study. After providing written, informed consent to participate in the study, the Aut-Eat questionnaire was sent or given to all parents and completed by them.

2.3. Instrumentation

2.3.1. Aut-Eat questionnaire

Aut-Eat questionnaire (2012) is a parent-report questionnaire that captures the breadth of eating problems and patterns in ASD. The questionnaire includes three parts: (a) demographic and developmental information, and (b) 44 items which are rated on a six-point Likert scale: (0) behavior does not occur/ irrelevant (1) very little (2) little (3) moderately (4) very much and (5) very frequently, for a total possible eating problems score of 220. The items in this part of the questionnaire are grouped into seven subscales described as (a) chewing and swallowing problems (b) eating avoidance (c) food selectivity (d) sameness behavior (e) ritualistic behavior during eating (f) excessive eating (g) aggressive behavior towards self and others. The last part of the questionnaire includes a food table in which items are rated on a five-point Likert scale, as follows: (0) never eats (1) eats only when he is pushed to (2) sometimes eats (3) frequently eats (4) favorite food/very frequently consumes. Raters are asked to refer to the previous month when completing the scale. The food tables include 137 items; for each item, the parent is to check off whether it is regularly eaten by the child and whether it is regularly consumed by the rest of the family. The questionnaire is currently in the process of further development in order to establish its norms and for adaptation for use with adolescents (Gal et al., 2018).

2.3.2. Internal consistency and reliability

In the initial validation study, the questionnaire was shown to have a high internal reliability/ α ranges. In addition, high discriminant validity between children with and without ASD was found. Initial testing of internal consistency of the questionnaire on a group of 26 children with ASD and 100 typical children revealed an α Cronbach of $\alpha = .76$ for the ASD group and $\alpha = .83$ for the typically developing children. Internal reliability of the five first domains of the questionnaire ranged from 0.77–0.92 and the 6th domain, “delaying and avoiding eating,” had a moderate internal reliability for typical children ($\alpha = .54$) and low reliability for children with ASD ($\alpha = .37$) (Gal & Gal, 2012). For the version used in the current study, a total Cronbach's α of 0.954 for all 44 questions in the Aut-Eat was found, including .95 for the ASD group and .95 for the TD group, representing excellent internal consistency.

2.4. Data analysis

Data analysis was conducted using the Statistical Package for the Social Sciences version 23 (SPSS, 2015). Descriptive statistics were used to assess and describe population characteristics. The Pearson test was used to check for correlations between age, assessed as a continuous variable, and eating problems and/or eating patterns for each separate group. Thereafter, two-way multivariate analysis of variance (MANOVA) was conducted to compare differences in eating problems and age group, assessed as a dichotomous

Table 1
Aut-Eat Scale Means.

Domain	ASD	TYP
A	.85	.74
B	.77	.92
C	.92	.91
D	.86	.80
E	.88	.80
F	.90	.77
G	.89	.73

variable (toddlers vs. young children), and group (ASD or typical). Interaction effects between percent food group consumption by age, group and diagnostic group were also assessed. Significance was set at $p \leq 0.05$.

3. Results

3.1. Eating problems and patterns among children with ASD vs. children with typical development

The differences in eating problems between the diagnostic groups (ASD vs. typically developing) were assessed using two-way MANOVA. A significant group effect was identified ($F(7,193) = 8.63$, $\eta_p^2 = 0.238$). Children with ASD were found to display significantly more eating problems in every eating domain assessed than children with typical development (Table 2). In addition, significant differences were found between the Aut-Eat total scores of the ASD group (51.05 (SD 36.57), $M = 1.18$ (SD .85)) and the TD group (23.56; SD 23.07; $M = .54$ (SD = .52)) ($t = 6.55$; $p > .001$) (means for each domain can be found in Table 1).

In addition, the differences in eating patterns between diagnostic groups (ASD and typical) were assessed and an overall group effect was found ($F_{(12,185)} = 5.09$; $\eta_p^2 = 0.248$). Typical children ate a significantly greater variety of all food groups than children with ASD, except drinks and snacks (Table 3).

3.2. Effect of age upon eating problems in ASD vs. children with typical development

In the typically developing group, age was negatively correlated with food avoidance and eating rituals, indicating a decrease in food avoidance and eating rituals with increasing age. In the ASD group, significant positive correlations were found between age and food selectivity, sameness, and eating rituals, indicating an increase in food selectivity, sameness and rituals with increasing age (Table 3).

The overall effect of age was marginally significant ($F(1,199) = 4.29$; $\eta_p^2 = 0.021$), with a difference found only in the domain of ritualistic behavior during eating, which young children displayed more than toddlers (Table 4). No significant interaction effect was identified between group and age (Table 5).

3.3. Effect of age upon eating patterns in ASD vs. children with typical development

In the typically developing group, a negative correlation was found between age and total number of foods consumed, indicating a decrease in number of foods with increasing age. Specifically, age was negatively correlated with consumption of fruits, vegetables, flour, dairy, legumes, meat, fats, spices, and casseroles. In the ASD group, a significant negative correlation was found between age and total number of foods consumed, indicating a decrease in number of foods consumed with increasing age. Significant negative correlations were found between age and consumption of foods from the flour, dairy, sweets, legumes and casseroles groups among children with ASD (Table 6).

The differences in eating patterns between diagnostic groups (ASD and typical), age groups (toddlers and young children) and the interaction effect between group and age were assessed using two-way MANOVA. An overall group effect was found ($F_{(12,185)} = 5.09$, $\eta_p^2 = 0.248$). Typical children ate a significantly greater variety of all food groups than children with ASD, except drinks and snacks

Table 2
Eating problems in children with ASD vs. typically developing children.

Eating problem	ASD Mean	TYP Mean	F	P	η_p^2
Chewing and swallowing problems	1.21 (1.79)	0.22 (0.47)	22.34	.000	0.101
Eating avoidance	0.905 (1.09)	0.12 (0.54)	28.87	.000	0.127
Food selectivity	4.08 (3.29)	1.61 (2.39)	33.71	.000	0.145
Sameness behavior	0.65 (1.24)	0.32 (0.82)	6.16	.014	0.030
Ritualistic behavior during eating	0.83 (1.52)	0.35 (0.64)	10.54	.001	0.050
Excessive eating	1.41 (1.88)	0.24 (0.64)	25.94	.000	0.115
Aggressive behavior towards self and others	0.47 (0.98)	0.09 (0.32)	12.14	.001	0.058

Table 3
Comparison of eating profiles of children by group.

	ASD total	TYP total	F	P	η_p^2
Fruit	36.42 (27.49)	58.52 (25.84)	46.27	.000	0.191
Vegetable	29.67 (29.10)	44.12 (30.94)	21.44	.000	0.099
Flour	48.25 (22.90)	56.97 (20.50)	13.53	.000	0.065
Dairy/milk	47.52 (29.08)	58.21 (25.93)	15.37	.000	0.073
Drinks	29.93 (24.00)	36.69 (19.92)	3.187	.076	0.016
Snacks	48.00 (33.24)	57.47 (31.86)	2.324	.129	0.012
Sweets	48.74 (29.97)	56.27 (25.17)	6.327	.013	0.031
Legumes	35.24 (28.94)	45.78 (29.09)	13.46	.000	0.064
Meats	42.86 (29.15)	55.13 (28.09)	12.73	.000	0.061
Fats	33.33 (37.77)	50.00 (39.27)	13.98	.000	0.067
Spices	34.67 (26.20)	39.79 (26.01)	4.98	.027	0.027
Casseroles	32.69 (36.39)	57.89 (35.13)	33.54	.000	0

Table 4
Correlations between age and eating problems among ASD vs. typically developing children.

Eating problem	ASD r(p)	TYP r(p)
Chewing and swallowing	-.061 (.539)	-.141 (.165)
Eating avoidance	-.141 (.153)	-.334** (.001)
Food selectivity	.239 [†] (.014)	-.100 (.329)
Sameness behavior	.203 [†] (.039)	-.071 (.485)
Ritualistic behavior during eating	.230 [†] (.019)	-.218* (.031)
Excessive eating	.147 (.133)	-.166 (.103)
Aggressive behavior towards self and others	.064 (.518)	-.173 (.089)

Table 5
Eating problems by age group among children with ASD.

Eating problem	2-3 years		3-7 years		F	P	η_p^2
	Mean (SD)		Mean (SD)				
Chewing and swallowing problems	1.33 (1.78)		1.02 (1.79)		0.76	.385	0.01
Eating avoidance	0.96 (1.15)		0.80 (0.99)		0.59	.445	0.01
Food selectivity	3.66 (3.25)		4.77 (3.28)		2.89	.092	0.03
Sameness behavior	0.55 (1.19)		0.80 (1.32)		0.98	.326	0.01
Ritualistic behavior during eating	0.56 (1.41)		1.25 (1.61)		5.15*	.025	0.05
Excessive eating	1.33 (1.85)		1.52 (1.93)		0.24	.624	0.00
Aggressive behavior towards self and others	0.38 (0.95)		0.60 (1.03)		1.19	.277	0.01

Table 6
Correlations between age and eating patterns.

Food group	ASD (p value)	Typical (p value)
Num. of foods	-.207 [†] (.034)	-.313** (.002)
Fruit	-.020 (.836)	-.387** (.000)
Vegetables	-.097 (.326)	-.333** (.001)
Flour	-.256** (.008)	-.230 [†] (.025)
Dairy	-.291** (.003)	-.367** (.000)
Drinks	-.075 (.448)	.080 (.443)
Snacks	-.168 (.087)	.090 (.383)
Sweets	-.261** (.007)	-.125 (.228)
Legumes	-.227 [†] (.020)	-.267** (.009)
Meat	-.103 (.294)	-.214 [†] (.038)
Fats	-.112 (.257)	-.244 [†] (.017)
Spices	-.161 (.101)	-.249 [†] (.015)
Casseroles	-.209 [†] (.033)	-.244 [†] (.017)

(Table 3). An overall age effect was also found ($F_{(12,185)} = 3.17$, $\eta_p^2 = 0.171$): toddlers ate a greater variety than young children in the majority of the food groups, except for drinks, snacks and meats (Table 7).

An interaction effect between group and age was also identified (Table 8). Typically developing children ate significantly more

Table 7
Comparison of eating profiles of children by age group.

	Toddler total	Young children total	F	P	η_p^2
Fruit	47.3 (30.74)	46.62 (27.39)	8.33	.004	0.041
Vegetable	39.67 (31.74)	34.02 (29.89)	9.97	.002	0.048
Flour	55.43 (20.65)	49.96 (23.13)	8.88	.003	0.043
Dairy/milk	57.64 (27.22)	48.56 (28.21)	13.28	.000	0.063
Drinks	31.86 (21.80)	34.16 (22.84)	0.012	.914	0
Snacks	51.24 (29.84)	53.51 (35.18)	0.015	.902	0
Sweets	55.98 (28.55)	49.39 (27.29)	5.71	.018	0.028
Legumes	44.38 (28.14)	36.94 (30.12)	9.83	.002	0.048
Meats	49.86 (26.81)	47.75 (31.13)	3.51	.063	0.018
Fats	43.26 (39.31)	39.64 (39.38)	4.42	.037	0.022
Spices	40.67 (25.49)	34.23 (26.48)	6.09	.014	0.03
Casseroles	47.19 (39.19)	42.64 (36.84)	9.13	.003	0.045

Table 8
Comparison of eating profiles of children with ASD and typically developing children by age.

Food group	ASD	TYP	F	P	η_p^2
Fruit			4.91	.028	0.024
2-3 years	37.46 (27.46)	73.96 (22.41)			
3-7 years	34.75 (27.80)	53.3 (24.96)			
Vegetable			4.74	.031	0.024
2-3 years	31.36 (29.14)	62.18 (27.68)			
3-7 years	26.92 (29.20)	38.03 (29.73)			
Flour			0.109	.742	0.001
2-3 years	52.44 (21.69)	63.54 (15.06)			
3-7 years	41.46 (23.44)	54.75 (21.69)			
Dairy/milk			0.021	.886	0.000
2-3 years	53.08 (27.15)	70 (23.77)			
3-7 years	38.5 (30.17)	54.23 (25.56)			
Sweetened drinks			1.17	.281	0.006
2-3 years	31.21 (23.84)	33.63 (15.26)			
3-7 years	27.86 (24.41)	37.73 (21.26)			
Snack foods			6.50	.012	0.032
2-3 years	52.62 (29.70)	47.5 (30.53)			
3-7 years	40.5 (37.48)	60.85 (31.79)			
Sweets			1.04	.308	0.005
2-3 years	54.27 (29.32)	60.61 (26.36)			
3-7 years	39.77 (29.16)	54.8 (24.78)			
Legumes			0.975	.325	0.005
2-3 years	38.84 (27.96)	59.37 (23.09)			
3-7 years	29.38 (29.89)	41.19 (29.61)			
Meats			0.69	.408	0.003
2-3 years	44.62 (27.15)	64.06 (20.29)			
3-7 years	40 (32.29)	52.11 (29.80)			
Fats			1.42	.234	0.007
2-3 years	35.38 (39.25)	64.58 (31.20)			
3-7 years	30 (35.45)	45.07 (40.67)			
Spices			0.15	.701	0.001
2-3 years	37.85 (26.72)	48.33 (20.36)			
3-7 years	29.5 (24.80)	36.9 (27.18)			
Casseroles			0.24	.622	0.001
2-3 years	37.95 (38.58)	72.22 (28.93)			
3-7 years	24.17 (31.11)	53.05 (35.89)			

fruit and vegetables than children with ASD in both age groups. Toddlers with ASD ate more snacks than typical toddlers; young children with ASD ate significantly fewer snacks than typical young children.

4. Discussion

This study illustrated that children with ASD displayed significantly more eating problems in every domain assessed than typically developing children, echoing the results of previous research (Schreck et al., 2004; Williams, Dalrymple, & Neal, 2000). This finding is of particular importance, as few studies have compared the eating problems of children with ASD to typically developing controls. In their study, Schreck et al. (2004) found that children with autism have more feeding problems, including food refusal,

idiosyncratic meal time behavior, and acceptance of a limited variety and texture of food items than typically developing children. Provost et al. (2010) compared the mealtime behaviors of young children (3–6 years old) with ASD and compared these behaviors to children with typical development matched for age, gender, and ethnicity and found significant differences between the pairs of children in specific mealtime behaviors, with more children with ASD found to be picky eaters, mouth nonfood items, resist new foods, limit foods based on textures, have problems with gagging, have difficulty eating at regular restaurants or at school, resist sitting at the table, and throw or dump food.

In the current study, children with ASD were also found to eat fewer foods than typical children, with the exception of drinks and snacks. In addition, typical children ate significantly more fruit and vegetables than children with ASD in both age groups (though it should also be noted that typical children of both age groups were also limited in their vegetable consumption). This finding has been broadly supported in the literature (Schreck et al., 2004; Williams et al., 2000) with studies highlighting the consumption of fewer servings of vegetables among children with ASD as well as lower intake of dairy products (Graf-Myles et al., 2013; Johnson, Handen, Mayer-Costa, & Sacco, 2008). In a 2014 study by Diolordi et al, a significant difference in the consumption of milk, yogurt, pulses, rice and fruit juices was observed between children with ASD and controls (Diolordi et al., 2014).

The limited food repertoire seen in the current study among children with ASD in comparison to children with typical development has been associated in some studies with physical conditions. In an analysis of the diet records of 28 children with ASD, two children markedly decreased the number of foods consumed at three years of age (approximately 50) and became severely limited in intake by five years of age partly due to infection, including acute gastroenteritis and upper respiratory tract infection. The number of foods consumed decreased gradually due to anxiety and stress, resulting in a severely limited food repertoire. In other cases, children who consumed a limited number of foods increased their intake gradually over time; (Tanoue, Takamasu, & Matsui, 2017).

The rejection of food groups that are considered to be healthy, such as fruits and vegetables, resulting from chronic eating/feeding problems, can put children at risk for medical and developmental problems, including under-nutrition, suboptimal growth and nutrient deficiencies, such as vitamins, minerals and amino acids (Sharp et al., 2013). A meta-analysis of 17 studies found that children with ASD are subject to lower intake of calcium and protein (Sharp et al., 2013); other commonly reported nutrients consumed in insufficient amounts include calcium, iron, vitamins A, C, D, B6, B12, E, and K, as well as fiber, folic acid, and zinc (Hyman et al., 2012). In a 2000 report on the nutrient status of children with ASD, more than half were abnormally low in vitamins A, B1, B3, and B5, as well as biotin, zinc, magnesium, essential amino acids and essential fatty acids (Kidd, 2009). In addition, in a 2013 study, the calcium, zinc, vitamin B6 and folate intake of the majority of the children was found to be inadequate (Bicer & Alsaffar, 2013). Therefore, it is imperative to address extreme food selectivity or refusal clinically, without delay.

The initial assessment for correlations between age and eating problems in the ASD group, indicated an increase in food selectivity, sameness and rituals with increasing age. Further exploration of the eating problems profile of the ASD group, by examination of group (toddlers vs. young children), revealed the overall effect of age on eating problems was found to be marginally significant, with a difference found only in the domain of ritualistic behavior during eating, suggesting that the increased rituals and sameness in children with ASD as they grow up, may reflect a root cause for the effect of age on eating problems in children with ASD.

According to the DSM 5 (2013), rituals are a part of the ASD diagnostic criterion which refers to restricted, repetitive patterns of behavior, interests, or activities, along with insistence on sameness. In 2004, Schreck et al. reported that children with ASD had more 'ritualistic eating behaviors' (i.e., required a specific utensil or food presentation to consume a food), refused more foods, rejected more foods due to texture, and in general, had more feeding problems than typically developing children. However, restricted and repetitive behaviors are not unique to children with ASD; some of these behaviors, specifically lower order motor stereotypes, tend to continue into the second year of life in typically developing children followed by a gradual shift into higher order forms, including insistence on sameness, which involves ritualistic behaviors and resistance to changes in routines, between the ages of 2–4 (Ahearn et al., 2001; Schreck et al., 2004; Williams et al., 2005). Nevertheless, among children with ASD, such behaviors often manifest with greater severity and duration (Schertz, Odom, Baggett, & Sideris, 2016) and previous studies have indeed reported that insistence on sameness increases in prevalence as children with ASD age (Schertz et al., 2016). Like the current study, other studies have also found an age effect to be of marginal significance as related to eating problems in ASD. Provost et al. (2010) found individuals with ASD had significantly more food selectivity than both atypically developing and typically developing comparison groups. Furthermore, Beighley et al. (2013) found that although the ASD groups showed a decrease in food selectivity across childhood, age was not found to be a significant predictor of food selectivity among children with ASD.

In the current study, though the correlations were weak, the effect of age upon eating patterns was also exhibited, with toddlers eating a greater variety than young children in the majority of the healthy food groups. These results may be attributed to the influence of parents on the child's food intake. Indeed, parents have been shown to have a clear influence over early intake, food neophobia (i.e. fear of trying new foods) and children's willingness to try new foods (Birch & Doub, 2014; Falciglia, Pabst, Couch, & Goody, 2004; Musaad, Donovan, & Fiese, 2015). Thus, it is possible that parents may have greater control of their child's intake when still a toddler, resulting in intake of greater variety of foods, though this may change with age. The age effect may also result from some other change occurring in autistic symptomatology or comorbidities.

Finally, toddlers with ASD ate significantly more snacks than their typical counterparts while young children with ASD ate significantly fewer snacks than their typical counterparts. The intake of more snack foods by toddlers with autism may be due both to the predisposition of children for sweet and salty foods (while rejecting bitter or sour foods (Birch, 1999) and the altered reward system among these children. Furthermore, the snack foods commonly consumed by children with ASD may be extremely rewarding for them, when eaten, and place a high emotional and motivational drive upon immature executive cognitive systems, making it difficult to inhibit highly desirable foods (Twachtman-Reilly et al., 2008). Such deficits in inhibitory control have been associated with characteristics of food selectivity in previous studies, such as poorer eating behavior, and consumption of unhealthy foods

(Germani et al., 2014). In the case of children with ASD, many children may have become accustomed to the salty/sweet tastes of food items such that continual consumption may result in more powerful cravings, at the expense of other more challenging tastes such as the bitterness of vegetables or sourness of fruits. The intense flavors experienced by children with ASD may result in the refusal of and aversion to many healthy foods (Schreck & Williams, 2006). Parents may also play a role in snack consumption among younger, selective children with ASD, offering snack foods when healthier foods are rejected. It is possible that over time, the increased snack consumption of typically developing children as they grow and become more social, more engaged in and responsible for food choices outside the home, may surpass the frequent consumption of snacks seen early on in children with ASD. Identifying innovative and palatable ways to offer vegetables and fruits to young children with ASD may help to prevent rejection of these nutritionally essential foods and ensure more balanced consumption, in these critical years of development.

4.1. Conclusions and limitations

This study supports previous findings regarding the greater incidence of eating problems and unique eating patterns among children with ASD compared to typically developing children. Though age was found to be correlated with various eating problems in both groups, the overall effect of age on eating problems was of marginal significance, with a difference found only in the domain of ritualistic behavior during eating, which young children displayed more than toddlers. Age did have an important effect on eating patterns in both groups, with both typical children and those with ASD found to consume fewer healthy foods with increasing age. It is important to note that the use of parental report relies on information that is prone to bias. In addition, this study included a heavier representation of children with ASD in the toddler group and lighter representation in the young children group.

Overall, findings regarding food patterns and the increase in reports of inadequate micronutrient intake, as well as the inconsistent results about the extent and type of nutrient deficiencies among children with ASD supports the need for further study as well as the need for interventions early in childhood to increase variety and promote healthy eating among this population. It is recommended that: a. further research should study larger populations of children with a control group for comparison and b. future studies on eating problems should specifically explore the various sensory properties of food such as texture, smell, color and taste and may consider the use of a diet log or diary to obtain more specific and objective information on intake. In addition, more research is needed to shed light on the underlying causes of eating problems and patterns in ASD.

Conflict of interest statement

The authors have no potential conflict of interest including any financial, personal or other relationships with other people or organizations that could inappropriately influence, or be perceived to influence, the above work.

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