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Original Article

Impact of eating habits and nutritional status on children with autism spectrum disorder

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الملخص

أهداف البحث: تنتشر السمنة عند الأطفال المصابين باضطراب طيف التوحد، ويواجهون مشاكل في التغذية بالمقارنة بالأطفال ذوي النمو الطبيعي. ويوصَى بأنواع مختلفة من الوجبات الغذائية لأطفال اضطراب طيف التوحد. تهدف هذه الدراسة لتحديد تكرار اضطرابات الأكل وزيادة الوزن بين الأطفال المصابين باضطراب طيف التوحد. كما قمنا بدراسة العوامل المسببة لاضطرابات الأكل ودرسنا آثار الطعام المستهلك على درجات التوحد.

طرق البحث: أجريت هذه الدراسة المستعرضة في مركز واحد، وتم اشراك ٤٦ طفلا أعمارهم بين ٢-١٠ عاما. تم تسجيل نماذج القياسات الأنثروبومترية، وتسجيل موجز لسلوكيات وجبات التوحد، القائمة المرجعية لسلوك التوحد واستبانة تكرار الغذاء التي تم تعبئتها من قبل والديهم.

النتائج: كان معدل زيادة الوزن والسمنة عند الأطفال ١٠.٩٪ و٢٨.٣٪ على التوالي. كما تم ملاحظة انتقائية الطعام عند ٨٤.٨٪ من الأطفال، وكان موجز سلوكيات وجبات التوحد ودرجة رفض الطعام أعلى بكثير في الأعمار بين ٢-٥ أعوام، كما تم العثور على ارتباط كبير بين درجات التوحد واستهلاك الحليب، والزبادي، والبذور الزيتية، والرز / المعكرونة والفواكه. تم تسجيل اختلاف كبير أيضا بين هذه الدرجات وتكرار البيض، البقوليات واستهلاك الحبوب الأخرى.

الاستنتاجات: في هذه الدراسة، كانت السمنة أكثر شيوعا عند الأطفال الذين لديهم إضطراب طيف التوحد عن الأطفال الذين لديهم نمو عادي. على الرغم أنه تم ملاحظة انتقائية الطعام بمعدل مرتفع، تدعم نتائجنا حقيقة أن انتقائية الطعام يمكن أخذها في الاعتبار بصرف النظر عن السمنة على أساس هذه النتائج، النظام الغذائي لمرضى إضطراب طيف التوحد يجب أن يشمل كمية أكبر من الفواكه، والألبان، والبيض والبقوليات، والحبوب الأخرى وحليب أقل والرز/ المعكرونة.

الكلمات المفتاحية: اضطراب طيف التوحد؛ أعراض التوحد؛ اضطرابات الأكل؛ الحالة التغذوية؛ السمنة عند الأطفال

Abstract

Objectives: Obesity is common among children with Autism Spectrum Disorder (ASD). They suffer more feeding problems than children with normal developmental milestones. Several kinds of diet are recommended for children with ASD. This study determines the frequency of eating disorders and obesity among such children. We investigate the predisposing factors of eating disorders and examine the effects of consumed food on autism scores.

Methods: In this single-centre, cross-sectional study, 46 children with ASD aged between 2 and 10 years were included. Anthropometric measurements were recorded and Brief Autism Mealtime Behavior Inventory (BAMBI), Autism Behavior Checklist (ABC), and Food Frequency Questionnaire (FFQ) forms were filled in by their parents.

Results: The rates of being overweight and obese were 10.9% and 28.3%, respectively. Food selectivity was observed in 84.8% of the children, and BAMBI food refusal scores were significantly higher for those aged between 2 and 5 years ($p = 0.03$). Autism scores and consumption of milk, yoghurt, oily seeds, rice/pasta, and fruits ($p < 0.05$) were significantly correlated. There were also significant differences between these scores and the frequency of consuming eggs, legumes, and other cereals ($p < 0.05$).

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Conclusion: Obesity was more common in children with ASD than typically developed children. Despite the high rate of food selectivity, our findings confirmed that food selectivity could be considered independent of obesity. Further, the diet of patients with ASD must include more fruits, yogurt, eggs, legumes, other cereals, less milk, and less rice/pasta.

Keywords: Autism spectrum disorder; Autism symptoms; Eating disorders; Nutritional status; Paediatric obesity

Introduction

Autism Spectrum Disorder (ASD) is a condition characterised by complex neurodevelopmental disabilities, including insufficient social communication and social interaction, deficits in nonverbal communicative behaviours used for social interaction and developing skills, maintaining and understanding relationships. Additionally, restricted repetitive patterns of behaviour, interests or activities might also be observed.[1–3]

Approximately, 1 out of 59 children are diagnosed with ASD, and it is 4 times more common among boys than girls.[4] Although accurate prevalence data are not available, according to the Ministry of Health, Health Net recorded a total of 107,834 people diagnosed with ASD in Turkey in 2018. Out of these, 90,671 were aged between 0 and 14 years.[5]

Childhood obesity is one of the most serious public health problems. In 2016, the number of overweight children worldwide under the age of 5 was estimated to be over 41 million.[6] Previous studies demonstrated that the rates of being overweight and obese are higher in children with ASD than typically developing children.[7–10] Children with ASD have more feeding problems compared to their peers.[7] Although food refusal and restricted eating behaviour might be observed in most children, it is more common in children with ASD than typically developing children.[11] The most common feeding problem is food selectivity.[12] Sensory sensitivity and persistence in routine are common reasons for selective feeding behaviour in individuals with ASD.[5,12] In the existing literature, there are measurement tools that are used to measure autism behaviours, such as Autism Behavior Checklist (ABC) and mealtime behavioural problems, such as Brief Autism Mealtime Behavior Inventory (BAMBI).[13,14] ABC assesses the degree of autism where increased scores indicate increased severity. On the other hand, BAMBI evaluates limited food variety, food refusal, and autism features. Although there were conflicting results in studies examining the relationship between food selectivity and nutritional deficiency,[15] some studies stated that fibre, vitamin D, vitamin E, calcium, zinc, vitamin B6, and folate intakes are insufficient in children with ASD.[11,12]

We aimed at determining the eating disorders and frequency of being overweight among our patients with ASD. We also investigated the predisposing factors of eating disorders.

Materials and Methods

Participants

The study participants were 46 consecutive children aged between 2 and 10 years (males 82.6% and females 17.4%) followed up in our paediatric neurology clinic and included retrospectively from patients' files. All participants were previously diagnosed with ASD by a child neurologist.

Data collection

The participants wore thin clothing without shoes for the measurement of their height and weight using a portable scale (accuracy 100 g; Tefal Bien) and a stable stadiometer (accuracy 1 mm). The measurements were taken in our clinic by one of the authors, who is a dietitian. The BMI-for-age values were calculated using the WHO Anthro Software version 3.2.2 and WHO AnthroPlus Software version 1.0.4. The children were classified as severely thin (<3rd percentile), thin (3rd-15th percentile), normal (15th-85th percentile), overweight (85th-97th percentile), and obese (>97th percentile).

Their parents/caregivers were asked to fill in four different questionnaires by the dietitian: (1) general questionnaire, (2) Food Frequency Questionnaire (FFQ), (3) Brief Autism Mealtime Behavior Inventory (BAMBI), (4) Autism Behavior Checklist (ABC).

Measurements

The dietician prepared the general questionnaire. It is used in routine clinical visits. It includes questions about the date of birth and weeks of gestation, birth weight, time when breastfeeding was stopped, time when complementary feeding began, child's medical history (current medications and non-drug treatment), any allergies the child or family is known to have, mothers' work status, who prepares the food, eating environment, number of meals per day, meal omitting, self-feeding status, appetite status, swallowing and chewing function status, preferred food forms, physical activity status, and gastrointestinal status (constipation, diarrhoea, indigestion etc.) of the child.

Food Frequency Questionnaire determines how often the child consumed food groups within the last month. It was modified and filled in by the dietitian based on standard portion sizes.

Brief Autism Mealtime Behavior Inventory (BAMBI) assesses mealtime behavioural problems in children with ASD aged between 3 and 11 years. Higher score indicates more mealtime behavioural problems.[13] The validity and reliability study was conducted in Turkey.[16] BAMBI contains three factors, namely limited variety, food refusal, and features of autism.

Autism Behavior Checklist (ABC) determines ASD diagnosis and assesses the degree of ASD and the presence of other additional conditions.[14] The validity and reliability study was conducted in Turkey.[17] Increased score on the ABC indicates increased severity of autism. ABC contains four factors, namely sensorial, relating, body and object use, language and social and self-help.

Statistical analysis

Statistical Package for Social Sciences, SPSS (Version 16) (SPSS INC., Chicago, IL, USA), was used for all statistical analyses. The statistical significance was set at $p < 0.05$. Chi-square tests were used to assess the distribution of the BMI classifications by the children's age. Data were tested for normal distribution using the Shapiro–Wilk test. The t test in independent groups was used for parametric values. The Mann–Whitney U test was used for non-parametric values, and the Pearson and Spearman's tests were used for correlations.

Results

The 46 children (males 82.6% and females 17.4%) aged between 2 and 10 years were divided into 2 age groups: 2–5 years (56.5%, 26 children) and 6–10 years (43.5%, 20 children).

A total of 41 children (89.1%) had normal birth weight (Normal birth weight is defined between 2.5 and 4.5 kg, low birth weight 6.5%, high birth weight 4.3%), 44 (95.7%) were born in term (preterm 4.3%), 26 (56.5%) were breastfed for less than 6 months, 24 (52.2%) were provided complementary feeding at 6 months (13 children started before 6 months and 9 started after 6 months), 34 (73.9%) were receiving medical treatment, 43 (93.5%) were receiving non-drug

Table 1: BMI classifications, eating habits and gastrointestinal problems of children with ASD.

	2–5 years (n = 26) n (%)	6–10 years (n = 20) n (%)	Total (n = 46) n (%)	*p* value
BMI classifications				**0.974
Severely thin	2 (7.7)	1 (5.0)	3 (6.5)	
Thin	2 (7.7)	2 (10.0)	4 (8.7)	
Normal	11 (42.3)	10 (50.0)	21 (45.6)	
Overweight	3 (11.5)	2 (10.0)	5 (10.9)	
Obese	8 (30.8)	5 (25.0)	13 (28.3)	
Apetite status				**0.007
Bad	4 (15.4)	–	4 (8.7)	
Mid	9 (34.6)	1 (5.0)	10 (21.7)	
Good	8 (30.8)	8 (40.0)	16 (34.8)	
Very good	5 (19.2)	11 (55.5)	16 (34.8)	
Swallowing and chewing function				1.000
Normal	16 (61.5)	12 (60.0)	28 (60.9)	
Dysfunction	10 (38.5)	8 (40.0)	18 (39.1)	
Low chewing	*9 (90.0)*	*7 (87.5)*	*16 (88.9)*	
Mouth hold	*1 (10.0)*	*1 (12.5)*	*2 (11.1)*	
Food selection status				0.213
Selective	24 (92.3)	15 (75.0)	39 (84.8)	
Not selective	2 (7.7)	5 (25.0)	7 (15.2)	
***Preferred food forms**				
Solid	26 (100.0)	26 (100.0)	46 (100.0)	–
Mashed	24 (92.3)	18 (90.0)	42 (91.3)	1,000
Liquid	22 (84.6)	17 (85.0)	39 (84.8)	1,000
All forms	21 (80.8)	17 (85.0)	38 (82.6)	0,571
Working status of mother				**0.013**
Working	10 (38.5)	1 (5.0)	11 (23.9)	
Not working	16 (61.5)	19 (95.0)	35 (76.1)	
***Who prepares the food?**				
Mother	23 (88.5)	19 (95.0)	42 (91.3)	0,622
Father	1 (3.8)	1 (5.0)	2 (4.3)	1,000
Sister/Brother	–	1 (5.0)	1 (2.2)	0,435
Caregiver	3 (11.5)	–	3 (6.5)	0,246
Grandmother/ Grandfather	4 (15.4)	2 (10.0)	6 (13.0)	0,684
***Eating environment**				
Kitchen table	17 (65.4)	18 (90.0)	35 (76.1)	0.082
Highchairs	4 (15,4)	–	4 (8.7)	0,121
Living room	4 (15.4)	1 (5.0)	5 (10.9)	0,369
Table on the floor	1 (3.8)	2 (10.0)	3 (6.5)	0,572
Jaunting	1 (3.8)	2 (10.0)	3 (6.5)	0,572
Staring at screen while eating				0.155
Yes	10 (38.5)	3 (15.0)	13 (28.3)	
No	16 (61.5)	17 (85.0)	33 (71.7)	
Number of meals per day				**0,126
<3 meals	2 (7.7)	–	2 (4.3)	
3-6 meals	24 (92.3)	18 (90.2)	42 (91.3)	
>6 meals	–	2 (10.0)	2 (4.3)	
Meal omitting				0.711
Yes	6 (23.1)	3 (15.0)	9 (19.6)	
No	20 (76.9)	17 (85.0)	37 (80.4)	
Skipped meal				*0.167*
Breakfast	*2 (33.3)*	*3 (100.0)*	*5 (55.6)*	
Lunch	*4 (66.7)*	–	*4 (44.4)*	
Dinner	-	-	-	
Self-feeding status				1.000
Yes	24 (92.3)	18 (90.0)	42 (91.3)	
No	2 (7.7)	2 (10.0)	4 (8.7)	
***GI problems**				
Constipation	8 (30.8)	3 (15.0)	11 (23.9)	0.302
Diarrhea	1 (3.8)	1 (5.0)	2 (4.3)	1.000
Gas complaint	1 (3.8)	7 (35.0)	8 (17.4)	**0.014**
Indigestion	1 (3.8)	3 (15.0)	4 (8.7)	0.303
Reflux	2 (7.7)	1 (5.0)	3 (6.5)	1.000
Vomiting after eating	1 (3.8)	1 (5.0)	2 (4.3)	1.000

Chi-square test was used. $p < 0.05$ was significant; the values that meet this condition are emphasized in bold.
* Multiple options are selected.
** Not suitable for distribution.

Table 2: BAMBI and ABC scores of children with ASD.

BAMBI and Domains	2–5 years (n = 26) Mean ± SD	6–10 years (n = 20) Mean ± SD	Total (n = 46) Mean ± SD	Possible range of scores	*p* value
Total score	41.92 ± 10.95	37.45 ± 10.69	39.97 ± 10.95	18–90	0.172
Limited variety	22.11 ± 6.40	20.85 ± 7.74	21.56 ± 6.96	8–40	0.547
**Food refusal	8.00 (5.75–11.25)	6.00 (5.00–8.00)	7.00 (5.00–9.25)	5–25	**0.030**
Features of autism	10.65 ± 3.80	9.80 ± 2.41	10.28 ± 3.27	5–25	0.359
ABC and Domains					
Total score	56.53 ± 22.64	57.05 ± 24.11	56.76 ± 23.03	0–159	0.941
**Sensorial	6.00 (3.00–10.25)	7.50 (3.00–10.00)	6.00 (3.00–10.00)	0–26	0.806
Relating	12.03 ± 7.75	13.60 ± 6.90	12.71 ± 7.36	0–38	0.482
Body and object use	13.80 ± 8.37	12.90 ± 8.57	13.41 ± 83.7	0–39	0.720
**Language	11.00 (7.75–17.00)	11.00 (6.00–18.00)	11.00 (7.00–17.00)	0–31	0.816
Social and selfhelp	12.07 ± 4.73	10.45 ± 4.55	11.36 ± 4.67	0–25	0.247

T test in independent groups was used. $p < 0.05$ was significant; the values that meet this condition are emphasized in bold.
**Median (IQR 25–75) were given and Mann Whitney U test was used because they do not fit the normal distribution.

Table 3: Frequency of food consumptions of children with ASD.

Food Frequency n (%)	Every day	5-6 per week	3-4 per week	1-2 per week	1 in 15 days	1 per month	Never
Milk	10 (21.7)	–	4 (8.7)	3 (6.5)	1 (2.2)	–	28 (60.9)
Yoghurt	29 (63.0)	3 (6.5)	5 (10.9)	4 (8.7)	–	–	5 (10.9)
Cheese	23 (50.0)	3 (6.5)	4 (8.7)	3 (6.5)	2 (4.3)	1 (2.2)	10 (21.7)
Red meat	13 (28.3)	4 (8.7)	15 (32.6)	11 (23.9)	1 (2.2)	–	2 (4.3)
White meat	5 (10.9)	1 (2.2)	6 (13.0)	20 (43.5)	4 (8.7)	3 (6.5)	7 (15.2)
Egg	21 (45.7)	2 (4.3)	6 (13.0)	8 (17.4)	1 (2.2)	–	8 (17.4)
Legumes	1 (2.2)	2 (4.3)	8 (17.4)	22 (47.8)	3 (6.5)	1 (2.2)	9 (19.6)
Fresh vegetable	24 (52.2)	2 (4.3)	7 (15.2)	6 (13.0)	1 (2.2)	1 (2.2)	5 (10.9)
Fresh fruit	37 (80.4)	1 (2.2)	4 (8.7)	3 (6.5)	–	–	1 (2.2)
Bread	45 (97.8)	–	–	1 (2.2)	–	–	–
Rice/pasta	21 (45.7)	1 (2.2)	11 (23.9)	7 (15.2)	–	2 (4.3)	4 (8.7)
Other cereals (like soup)	24 (52.2)	2 (4.3)	6 (13.0)	6 (13.0)	2 (4.3)	–	6 (13.0)
Liquid oil	45 (97.8)	–	–	–	–	–	1 (2.2)
Butter	30 (65.2)	1 (2.2)	3 (6.5)	2 (4.3)	–	–	10 (21.7)
Oily seeds	21 (45.7)	–	6 (13.0)	4 (8.7)	1 (2.2)	–	14 (30.4)
Packaged food	23 (50.0)	2 (4.3)	3 (6.5)	15 (32.6)	1 (2.2)	2 (4.3)	–

treatment (such as play therapy, occupational therapy, special education), 16 (34.8%) were allergic, and 14 (30.4%) had a family history of allergy.

A total of 13 children (28.7%) had a history of previous dietary programme. The most common diet among these was the gluten-free-casein-free diet (GFCF) (53.8%). This was followed by Gut and Psychology Syndrome (GAPS) diet with the rate of 23.1%, and 78.6% of those included in dietary programmes were not followed by any health professionals for diet. Nevertheless, 57.1% of those who followed dietary programmes in the past reported them to be beneficial. However, none of the children attended or followed a special diet during the clinical interview. Table 1 shows BMI classifications, eating habits, and gastrointestinal problems of children with ASD by age groups. Although there was a significant difference between the work status of mothers according to the children's age groups ($p = 0.013$), there was no significant difference according to their BMI classification ($p > 0.05$). We found no significant difference between children's BMI classification and their physical activity status declared by their families ($p > 0.05$).

Table 2 shows BAMBI total and subgroup scores, ABC total and subgroup scores of children with ASD. Although food refusal rate was higher for those aged 2–5 years, no significant difference was found between BMI classification by age and BAMBI total and subgroup scores, ABC total and subgroup scores ($p > 0.05$). (Data not shown).

The ABC total and the BAMBI total scores (r = 0.379, $p = 0.009$) were significantly related, indicating that higher severity of ABC total scores related to greater levels of feeding difficulties. However, the relationship between the ABC total and the BAMBI limited variety scores was not significant.

Table 3 shows food frequency of children with ASD. We found no significant difference in terms of gender and age among those with obesity. On the other hand, there were significant correlations between being obese and increased packaged food consumption (r = −0.424, $p = 0.003$), decreased fresh fruit consumption (r = 0.368, $p = 0.012$), good appetite status (r = 0.324, $p = 0.028$), no meal skipping (r = 0.468, $p = 0.001$), increasing number of meals (r = 0.299, $p = 0.044$), and high birth weight (r = 0.299, $p = 0.044$).

Table 4: Comparison of BAMBI and ABC scores regarding to frequency of food consumption of children with ASD.

BAMBI and Domains	Food	Frequency	N	Score mean ± SD	*p* value
Total score	Legumes	1-2 per week	22	38.54 ± 9.55	0.035
		Never	9	47.77 ± 12.86	
	Rice/pasta	Everyday	21	40.66 ± 10.08	0.021
		1-2 per week	7	30.00 ± 9.48	
	Rice/pasta	3-4 per week	11	40.72 ± 8.11	0.021
		1-2 per week	7	30.00 ± 9.48	
	Rice/pasta	1-2 per week	7	30.00 ± 9.48	0.039
		Never	4	45.25 ± 11.11	
	Other cereal (like soup)	Everyday	24	39.95 ± 10.71	0.0001
		5-6 per week	2	30.00 ± 0.00	
	Other cereal (like soup)	5-6 per week	2	30.00 ± 0.00	0.020
		3-4 per week	6	44.50 ± 10.52	
	Other cereal (like soup)	5-6 per week	2	30.00 ± 0.00	0.017
		Never	6	46.33 ± 11.41	
	Other cereal (like soup)	3-4 per week	6	44.50 ± 10.52	0.026
		1-2 per week	6	30.50 ± 7.84	
	Other cereal (like soup)	1-2 per week	6	30.50 ± 7.84	0.019
		Never	6	46.33 ± 1.21	
	Butter	3-4 per week	3	50.00 ± 4.58	0.019
		1-2 per week	2	24.00 ± 8.48	
	Butter	1-2 per week	2	24.00 ± 8.48	0.034
		Never	10	40.30 ± 8.59	
Limited variety	Rice/pasta	Everyday	21	21.09 ± 5.98	0.031
		1-2 per week	7	15.28 ± 5.34	
	Rice/pasta	Everyday	21	21.09 ± 5.98	0.021
		Never	4	30.00 ± 9.66	
	Rice/pasta	3-4 per week	11	22.63 ± 4.63	0.007
		1-2 per week	7	15.28 ± 5.34	
	Rice/pasta	1-2 per week	7	15.28 ± 5.34	0.009
		Never	4	30.00 ± 9.66	
	Other cereal (like soup)	5-6 per week	2	15.50 ± 0.70	0.013
		3-4 per week	6	24.33 ± 5.81	
	Butter	1-2 per week	2	11.50 ± 4.94	0.047
		Never	10	21.30 ± 5.63	
Features of autism	Egg	Everyday	21	9.80 ± 2.63	0.025
		5-6 per week	2	14.50 ± 2.12	
	Egg	5-6 per week	2	14.50 ± 2.12	0.032
		3-4 per week	6	9,16 ± 2.40	
	Other cereal (like soup)	Everyday	24	10.54 ± 3.42	0.007
		1-2 per week	6	6.33 ± 1.21	
	Other cereal (like soup)	5-6 per week	2	9.50 ± 0.70	0.015
		1-2 per week	6	6.33 ± 1.21	
	Other cereal (like soup)	3-4 per week	6	11.50 ± 2.73	0.002
		1-2 per week	6	6.33 ± 1.21	
	Other cereal (like soup)	1-2 per week	6	6.33 ± 1.21	0.001
		1 in 15 days	2	12.00 ± 1.41	
	Other cereal (like soup)	1-2 per week	6	6.33 ± 1.21	0.002
		Never	6	11.66 ± 2.87	
ABC and Domains					
Total score	Yoghurt	Everyday	29	52.62 ± 22.56	0.043
		Never	5	74.80 ± 15.08	
	Yoghurt	3-4 per week	5	72.00 ± 21.10	0.044
		1-2 per week	4	42.00 ± 13.36	
	Yoghurt	1-2 per week	4	42.00 ± 13.36	0.011
		Never	5	74.80 ± 15.08	
	Cheese	Everyday	23	51.91 ± 19.44	0.036
		3-4 per week	4	76.75 ± 27.87	
	Legumes	1 in 15 day	3	27.33 ± 25.32	0.034
		Never	9	64.44 ± 21.99	
	Rice/pasta	Everyday	21	62.57 ± 24.12	0.015
		1-2 per week	7	36.42 ± 18.22	
	Rice/pasta	3-4 per week	11	62.09 ± 20.70	0.016
		1-2 per week	7	36.42 ± 18.22	

(*continued on next page*)

Table 4 (*continued*)

BAMBI and Domains	Food	Frequency	N	Score mean ± SD	*p* value
	Other cereal (like soup)	Everyday	24	55.33 ± 20.27	0.0001
		5-6 per week	2	27.00 ± 2.82	
	Other cereal (like soup)	5-6 per week	2	27.00 ± 2.82	0.006
		3-4 per week	6	73.16 ± 25.18	
	Other cereal (like soup)	5-6 per week	2	27.00 ± 2.82	0.029
		Never	6	71.16 ± 20.73	
	Butter	3-4 per week	6	76.16 ± 21,94	0.005
		Never	14	44.78 ± 19.26	
Relating	Cheese	Everyday	23	10.56 ± 6.32	0.015
		1 in 15 days	2	22.50 ± 0.70	
	Cheese	5-6 per week	3	9,66 ± 6.02	0.049
		1 in 15 days	2	22.50 ± 0.70	
	Cheese	1 in 15 days	2	22.50 ± 0.70	0.010
		Never	10	14.00 ± 8.20	
	Egg	Everyday	21	10.76 ± 6.61	0.009
		5-6 per week	2	24.50 ± 3,53	
	Egg	5-6 per week	2	24.50 ± 3,53	0.035
		3-4 per week	6	12.16 ± 5,87	
	Egg	5-6 per week	2	24.50 ± 3,53	0.043
		Never	8	12.37 ± 6.69	
	Legumes	5-6 per week	2	20.50 ± 2.12	0.048
		1 in 15 days	3	5.00 ± 6.24	
	Legumes	1 in 15 days	3	5.00 ± 6.24	0.045
		Never	9	14.77 ± 6.43	
	Other cereal (like soup)	5-6 per week	2	5.50 ± 2.12	0.020
		3-4 per week	6	17.00 ± 8.17	
	Nuts	Everyday	21	12.71 ± 7.03	0.040
		3-4 per week	6	19.66 ± 6.56	
	Butter	3-4 per week	6	19.66 ± 6.56	0.002
		Never	14	9.28 ± 5.62	
Body and object use	Yoghurt	1-2 per week	4	7.00 ± 3.91	0.016
		Never	5	18.20 ± 6.09	
	Legumes	5-6 per week	2	14.50 ± 2.12	0.032
		1 in 15 days	3	3.66 ± 3.51	
	Legumes	1 in 15 days	3	3.66 ± 3.51	0.029
		Never	9	17.66 ± 9.06	
	Rice/pasta	Everyday	21	14.19 ± 7.38	0.012
		1-2 per week	7	6.00 ± 5.13	
	Rice/pasta	3-4 per week	11	15.72 ± 9.76	0.028
		1-2 per week	7	6.00 ± 5.13	
	Other cereal (like soup)	Everyday	24	12.54 ± 8.16	0.016
		5-6 per week	2	7.00 ± 1.41	
Social and selfhelp	Milk	3-4 per week	4	14.75 ± 2.62	0.020
		1-2 per week	3	9.33 ± 1.52	
	Yoghurt	1-2 per week	4	9.25 ± 2.75	0.030
		Never	5	13.60 ± 2.07	
	Red meat	Everyday	13	12.84 ± 4.12	0.023
		5-6 per week	4	6.25 ± 5.96	
	White meat	Everyday	5	13.40 ± 1,94	0.024
		3-4 per week	6	10.83 ± 1.16	
	White meat	1-2 per week	20	12.55 ± 4.11	0.044
		Never	7	8.42 ± 5.28	
	Rice/pasta	Everyday	21	12.57 ± 4.31	0.012
		1-2 per week	7	7.42 ± 4.46	
	Rice/pasta	3-4 per week	11	11.36 ± 2.65	0.006
		1 per month	2	18.00 ± 0.00	
	Rice/pasta	1-2 per week	7	7.42 ± 4.46	0.001
		1 per month	2	18.00 ± 0.00	
	Other cereal (like soup)	Everyday	24	11.83 ± 4.77	0.024
		5-6 per week	2	3.50 ± 0.70	
	Other cereal (like soup)	5-6 per week	2	3.50 ± 0.70	0.005
		3-4 per week	6	12.66 ± 2.87	
	Other cereal (like soup)	5-6 per week	2	3.50 ± 0.70	0.008
		Never	6	13.16 ± 3.31	

Table 4 (*continued*)

BAMBI and Domains	Food	Frequency	N	Score mean ± SD	*p* value
	Butter	Everyday	30	11.10 ± 4.49	0.018
		1-2 per week	2	3.00 ± 1.41	
	Butter	3-4 per week	3	14.66 ± 3.21	0.019
		1-2 per week	2	3.00 ± 1.41	
	Butter	1-2 per week	2	3.00 ± 1.41	0.014
		Never	10	12.30 ± 4.21	

T test in independent groups was used. $p < 0.05$ was significant.

Table 4 shows the BAMBI and ABC scores of children with ASD according to their food consumption.

The BAMBI total scores were significantly higher for those who did not feed themselves ($p = 0.007$).

Regarding BAMBI limited variety scores for the limited behaviour pattern, the features that increased the score were food selectivity (r = −0.393, $p = 0.007$), eating without being in a sitting (r = −0.383, $p = 0.009$), not consuming liquid foods (r = 0.352, $p = 0.016$), no complaints of gas (r = 0.319, $p = 0.031$), no self-feeding (r = 0.315, $p = 0.033$), and no consumption of mashed foods (r = 0.309, $p = 0.037$).

The features that increased BAMBI food refusal scores for food selectivity were not being constipated (r = 0.336, $p = 0.022$), no self-feeding (r = 0.314, $p = 0.034$), and bad appetite status (r = −0.306, $p = 0.038$). Features that increased BAMBI autism scores were milk consumption and eating table on the floor ((r = −0.388, $p = 0.008$ and r = −0.304, $p = 0.04$, respectively).

Features that increased ABC sensorial scores were consumption of oily seeds (r = −0.338, $p = 0.022$), not eating without being in a sitting (r = 0.307, $p = 0.038$), and good appetite status (r = 0.297, $p = 0.045$).

Features that increased ABC relating scores were not consuming fresh fruits (r = 0.317, $p = 0.032$) and good appetite status (r = 0.315, p = 0.033).

ABC body and object use scores of those who did not consume liquid were higher (r = 0.301, $p = 0.042$).

Features that increased ABC language scores were good appetite status (r = 0.347, $p = 0.018$), no food selectivity (r = 0.336, $p = 0.022$), and no yoghurt consumption (r = 0.302, $p = 0.042$).

Discussion

This is the first study in our country that investigated ASD. Our results highlighted the importance of nutrition for those who suffer from autism and the need to evaluate their diet better.

Childhood obesity is an increasingly intensifying public health problem in Turkey. According to the data of Childhood Obesity Surveillance Initiative (COSI-TUR 2016), 74%, 14.9%, and 9.9% typically developed Turkish children aged between 6 and 9 years were normal, overweight, and obese, respectively.[18] Several studies reported that obesity is more common in children with ASD.[7–10,12,19] In our study, the rate of obesity in children with ASD was higher compared to typically developed children, especially in our younger age group. Our study revealed that obesity is more common among children with ASD than general population.

In another study conducted in Turkey (3028 typically developed children, 5–15 years of age), moderate and higher socioeconomic level, higher maternal education, overweight or obese parents, and consuming milk pudding more than four times per week were reported as risk factors for obesity. On the other hand, consuming nuts more than four times per week was found to be preventive.[20] There are also many studies in the literature that reveal the relationship between BMI and increased packaged-food consumption.[21,22] In our study, the features associated with obesity were not skipping meals, increased consumption of packaged foods, decreased consumption of fresh fruits, good appetite, increased number of daily meals, and high birth weight.

In a previous study conducted with children with ASD in Turkey (n = 164, aged between 4 and 18), most common nutritional problems were eating a limited variety of food, eating too much, and eating fast, although these habits were more common in overweight and obese children.[12] However, our study found no significant relationships between food selection, BAMBI limited variety scores, BAMBI food refusal score, and BMI. Our findings established that food selectivity can be considered independent of obesity.

We also investigated eating disorders. Although there is no "gold standard" for measuring food selectivity, previous literature stated that children with ASD refuse more foods compared to typically developing children.[11,15,23] In children with ASD, food selectivity was the most common feeding problem[12] because of sensory sensitivity and persistence in routine.[5,12] Based on the parents' answers, 84.8% of children with ASD had food selectivity and BAMBI food refusal score was significantly higher for those aged 2–5 years compared to those aged 6–10 years. Our results indicated that "picky eating" decreases with age in children with ASD. Although some children did undergo dietary programmes, no regular nutritional counselling was provided to them. Providing nutrition education to families of children with ASD when they are still young may reduce autism symptoms.

According to the data of Childhood Obesity Surveillance Initiative (COSI-TUR 2016), 6.7% of children never consumed vegetables, 1.9% never consumed fruits, 23% never consumed whole fat milk, 13.4% never consumed cheese, and 4.9% never consumed yoghurt.[18] Our findings suggested that children with ASD are more selective regarding all these foods. Previous studies supported that children with ASD consume less protein containing foods,[24] dairy products,[25] vegetables,[24,26] fruits,[24] and consume more snacks and fruit juices.[25]

In the existing literature, studies examining the effect of food consumption on autism scores show conflicting results.[24,26] In our study, we found a correlation between the frequency of consumption of some foods and autism scores. While BAMBI subgroup scores increased with

increased milk consumption, they decreased with daily egg consumption. ABC and subgroup scores increased with more rice/pasta, oily seeds, legumes, and other cereals' consumption and decreased with more fruit and yoghurt consumption.

How the food is eaten is as important as its type. Our study found that eating without being seated, self-feeding status, and the form of food affect autism scores. Although not as common as other nutritional problems, children with ASD usually demand being fed by the caregiver or parents,[12] and they do not stay seated during meals.[27] They are also selective in terms of food texture.[12,23,27,28]

We provided detailed information regarding feeding behaviour and nutritional status of children with ASD. The strengths of our study lies in its investigation of an important topic, objective measurement of participants' height and weight, and use of modified FFQ form, BAMBI, and ABC scales together.

The limitations of this study include its small sample size and its cross-sectional design, which prevented us from drawing a conclusion regarding a causal link between eating disorders and ASD. Another limitation of our study is the lack of control group. Although physical activity is attributed to the degree of obesity in individuals with autism, we could not measure physical activity objectively because this was based on family expression. While we found no difference in reported physical activity between overweight/obese participants and those with normal weight, not using a scale to determine physical activity status prevented us from an objective evaluation. Lastly, we could not calculate the quantity of daily portions.

Conclusion

This study identified the predisposing factors of eating disorders in children with ASD. We found significant correlations between autism scores and consumption of certain foods (milk, yoghurt, oily seeds, rice/pasta, and fruits). Moreover, obesity was more prevalent in such children than the general population. "Picky eating" or eating a limited variety of foods while avoiding new foods is a common problem among children with ASD, which fortunately decreases with age. The results of our study highlighted the importance of a closer evaluation and improvement of the diet of children with ASD.

Recommendations

Based on our findings, we suggest that personal nutrition planning should be made for patients with ASD, and their diet should include more fruits, yogurt, eggs, legumes, other cereals, and less milk and rice/pasta. We also recommend that children with ASD must eat at the same table with their family, be offered different forms of food, not skip meals, be given the opportunity to feed himself/herself with appropriate equipments without staring at a screen (such as television, telephone or tablet).

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The Clinical Researches Ethic Committee of Istinye University, Istanbul approved this study (08 April 2019; approval no.: (2017-KAEK-120)/2019-12).

Authors contributions

SŞ conducted the literature search, collected, organised, analysed, and interpreted data, and wrote the initial and final drafts. ANC designed the study, interpreted data, revised the initial draft, and edited the final version of the manuscript. BE conceived and designed the study and conducted research. IG conceived the study. BT collected and organised data and provided research materials. All authors critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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