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ORIGINAL ARTICLE

Does parental nutrition knowledge affect gastrointestinal symptoms and dietary intake in children with Autism Spectrum Disorder?

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Abstract

This study aims to investigate the relationship between parental nutrition knowledge levels and the gastrointestinal symptoms and dietary intakes of children with autism spectrum disorder (ASD). This cross-sectional study was conducted with 120 children under the age of 18, diagnosed with ASD, and their parents living in Kütahya, Türkiye. Data were collected through face-to-face interviews using the Gastrointestinal Symptom Rating Scale (GSRS), the Brief Autism Mealtime Behavior Inventory (BAMBI), the Nutrition Knowledge Level Scale for Adults (NKLSA), anthropometric measurements, and a 24-hour dietary recall. Among the participating children, 39.2% (n = 47) were girls, with a mean age of 9.04 ± 3.3 years. Most parents (84.2%) reported that their children experienced feeding-related problems. The most frequently reported issues were

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food refusal (48.3%), neophobia (37.5%), and loss of appetite (28.3%). A statistically significant difference was found between mothers' NKLSA category and the variables of monthly income, maternal education, the child's sleep pattern, use of dietary supplements, and food refusal. As maternal nutrition knowledge increased, the child's GSRS score decreased (p=0.004). In addition, the GSRS subscales of abdominal pain and indigestion showed statistically significant differences according to the mother's NKLSA category. It was determined that children's total BAMBI scores did not differ significantly according to the mothers' level of nutrition knowledge. The findings suggest that health problems co-occurring with autism may complicate the nutritional status of children with ASD. Therefore, developing nutrition education programs for parents could be of paramount importance in supporting the optimal growth, development, and overall well-being of children with ASD.

Introduction

Autism Spectrum Disorder (ASD) is a heterogeneous group of neurodevelopmental disorders that begin in childhood and persist throughout life, characterized by persistent deficits in social communication and interaction, accompanied by restricted, repetitive patterns of behaviour and atypical sensory responses. ASD has a complex and multifactorial etiology resulting from the interaction of genetic and environmental factors, and its clinical features, which vary widely among individuals, make diagnosis challenging. Therefore, the diagnostic process requires both early awareness from parents and caregivers and a comprehensive evaluation by a multidisciplinary healthcare team [1]. The global prevalence of ASD is reported to be approximately 0.6%, rates of around 0.4% in Asia, 1.0% in the Americas, 0.5% in Europe, 1.0% in Africa, and 1.7% in Australia [2]. In Türkiye, ASD is diagnosed in approximately one in every 80 children [3].

Children and adolescents with ASD are more likely to experience comorbid conditions such as Attention-Deficit/Hyperactivity Disorder (ADHD), anxiety, depressive disorders, sleep disturbances, epilepsy, gastrointestinal (GI) disorders, and visual or hearing impairments [1,4]. Individuals with ASD commonly experience a variety of feeding and eating behavioral problems, including food refusal, limited dietary intake, obsessive eating habits, eating rituals, atypical eating patterns, eating too quickly or too slowly, sensitivity to the color and texture of certain foods, pica, regurgitation, and rumination [1,4,5]. The prevalence of these issues ranges from 46% to 89% and is often linked to challenges in the healthy growth and development of children [5].

Similar to feeding problems, between 9% and 91% of children with ASD experience GI issues. The most commonly reported symptoms are abdominal pain, diarrhoea, and constipation [6]. These are followed by nausea, vomiting, faecal incontinence, gastroesophageal reflux, achalasia, and bloating [7,8]. Such physiological problems may contribute to feeding/eating difficulties in children with ASD, as well as to the emergence or exacerbation of behavioural symptoms such as sleep disturbances, anxiety, aggressive behaviours, and hypersensitivity to certain stimuli [6-8]. This situation is associated with a higher risk of complications, growth and developmental problems, healthcare costs, and frequency of hospitalization in children with ASD, while potentially limiting their quality of life [7,8].

The nutritional status, eating behaviours, and GI symptoms of children with ASD are closely related to the nutrition knowledge of their parents or caregivers [7-9]. It has been shown that interventions aimed at improving mothers' education and nutrition knowledge can enhance the dietary habits of children with ASD and thereby help alleviate certain nutrition-related problems. Behavioural changes observed

after nutrition counselling demonstrate a direct relationship between mothers' increased knowledge and health outcomes in children with ASD, such as a reduction in obesity prevalence and improvements in gastrointestinal problems [7,8]. Increased parental knowledge about nutrition can contribute to healthier food choices and the establishment of structured eating routines. This, in turn, can support the regulation of gastrointestinal function in children with ASD by improving their nutrient intake and eating habits [5-8]. This study aimed to examine the relationship between parental nutritional knowledge and gastrointestinal symptoms and dietary habits in children with ASD.

Materials and Methods

Included in this study, which was designed as a cross-sectional type of research, were 120 children under the age of 18 and their parents, who were residents of Kütahya, receiving education at special education centers, and had been diagnosed with autism by a child and adolescent psychiatrist according to the Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) criteria, and who were selected using a random sampling method based on voluntary participation, between January 15 and April 1, 2025. (Fig. 1) The sample size was calculated using G*Power as 115 participants (±10%), based on the prevalence of ASD in Türkiye and the number of children under 18 living in Kütahya, with a power of 85%, an effect size of 0.5, and a significance level of $\alpha = 0.05$ [3-5]. To conduct the study, ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Kütahya University of Health Sciences (Approval No. 2024/14-26, dated 16 December 2024). Written informed consent was obtained from the parents or legal guardians of all participating children. Assent was obtained from the children when developmentally and cognitively appropriate; however, for those with significant communication or cognitive limitations related to ASD, assent could not be obtained, and participation was carried out based on parental consent. The study data were collected by the researchers through face-to-face interviews specifically conducted with the mothers of the children. Participants who were following a special nutrition/diet program, receiving enteral feeding, over 18 years of age, or had chronic disease (such as diabetes, cardiovascular diseases, etc.) or gastrointestinal disease (such as reflux, diarrhoea, constipation, etc.) were excluded from the study. Of the 128 initial volunteers, seven were excluded for not meeting the inclusion criteria: three did not fulfill the age requirements (<18 years), and four were following specialized diet programs. Additionally, one participant was excluded due to incomplete records, resulting in data loss. Consequently, the final analysis included 120 participants (Fig 1).

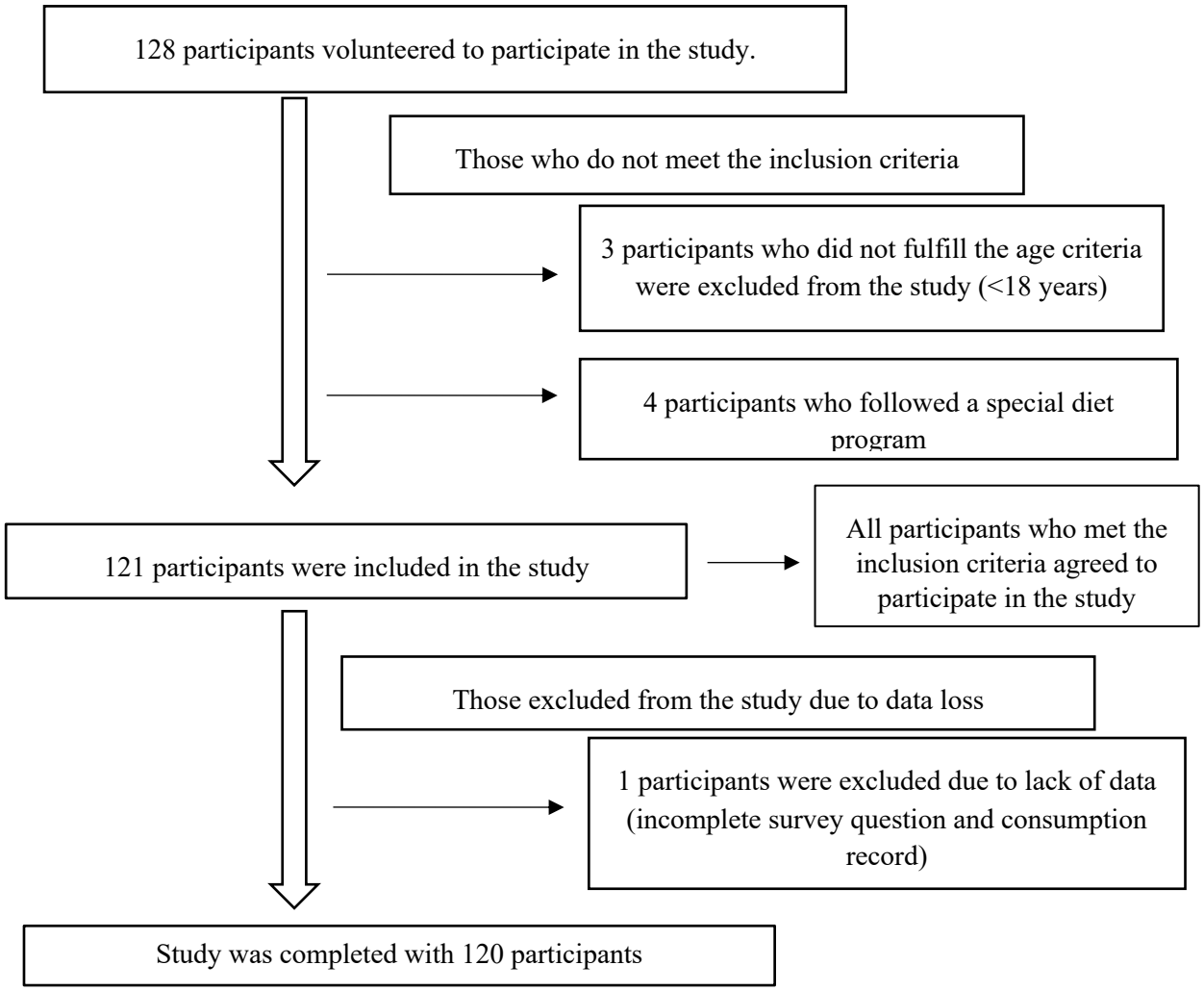

Figure 1. Participants recruitment flow chart.

Assessment of anthropometric measurements

Body weight (kg) and height (cm) of the participants were measured by the researchers using standardized procedures, and body mass index (BMI) was calculated. Body weight was measured without shoes on a SECA-813 professional scale with an accuracy of 100 g. A Mesilife-13539 portable stadiometer with an accuracy of 1 mm was used to measure height. Participants' heights were measured while standing upright and without shoes, with the Frankfort plane in the correct position. Age- and sex-specific BMI percentile values were evaluated according to the percentile curves developed for Turkish children by Neyzi et al. [10]. BMI is defined by age and gender as 5th percentile underweight, 5th to less than the 85th percentile normal weight, 85th to less than the 95th percentile overweight, and ≥95th percentile obesity [10]. Parental anthropometric measurements (body eight, height) were obtained using standardized procedures and BMI was calculated using the formula weight (kg)/height (m^2) and categorized according to World Health Organization (WHO) guidelines.

Assessment of dietary intake

To evaluate children's dietary intake, dietary data were collected using a 24-hour dietary recall on a weekday. Participants were trained in advance by the researchers on portion sizes and measurement

methods to ensure they could accurately complete the food record form. Dietary records were analysed using the Nutrition Information System (BeBiS).

Assessment of gastrointestinal symptoms

Gastrointestinal symptoms were assessed using the Gastrointestinal Symptom Rating Scale (GSRS), validated for the Turkish population by Turan et al. (α:0.82) [11]. This self-administered instrument captures the participants' perception of their gastrointestinal symptoms over the preceding week. It encompasses five distinct subscales: Abdominal Pain (including abdominal pain, hunger pains, and nausea), Reflux (heartburn and acid regurgitation), Indigestion (borborygmus, abdominal bloating, belching, and increased flatulence), Diarrhoea (loose stools, and urgent need for defecation), and Constipation (constipation, hard stools, and sensation of incomplete evacuation). Participants rated the frequency and severity of each symptom on a 7-point Likert scale, ranging from 1 to 7. Higher scores indicate greater severity of gastrointestinal symptoms experienced by the individual [11].

Assessment of feeding problems in children

Children's feeding problems were assessed using the Brief Autism Mealtime Behavior Inventory (BAMBI). The Turkish validity and reliability of the BAMBI, which was developed to determine mealtime behaviours and feeding problems in children with autism, was established by Meral et al. (α:0.79) [12]. Higher total and subscale scores on the BAMBI indicate a greater frequency of autism-specific problematic mealtime behaviours.

Assessment of mother's nutrition knowledge

Mother's nutrition knowledge was assessed using the Nutrition Knowledge Level Scale for Adults (NKLSA) developed by Batmaz in 2018 [13]. The validity and reliability of the scale were also assessed in the same study. The scale includes two sections, 'Basic Nutrition Knowledge' and 'Food Preferences', and comprises 32 items. The maximum obtainable score under the 'Basic Nutrition Knowledge' section is 80 (<45 = Poor, 45–55 = Moderate, 56–65 = Good, and >65 = Very Good). Under the 'Food Preferences' section, the maximum score is 48 (<30 = Poor, 30–36 = Moderate, 37–42 = Good, and >42 = Very Good) [13].

Statistical data analysis

All statistical analyses were performed using IBM SPSS Statistics version 26.0. The normality of the distribution for continuous variables was assessed using the Kolmogorov-Smirnov test. Data are presented as mean ± standard deviation ($\bar{X}$ ± SD) for normally distributed variables and as median (minimum-maximum) for non-normally distributed variables. Categorical variables are summarized as frequency and percentage (n, %). For group comparisons, the appropriate statistical tests were selected based on data distribution and variable type. The differences in continuous variables between two independent groups were analysed using the Student's t-test for parametric data and the Mann-Whitney U test for non-parametric data. For comparisons across more than two independent groups, the One-Way ANOVA (for parametric data) or the Kruskal-Wallis H test (for non-parametric data) was employed. When the Kruskal-Wallis H test indicated a statistically significant difference, post-hoc pairwise comparisons were conducted using Dunn's test with Bonferroni correction. Associations between categorical variables were evaluated using the Pearson Chi-Square and Fisher Freeman Halton test. In all analyses, a p-value of less than 0.05 was considered statistically significant.

Results

The basic and anthropometric characteristics of the participants (n = 120, 39.2% female) by sex are presented in Table 1. The mean age of the participants was 9.0 ± 3.3 years. The mean age of the mothers

was 38.8 ± 5.2 years, and 20.5% had attained a university-level education or higher. The participants' average daily sleep duration was 8.5 ± 1.6 hours, with 74.0% of boys and 76.6% of girls having a normal sleep pattern. Among female participants, the prevalence of dietary supplement use, medication use, and chronic disease was 68.1%, 17.0%, and 25.5%, respectively. Among male participants, these rates were 56.2%, 28.8%, and 35.6%, respectively, but the differences were not statistically significant. The mean body weight and height of the girls were 30.5 ± 11.6 kg and 129.2 ± 15.5 cm, respectively, while those of the boys were 33.0 ± 16.7 kg and 129.5 ± 21.5 cm, respectively. According to BMI percentile classification, 65.8% of the children were of normal weight, while 13.4% were classified as obese. Among girls, 4.3% were underweight and 8.5% were classified as obese, whereas among boys, these rates were 6.8% and 16.4%, respectively.

Table 1. Basic demographic and anthropometric characteristics of the participants by gender.

	Gender		
	Female (n:47, 39.2%)	**Male** (n:73, 60.8%)	**Total** (n:120)
Child Age (years)	9.0±2.9	9.0±3.6	9.04±3.3
Mother's age (years)	38.4±5.1	39.1±5.4	38.8±5.2
Maternal education			
Primary/secondary school	11(24.4)	31(43.1)	42(35.9)
High school	22(48.9)	29(40.3)	51(43.6)
University or higher	12(26.7)	12(16.7)	24(20.5)
Monthly income			
Minimum wage or below	5(10.6)	4(5.5)	9(7.5)
Twice the minimum wage	21(44.7)	49(67.1)	70(58.3)
3–4 times the minimum wage	21(44.7)	20(27.4)	41(34.2)
Normal sleep pattern			
Yes	36(76.6)	54(74.0)	90(75.0)
No	11(23.4)	19(26.0)	30(25.0)
Sleep duration (hours/day)	8.5±1.6	8.5±1.6	8.5±1.6
Chronic disease			
Yes	12(25.5)	26(35.6)	38(31.7)
No	35(74.5)	47(64.4)	82(68.3)
Use of dietary supplements			
Yes	32(68.1)	41(56.2)	73(60.8)
No	15(31.9)	32(43.8)	47(39.2)
Use of medication			
Yes	8(17.0)	21(28.8)	29(24.2)
No	39(83.0)	52(71.2)	91(75.8)
Child			
Body weight (kg)	30.5±11.6	33.0±16.7	32.0±14.9
Height (cm)	129.2±15.5	129.5±21.5	129.4±19.3
BMI (kg/m^2)	17.5±3.1	18.5±4.6	18.1±4.1
Child BMI classification			
Underweight	2(4.3)	5(6.8)	7(5.8)
Normal	18(39.1)	46(63.0)	79(65.8)
Overweight	8(17.0)	10(13.7)	18(15.0)
Obese	4(8.5)	12(16.4)	16(13.4)
Mother BMI classification			
Normal	28(60.8)	33(45.2)	61(51.3)
Overweight and obesity	18(39.2)	40(54.8)	58(48.7)

Results regarding participants' feeding problems, gastrointestinal symptoms, eating behaviors, and mother's nutrition knowledge by gender are presented in Table 2. A total of 84.2% of parents reported feeding problems in their children, with a higher prevalence in girls (89.4%) compared to boys (80.8%) (p<0.05). The most common feeding problems among children were food refusal (48.3%) and food neophobia (37.5%). The prevalence of rapid eating behavior was notably higher in boys (26.0%) compared to girls (8.5%), although the difference was not statistically significant (p>0.05). The total

BAMBI score was 44.8 ± 11.1 in girls and 43.4 ± 11.0 in boys. Regarding the subscales, girls had higher scores than boys in food refusal (10.6 ± 4.8) and limited variety although not statistically significant (20.4 ± 5.9) (p>0.05). The mean total GSRS score was 25.5 ± 9.7 in girls and 23.1 ± 8.3 in boys. Among the subscales, the most frequently reported symptom was indigestion, with a mean score of 7.2 ± 3.6, followed by constipation (5.3 ± 3.4) and abdominal pain (4.7 ± 2.2). Girls had higher scores than boys in constipation (5.7 ± 4.0) and abdominal pain (5.2 ± 2.3).

Table 2. Participants' feeding problems, gastrointestinal symptoms, eating behaviors, and mother's nutrition knowledge by gender.

	Gender		
	Female (n:47, 39.2%)	**Male** (n:73, 60.8%)	**Total** (n:120)
Feeding problem			
Yes	42(89.4)	59(80.8)	101(84.2)
No	5(10.6)	14(19.2)	19(15.8)
Poor appetite			
Yes	12(25.5)	22(30.1)	34(28.3)
No	35(74.5)	51(69.9)	86(71.7)
Choking / Gagging			
Yes	3(6.4)	4(5.5)	7(5.8)
No	44(93.6)	69(94.5)	113(94.2)
Food refusal			
Yes	25(53.2)	33(45.2)	58(48.3)
No	22(46.8)	40(54.8)	62(51.7)
Fast eating			
Yes	4(8.5)	19(26.0)	23(19.2)
No	43(91.5)	54(740)*	97(80.8)
Overeating			
Yes	6(12.8)	11(15.1)	17 (14.2)
No	41(87.2)	62(84.9)	103(85.8)
Food neophobia			
Yes	19(40.4)	26(35.6)	45(37.5)
No	28(59.6)	47(64.4)	75(62.5)
BAMBI total score	44.8±11.1	43.4±11.0	44.0±11.0
GSRS total score	25.5±9.7	23.1±8.3	24.1±8.9
NKLSA total score	55.0±9.8	52.5± 7.2	53.5±8.4
BAMBI category			
Food refusal	10.6±4.8	9.8±4.3	10.1±4.5
Features of autism	14.0±6.2	14.8±6.3	14.5±6.3
Limited variety	20.4±5.9	19.0±6.4	19.6±6.2
GSRS category			
Abdominal pain	5.2±2.3	4.4±2.1	4.7±2.2
Reflux	2.81±1.3	2.71±1.5	2.7±1.4
Indigestion	7.62±4.0	7.03±3.3	7.2±3.6
Diarrhea	4.51±3.2	4.04±1.9	4.2±2.5
Constipation	5.79±4.0	5.12±3.1	5.3±3.4
NKLSA category			
Poor	37.8±10.6	43.2±8.4	40.5±7.6
Moderate	49.4±2.9	49.2±3.2	49.3±3.1
Good	59.8±2.4	58.9±3.1	59.4±2.7
Very good	68.7±16	68.5±3.5	68.6±2.5

BAMI: Brief autism mealtime behavior inventory, GSRS: Gastrointestinal symptom rating scale, NKLSA: Nutrition knowledge level scale for adults,

Table 3 presents children's demographic and anthropometric characteristics, feeding problems, and gastrointestinal symptoms according to mother's nutrition knowledge level. Among parents with a moderate level of nutrition knowledge, the majority of their children were boys (73.0%), while 27.0% were girls. The difference between mother's nutrition knowledge level and children's sex was found to be statistically significant (p<0.05). No statistically significant relationship was found between mother's nutrition knowledge level and children's body weight, height, BMI, and BMI classification (p>0.05). A higher proportion of parents with good and very good nutrition knowledge was observed among families

with higher income levels (p<0.05). Similarly, a higher proportion of children with regular sleep habits was observed among those whose parents had good or very good nutrition knowledge compared to children whose parents had low nutrition knowledge (p=0.043). However, no statistically significant differences were observed between mother's nutrition knowledge levels and children's sleep duration, presence of chronic disease, or medication use (p>0.05).

Table 3. Children's demographic and anthropometric characteristics, feeding problems and gastrointestinal symptoms according to mother's nutrition knowledge level.

	NKLSA category				
	Poor 10(8.3%)	**Moderate** 63(52.5%)	**Good** 34(28.3%)	**Very good** 13(10.9%)	***p***
Gender					
Female	5(50.0)	17(27.0)	18(52.9)	7(53.8)	0.041[b]
Male	5(50.0)	46(73.0)	16(47.1)	6(46.2)	
Body weight (kg)	27.8±9.6	31.4±16.5	31.9±12.7	37.3±15.3	0.448[a]
Height (cm)	122.3±15.4	128.5± 20.9	130.3±17.2	136.8±18.6	0.253 [a]
BMI (kg/m^2)	18.8±6.6	18.1±3.9	17.7±3.6	18.8±3.7	0.937[a]
BMI classification					
Underweight	1(10.0)	3(4.8)	3(8.8)	-	0.659[c]
Normal	6(60.0)	42(66.7)	24(70.6)	7(53.8)	
Overweight	2(20.0)	8(12.7)	5(14.7)	3(23.1)	
Obese	1(10.0)	10(15.9)	2(5.9)	3(23.1)	
Monthly income					
Minimum wage or below	1(10.0)	7(11.1)	1(2.9)	-	0.005
Twice the minimum wage	6(60.0)	39(61.9)	23(67.6)	2(15.4)	
3–4 times the minimum wage	3(30.0)	17(27.0)	10(29.4)	11(84.6)	
Mother education					
Literate only	-	3(4.8)	-	-	0.001[c]
Primary/secondary school	5(50.0)	27(42.9)	9(26.5)	1(7.7)	
High school	4(40.0)	28(44.4)	16(47.1)	3(23.1)	
University or higher	1(10.0)	5(7.9)	9(26.4)	9(69.2)	
Sleep duration	7.36±1.81	8.55±1.52	8.82±1.82	9.02±1.49	0.088[a]
Normal sleep pattern					
Yes	4(40.0)	47(74.6)	28(82.4)	11(84.6)	0.043[c]
No	6(60.0)	16(25.4)	6(17.6)	2(15.4)	
Chronic disease					
Yes	3(30.0)	18(28.6)	13(38.2)	4(30.8)	0.788[c]
No	7(70.0)	45(71.4)	21(61.8)	9(69.2)	
Use of dietary supplements					
Yes	6(60.0)	28(44.4)	28(82.4)	11(84.6)	0.001[b]
No	4(40.0)	35(55.6)	6(17.6)	2(15.4)	
Use of medication					
Yes	1(10.0)	15(23.8)	11(32.4)	2(15.4)	0.409
No	9(90.0)	48(78.2)	23(67.6)	11(84.6)	
Feeding problem					
Yes	9(90.0)	53(84.1)	30(88.2)	9(69.2)	0.456[c]
No	1(10.0)	10(15.3)	4(11.8)	4(30.8)	
Poor appetite					
Yes	2(20.0)	19(30.2)	10(29.4)	3(23.1)	0.939[c]
No	8(80.0)	44(69.8)	24(70.6)	10(76.9)	
Choking / Gagging					
Yes	2(20.0)	1(1.6)	4(11.8)	-	0.028[c]
No	8(80.0)	62(98.4)	30(88.2)	13(100.0)	
Food refusal					
Yes	3(30.0)	30(47.6)	22(64.7)	3(23.1)	0.040[b]
No	7(70.0)	33(52.4)	12(35.3)	10(76.9)	
Overeating					
Yes	3(30.0)	9(14.3)	2(5.9)	3(23.1)	0.133[c]
No	7(70.0)	54(85.7)	32(94.1)	10(76.9)	
Food neophobia					
Yes	3(30.0)	23(36.5)	17(50.0)	2(15.4)	0.159[c]
No	7(70.0)	54(85.7)	17(50.0)	11(84.6)	
BAMBI total score	44.3±16.2	43.6±10.2	46.2±10.6	39.6±11.2	0.322[a]

GSRS total score	30.0±10.2	21.1±5.9	22.7±7.1	20.3±12.7	0.004[a]
NKLSA total score	40.5±7.6	49.3±3.1	59.4±2.7	68.6±2.5	<0.001[a]
BAMBİ category					
Food refusal	10.9±5.5	10.0±4.3	10.6±4.1	8.6±5.5	0.193[a]
Features of autism	15.5±5.5	14.8±6.0	15.4±7.2	10.1±3.4	0.021[a]
Limited variety	17.9±10.5	19.1±5.8	20.5±6.0	20.9±4.5	0.384[a]
GSRS category					
Abdominal pain	6.60 ± 3.47	4.16 ± 1.69	5.26 ± 2.34	4.54 ± 2.40	0.010[a]
Reflux	3.50 ± 2.51	2.44 ± 1.03	3.06 ± 1.52	2.85 ± 1.72	0.069[a]
Indigestion	9.46 ± 4.80	5.98 ± 2.51	8.21 ± 3.21	9.06 ± 5.80	0.001[a]
Diarrhea	4.50 ± 1.90	3.81 ± 1.65	4.41 ± 3.29	5.54 ± 3.73	0.253[a]
Constipation	7.70 ± 4.81	4.52 ± 2.44	5.79 ± 3.48	6.69 ± 5.41	0.095[a]

BAMI: Brief autism mealtime behavior inventory, GSRS: Gastrointestinal symptom rating scale, NKLSA: Nutrition knowledge level scale for adults, a: Kruskal-Wallis H test, b: Pearson Chi-square test, c: Fisher Freeman Halton test

Table 4. Children's energy macronutrient and micronutrient intakes according to mother's nutrition knowledge level.

	NKLSA category				
	Poor (n:10, 8.3%)	**Moderate** (n:63, 52.5%)	**Good** (n:34, 28.3%)	**Very good** (n:13, 10.9%)	***p***
Energy (kcal)	1056.7±486.1	1033.3±554.9	1244.1±531.8	1320.0±737.1	0.089[a]
Carbohydrate (g)	130.4±67.9	128.3±83.2	148.4±78.8	148.6±109.6	0.399[a]
Carbohydrate (%)	51.6±13.8	50.0±12.3	51.6±22.1	44.6±13.3	0.504[a]
Protein (g)	36.5±15.4	38.4±18.4	45.0±20.6	53.3±24.5	0.092[a]
Protein (%)	14.8±4.0	15.9±6.4	15.2±5.2	17.8±6.0	0.378[a]
Fat (g)	41.5±27.9	39.4±22.6	49.2±22.0	55.0±29.4	0.069[a]
Fat (%)	33.8±12.4	33.4±10.0	36.0±8.9	37.3±12.2	0.486[d]
Cholesterol (g)	257.0±169.0	245.9±272.0	213.1±147.2	318.9±187.2	0.265[a]
Fiber (g)	11.7±4.6	10.1±5.0	11.2±7.3	12.5±6.4	0.385[a]
Vitamin A(µg)	495.1±322.1	553.9±482.4	594.3±439.3	542.9±318.3	0.738[a]
Vitamin E (µg)	7.96±5.91	6.72±5.61	8.53±5.36	12.26±16.04	0.126[a]
Vitamin B_1 (mg)	0.53±0.28	0.50±0.30	0.61±0.38	0.58 ±0.29	0.338[a]
Vitamin B_2 (mg)	0.88±0.46	0.84±0.46	0.92±0.39	1.0 ±0.39	0.191[a]
Niacin (mg)	12.4±6.1	13.3 ± 7.0	18.1±11.9	19.6±10.33	0.038[a]
Vitamin B_6 (mg)	0.85±0.45	0.73 ±0.31	1.04±0.78	0.93±0.58	0.352[a]
Vitamin B_{12} (µg)	2.50±1.52	2.75±2.17	2.59±1.79	4.05±2.12	0.127[a]
Folate (µg)	156.7±79.7	147.6±76.2	173.1±99.8	166.2±91.3	0.691[a]
Vitamin C (mg)	65.5±52.2	58.4± 47.1	66.9±47.9	86.3±58.1	0.761[a]
Sodium (mg)	1259.3±628.1	1911.4±1055.7	2225.5±1339.7	2612.3±1821.1	0.117[a]
Potassium (mg)	1481.9±680.2	1379.7±593.7	1649.9±770.3	1680.9±791.6	0.164[a]
Calcium (mg)	406.7±237.8	472.2±480.5	464.5±236.4	520.7±228.1	0.326[a]
Magnesium (mg)	148.3±61.3	155.7±148.1	199.8±195.7	172.7±80.7	0.257[a]
Phosphorus (mg)	650.8±262.0	631.6±393.4	756.0±357.5	813.9±327.0	0.102[a]
Iron (mg)	5.08±1.87	4.97±2.21	6.24±2.72	6.86±3.16	0.021[d]
Zinc (mg)	67.2±33.5	90.9±55.9	104.2±59.7	101.6±68.4	0.319[a]

NKLSA: Nutrition knowledge level scale for adults, a: Kruskal-Wallis H test, d: One Way ANOVA test

Children's energy, macronutrient, and micronutrient intakes according to mother's nutrition knowledge level are presented in Table 4. The mean daily energy intake of children whose parents had poor and moderate nutrition knowledge was 1056.7 ± 486.1 kcal and 1033.3 ± 554.9 kcal, respectively, whereas for those in the good and very good categories, mean daily energy intake was 1244.1 ± 531.8 kcal and 1320.0 ± 737.1 kcal, respectively. However, no statistically significant differences were observed between mother's nutrition knowledge levels and children's mean daily energy intake (p=0.089). As mother's nutrition knowledge increased, children's intakes of protein (g), fat (g), and fiber (g) tended to increase; however, no statistically significant differences were observed (p>0.05). In contrast, intakes of niacin (p=0.038) and iron (p=0.020) increased significantly as mother's nutrition knowledge increased.

Discussion

This study aimed to evaluate the relationship between mother's nutrition knowledge and gastrointestinal symptoms and dietary intakes in children with ASD and was conducted with 120 children and their parents. It was found that 84.2% of the children experienced feeding problems, with the most common issues being food refusal, food neophobia, and lack of appetite. It was determined that the nutrition knowledge level of mothers of children with ASD was moderate (53.5 ± 8.4). Additionally, the NKLSA total scores of mothers of girls were found to be higher compared to those of mothers of boys. As family income (p=0.005) and maternal education level (p=0.001) increased, maternal nutritional knowledge increased significantly; the majority of mothers with very good nutritional knowledge were university graduates. Children of mothers with poor nutritional knowledge had significantly higher rates of abdominal pain (p=0.010), indigestion (p=0.001), features of autism (p=0.021), and total GSRS scores (p=0.004). Additionally, choking/gagging problems (p=0.028) were more common in children of these mothers.

Children with ASD often present with co-occurring problems such as feeding difficulties, sleep disturbances, and excessive use of medications and dietary supplements. The prevalence of sleep disorders in individuals with ASD has been reported to range from 64% to 93%, while approximately half of individuals receive psychotropic medications despite limited evidence regarding their efficacy [4,14,15]. Furthermore, a substantial proportion of children with ASD use multivitamins and multiple dietary supplements [14,15]. In our study, 60.8% of participants were found to use dietary supplements, 25% experienced sleep disorders, and 24.2% were taking one or more medications. Trudeau et al. [15] reported that 75.9% of children and adolescents aged 4–18 years with ASD in Canada used dietary supplements. The most commonly used supplements were multivitamins (77.8%), vitamin D (44.9%), omega-3 fatty acids (42.5%), probiotics (36.5%), and magnesium (28.1%). Similarly, a study conducted by the Autism Speaks Autism Treatment Network reported that 56% of children with ASD used multivitamin/mineral supplements [16]. Studies from Italy and Pakistan reported sleep disorder rates of sleep disorders, ranging from 39.8% to 57%, characterized by insomnia and disrupted sleep patterns [17,18]. Medication use is also common among children with ASD. In a population-based cohort study conducted by Feroe et al.involving 26,722 individuals, 28.6% to 31.5% of participants were found to be using multiple medications, most of which were prescribed for mood disorders and attention-deficit/hyperactivity disorder (ADHD) [19]. Overall, while the findings of the studies are largely consistent, it is thought that differences in prescribing practices, access to healthcare, parental attitudes toward medications and supplements, assessment methods, national guidelines, and sociodemographic factors may contribute to this situation.

Children with ASD are generally at higher risk of being overweight or obese compared to their typically developing peers. In children with ASD, disordered eating behaviours and lifestyle patterns, secondary comorbidities, medication use, hormonal imbalances, irregular sleep, and dysbiosis are considered potential risk factors contributing to the development of obesity [19-21]. In China, the prevalence of

overweight and obesity among children with ASD has been reported as 14.2% and 11.6%, respectively [20]. In a meta-analysis, Sammels et al. [20] reported that the prevalence of obesity among children with ASD ranged from 7.9% to 31.8%. Among Turkish children with ASD, 42.5% were found to be obese and 17.5% overweight [21]. In our study, 15.0% of the children were overweight and 13.4% were obese. By sex, the prevalence of overweight was higher in girls, whereas the prevalence of obesity was higher in boys.

Parental nutrition knowledge plays a critical role in shaping their children's eating habits. Well-informed parents and caregivers tend to foster healthier dietary behaviours in their children, and parents' attitudes toward food have been shown to significantly influence their children's nutrition knowledge and practices [22]. Wang et al. reported that 70.3% of parents of children with ASD lacked knowledge regarding the methods to address problematic behaviours [9]. Similarly, Ismail et al. found that parents and special educators had limited knowledge regarding the appropriate diet and nutritional needs of children with ASD [22]. In Türkiye, among parents of children with ASD, 36.4% had poor, 42.4% had moderate, 18.2% had good, and 3.0% had very good basic nutrition knowledge, whereas regarding food preferences, 72.7% of parents were classified as poor and 27.3% as moderate [23]. In our study, children whose parents had poor or moderate nutrition knowledge exhibited higher rates of feeding problems, including anorexia, choking/gagging, overeating, and food neophobia, as well as had lower scores for food refusal, features of autism, and limited variety compared to children whose parents had good or very good nutrition knowledge. These findings may reflect a potential association between higher mother’s nutrition knowledge and more structured feeding practices and supportive mealtime environments. Additionally, parental modeling—such as consuming a diverse and balanced diet themselves—may encourage children to adopt similar eating behaviours. Families with better nutrition knowledge also tend to limit the availability of nutrient-poor foods at home and offer healthier alternatives, thereby shaping children's food preferences and overall nutrient intake. Furthermore, improved parental understanding of ASD-related feeding challenges may enable more effective behavioral strategies during meals, contributing to better dietary outcomes in their children.

Children with ASD often experience gastrointestinal symptoms such as constipation, diarrhea, nausea, abnormal bowel movements, abdominal pain, and vomiting. Gastrointestinal dysfunction has been associated with sleep disturbances, food allergies, inadequate nutrient intake, and feeding problems. The prevalence of gastrointestinal symptoms among children with ASD has been reported to range from 9% to 91% [6,7]. In Türkiye, it has been reported that among children and adolescent participants with ASD, constipation was reported in approximately 31% of participants, abdominal pain in 19%, diarrhea in 11%, vomiting in 9%, and difficulty swallowing in about 5%. Overall, 52% of participants reported experiencing at least one gastrointestinal symptom [24]. Ferguson et al. found that children with ASD experienced constipation (65%), abdominal pain (47.9%), nausea (23.2%), and diarrhea (29.7%) [25]. Khalil et al. used the short form of the Gastrointestinal Severity Index (GSI) to assess GI symptoms and reported a mean GSI score of 3.95 ± 1.58, and that 67.2% of participants had high GSI scores [26]. Babinska et al. found that gastrointestinal symptoms were more prevalent in girls with ASD than in boys, with 70.6% of girls and 44.5% of boys experiencing GI symptoms several times per week or daily [27]. In our study, total GSRS scores and subscale scores were found to be higher in girls. Additionally, children of parents with poor nutrition knowledge had higher total and subscale GSRS scores compared to children of parents with good nutrition knowledge. In the literature, methods used to assess GI symptoms include participant self-reports, standardized scales, questionnaires, and clinical diagnoses. This methodological diversity can lead to significant differences in findings, increasing heterogeneity across studies and limiting the comparability of results. Standardizing methods for assessing the frequency and severity of GI symptoms in individuals with ASD could contribute to obtaining more reliable and comparable data.

Deficits in social communication, behavioral problems, GI symptoms, food selectivity, restrictive food intake, food neophobia, and difficulties with chewing and swallowing affect dietary intake in children with ASD. Reported nutrient deficiencies in these children include protein, fiber, omega-3 fatty acids, folate, calcium, sodium, potassium, zinc, iron, and vitamins A, D, E, B_5, B_6, B_{12}, and C. However, these children are often reported to have high intakes of energy, carbohydrates, fat, saturated fat, and simple sugars. In chronically undernourished children with ASD, various medical and developmental problems, such as growth retardation, deficits in social skills, and lower academic performance, may emerge or be exacerbated [1,28]. Although the literature reports that parental nutrition knowledge influences children's overall dietary habits and diet quality, the lack of studies directly assessing the relationship between parents' nutrition knowledge scores and the specific nutrient intakes of children with ASD has limited a comprehensive discussion of the findings obtained in our study [28,29]. In a study evaluating the relationship between maternal nutrition knowledge and children's dietary intake, 43.7% of mothers were found to have low nutrition knowledge. Moreover, it was found that children of mothers with high nutritional knowledge levels had increased consumption of vegetables, fruits, and legumes, whereas their intake of sugared drinks—such as carbonated beverages and juices—and fast foods was lower [29]. It has been reported that 30.3% of parents in Spain have low nutrition knowledge, and children of parents with lower educational levels were found to have lower intakes of energy, vitamins, and minerals [30]. Barhill et al. examined the dietary intakes of children with ASD and their typically developing peers, finding that children with ASD had lower energy, macronutrient, and micronutrient intakes compared to their peers [28]. In contrast, Mathew et al. found that children and adolescents with ASD in Australia had higher intakes of energy, carbohydrates, sugar, fat, saturated fat, and fiber compared to the control group [31]. In Türkiye, 36.4% of mothers of children with ASD were found to have poor nutrition knowledge, while 42.4% had moderate nutrition knowledge [23]. In our study, 8.3% of parents were found to have poor nutrition knowledge, while 52.5% had moderate nutrition knowledge. Children of parents with poor nutrition knowledge tended to have lower intakes of energy, carbohydrates, fat, protein, vitamins, and minerals compared to those whose parents had higher nutrition knowledge; however, these differences did not reach statistical significance ($p>0.05$). While some studies have reported higher energy and macro- and micronutrient intakes in children with ASD, our findings suggest a trend toward lower intakes in children of parents with lower nutrition knowledge. This difference may be related to differences in the socioeconomic characteristics of the sample, mother's education levels, cultural dietary habits, and variations in data collection methods. In children with ASD, inadequate dietary intake may be related to existing nutritional problems, growth and development, gastrointestinal symptoms, and clinical conditions associated with ASD. Supporting mother nutritional knowledge in this population can be considered an approach that contributes to improving children's dietary intake.

Limitations

One of the strengths of the study is that the questionnaire items were designed to be easily understood and answered by parents. Another strength is that dietary intake records were collected accurately under the supervision of a trained dietitian. Another strength of the study is its multidimensional assessment, covering mother's nutrition knowledge, children's nutrient intake, growth status, sleep duration, gastrointestinal symptoms, and eating behaviours. Nevertheless, certain limitations should also be acknowledged. Because the dietary intake data were based on self-report, recall bias and reporting errors may have been introduced. Furthermore, a one-day 24-hour dietary recall may not fully reflect an individual's usual long-term dietary habits due to day-to-day variations in food intake. Additionally, the self-reported assessment of mother's nutrition knowledge may be subject to social desirability bias, reflecting parents' tendency to provide idealized responses. The study's cross-sectional design is another limitation. Furthermore, the study did not control for ASD severity level, which may influence feeding behaviours and related outcomes. Finally, the lack of assessment of potential confounders, such as household composition and parental nutrition education, is also an important limitation. Since

participation was voluntary and the study was conducted solely in Kütahya, it remains uncertain whether the findings are fully representative of the general population.

Conclusion

This study suggests that maternal nutritional knowledge may be associated with feeding behaviors and gastrointestinal symptoms in children with ASD. Mother's nutritional knowledge was found to be at a moderate level. Maternal nutritional knowledge increased with increasing family income and mother's education level. It was determined that the vast majority of children with ASD experienced feeding problems such as food refusal, food phobia, and poor appetite. It was found that the child's anthropometric measurements and energy and macronutrient intake did not significantly change according to the mother's nutritional knowledge level. Children of mothers with poor nutritional knowledge had higher GSRS scores and more pronounced gastrointestinal symptoms. Based on these findings, it is thought that increasing the nutritional knowledge of mothers caring for children with ASD may improve the overall well-being of the children and allow for better management of gastrointestinal and nutritional problems. Therefore, it is believed that regular nutritional counseling for mothers of children with ASD can significantly contribute to the child's growth and development as well as the resolution of nutritional problems. Further research with longitudinal designs and larger populations is needed to better understand these relationships and increase generalizability.

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Conflict of interest

There are no conflicts of interest in connection with this study.

Data availability statement

The datasets presented in this article are not readily available due to restrictions (e.g., their containing information that could compromise the privacy of research participants). Requests to access the datasets should be directed to corresponding author.

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