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Determination of nutritional status of children with autism spectrum disorder and the effect of nutrition education on families

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Ethics Committee Approval
The study was approved by the Hasan Kalyoncu University Non-Invasive Research Ethics Committee on 02.05.2017, with reference number 2017-05.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
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Abstract

Background/Aim: Autism and autism spectrum disorder (ASD) are neurodevelopmental disorders that present with a wide range of behaviors and symptoms. These behaviors are lifelong and often lead to difficulties in social interaction, verbal and non-verbal communication, and repetitive actions. This study aimed to determine the nutritional status and anthropometric measurements of autistic children and to assess the impact of nutrition education provided to parents in a private education center in Gaziantep, Turkey.

Methods: A three-month intervention study was conducted at the Hasan Kalyoncu University Special Education and Research Centre on ten male and four female autistic children aged 4-9 years (7.2±1.37 years). Nutrition education was provided to the families at the onset, as well as at the first, second, and third month marks. A questionnaire was employed to ascertain the demographic characteristics and dietary habits of the children. At the onset of the study and at the conclusion of the three-month intervention, the participants were asked to record their food intake over a seven-day period. Anthropometric measurements and body composition were evaluated at the beginning of the study and at months one, two, and three. The body mass index (BMI), waist-to-hip circumference ratio (WC), and waist-to-height ratio (WHtR) were calculated. At the conclusion of the study, the Children's Eating Behavior Inventory (CEBI) and the Gastrointestinal Severity Index (GI) questionnaires were administered to the families. The intake of energy, fiber, vitamins D, B_1, folate, iron, and calcium were found to be below the recommended daily allowances.

Results: The percentage of energy contribution from fat was found to be high. The mean change in the differences between height (P=0.001), body weight (P=0.021), hip (P=0.001), neck (P=0.001), and head circumferences (P=0.004), body fat mass (P=0.001), and body fat percentage (P=0.001) were found to be statistically significant within three months and at 4-6 years but not at 7-9 years. Overall, 53.1% of children had at least one gastrointestinal (GI) symptom. The mean GI score was 5.6. The most common symptoms were diarrhea (64.3%), flatulence (57.1%), abdominal pain (50.0%) and constipation (35.7%).

Conclusion: Numerous studies demonstrate that nutritional education can lead to significant positive outcomes for children with autism spectrum disorder (ASD). To maximize these benefits, it is essential to integrate dietitians into the support team, as they can greatly enhance families' understanding of the nutritional needs of autistic children. In this and similar studies, it is very difficult to control and regulate nutrition in children with autism, because despite all efforts, parents are often unable to control their children's nutrition due to tantrums and behavioral problems. It is imperative that doctors and parents work with nutritionists and dietitians to help these children stay fit and improve their quality of life by eating healthily.

Keywords: autism spectrum disorder, autism, nutrition education, nutritional status, anthropometry

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Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition that typically emerges in early childhood and affects social [1], communicative, and behavioral development. First described in 1943 by Leo Kanner, ASD is characterized by traits such as repetitive behaviors, social isolation, difficulty with verbal and non-verbal communication, and intense focus on specific interests [2]. The symptoms vary in severity and can range from mild to severe, affecting individuals differently over time. Terms like "autistic disorder," "Asperger's syndrome," and "high/low functioning autism" are used to describe various manifestations of ASD, but they do not necessarily reflect a child's abilities [3,4]. In Turkey, the term "autistic individual" refers to those with early childhood limitations in communication and social interaction, who require specialized education services [5].

The purpose of this study was to assess the nutritional status and anthropometric measurements of autistic children in a special education institution in Gaziantep, Turkey and evaluate the impact of nutrition education provided to their families [6]. The study aims to offer recommendations to improve the nutritional health of autistic children as part of a broader social responsibility initiative [7].

Researchers have investigated the impact of environmental factors on children with autism, in addition to genetic risks. These studies aim to understand the reasons behind the increase in autism diagnoses and determine potential solutions. One area of focus has been the composition of microbiota and microbial metabolites in children with autism, which have been found to be abnormal compared to typically developing children. Children with autism have also reported gastrointestinal disorders and food selectivity. Understanding the relationship between the microbiota-gut-brain axis and autism, as well as the connection between nutrition and autism, has provided a new perspective. It has been suggested that nutrition may play a role in the development of autism and could be an effective treatment by reducing symptoms [8]. Various nutritional approaches have been explored, including gluten-free and casein-free diets, ketogenic diets, antioxidant diets, Feingold diets, body ecology diets, elimination allergy diets, and vitamin and mineral supplements [9]. The aim of this study was to evaluate the nutritional status and anthropometric measurements of autistic children studying in a special education institution in Gaziantep and to determine the effect of nutrition education given to families. In line with the results obtained, it is aimed at developing suggested solutions for improving the nutritional status of autistic children and transform this into a social responsibility project.

Materials and methods

Research place, time, and sample selection

This research was conducted from May to December 2017. It was carried out with 14 children (ten boys, four girls) aged 4-9 years with autistic disorder. The study also included their families who were citizens of the Republic of Turkey and the children studying at Hasan Kalyoncu University Special Education and Research Centre in Gaziantep Province. The research continued for three months for each child. This was an intervention study.

Ethical aspects of the study

Permission for the study was obtained from Hasan Kalyoncu University Non-Interventional Research Ethics Committee on February 05, 2017, number 2017-05. Permission was obtained from Gaziantep Metropolitan Municipality, where Hasan Kalyoncu University Special Education and Research Center is located.

Institution permission

Hasan Kalyoncu University Special Education Center was contacted during the design and planning stages of the study, and necessary permissions were obtained from the center director. Prior to the beginning of the study, the center secretary was contacted, and special appointments were made for the parents. Children and parents were not taken out of the center during the study.

Family information and consent form

Since children constituted the sample in the study, the "Family Information and Consent Form" was explained to the families before the study, and they signed it in agreement. In the center where the study was conducted, the patients were given preliminary information about the research, and the study was continued with the parents and children who wanted to stay until the completion of the study.

Population and sample of the study

The study was conducted on ten boys and four girls who were diagnosed with autism by a physician at Hasan Kalyoncu University Special Education and Research Centre. The prevalence of autism spectrum disorder is one to two per thousand people. The autism spectrum spans a wide range, exhibiting large differences between individuals. This makes it difficult to homogenize the sample, as different subgroups (e.g., mild autism and severe autism) may need to be studied separately. Since most individuals with autism are children, ethical guidelines require parental consent for individuals to participate in research. This is another factor that limits the sample size. In addition, the sensitivity and special needs of individuals with autism may limit participation in research. Although the subheadings of autism vary, behavioral differences make it difficult to work in a large sample. Therefore, the sample size in this study is limited, as is the case in similar studies. At the same time, the parents of the children were trained four times (at baseline, first, second, and third months) on healthy eating, and behavioral changes of children were determined.

Data collection materials

A questionnaire was completed by the parents of the children regarding demographic characteristics and eating habits. Anthropometric measurements of the individuals were assessed, using the Children's Eating Behavior Inventory (CEBI) [10] and the Gastrointestinal Severity Index (GI Severity Index) [11]. The CEBI is a questionnaire that can be answered by families in approximately 15 minutes. It includes a total of 40 eating and meal-related questions, which are scored on a 5-point Likert scale (never, rarely, occasionally, frequently, and always). A total score of 41 points or more was defined as an eating problem. The GI severity index is a 0 to 17- point assessment. A score of seven or above indicates severe symptom status in the child. Along this line, the occurrence of GI symptoms in children was determined through consultation with the families. The 24-hour food consumption records of the children were taken. Before starting the study, consent was obtained using a volunteer information form.

Questionnaire Form

At the beginning of the study, general information, including characteristics of the individuals (age, gender, history of obesity, diseases, etc.), eating habits (number of main and intermediate meals, skipping meals, food preferences, etc.), the CEBI, and the GI Severity Index questionnaires were applied.

Children's Eating Behavior Inventory

The Children's Eating Behavior Inventory is the most comprehensive assessment tool used to detect eating behavior in children. In the adaptation study, it was shown that the factor structure, validity, and reliability of the Turkish adaptation of the CEBI were compatible with the original study of Wardle et al. [10]. This Likert-type questionnaire consists of 8 subscales and 35 questions regarding malnutrition, food selectivity, and eating behavior habits in children. It was adapted for Turkish children in 2011.

24-Hour Food Consumption Record

At the beginning of the study and again following the nutrition education given to the parents (at the third month), 24-hour food consumption records of children were assessed for seven consecutive days. Average daily energy and nutrient intake and average daily food consumption amounts were calculated from the 7-day, 24-hour food consumption records and repeated twice [12]. Daily energy and nutrient intake were evaluated according to the results of the Turkish Nutrition Guideline-2015 (TUBER-2015) [13]. Recommended daily energy and nutrient reference values according to age and gender are provided in Table 1.

Table 1: Reference Values for Daily Energy and Nutrient Intakes (TÜBER 2015) [13]

Energy and Nutrients		Age (year)					
		4	5	6	7	8	9
	E	1235	1307	1380	1456	1534	1615
Energy (kcal) K		1157	1224	1286	1352	1428	1517
	E	14.0	15.6	18.2	20.8	23.4	25.9
Protein (g) K		13.8	15.5	18.0	20.4	23.0	25.9
Protein E%		5-20	5-20	5-20	5-20	5-20	5-20
Oil(g)		35-45	35-45	35-45	35-45	35-45	35-45
Saturated fat (g)			<7%	<7%	<7%	<7%	<7%
DPN (g)		<14%	<14%	<14%	<14%	<14%	<14%
CSA(g)		<10%	<10%	<10%	<10%	<10%	<10%
Oil E%		20-35	20-35	20-35	20-35	20-35	20-35
Cholesterol (mg)		300	300	300	300	300	300
Carbohydrate (g)			130	130	130	130	130
Carbohydrate E%			45-60	45-60	45-60	45-60	45-60
Pulp (g)		14	14	14	16	16	16
Vitamin A (mcg)			300	300	400	400	400
Vitamin E (mg)		9	9	9	9	9	9
Vitamin D (mcg)			15	15	15	15	15
Vitamin B1 (mg)			0.6	0.6	0.6	0.6	0.9
Vitamin B2 (mg)			0.6	0.6	0.6	0.6	0.9
Niacin (mg)		6.7	6.7	6.7	6.7	6.7	6.7
Vitamin B6 (mg)			0.6	0.6	0.6	0.6	1
Folate (mcg)		140	140	140	200	200	200
Vitamin B12 (mcg)			1.5	1.5	1.5	1.5	1.5
Vitamin C (mg)			30	30	45	45	45
Calcium (mg)		800	800	800	800	800	800
Magnesium (mg)			230	230	230	230	230
Iron (mg)		7	7	7	11	11	11
Zinc (mg)		5.5	5.5	5.5	7.4	7.4	7.4

Anthropometric Measurements

Height, body weight, waist, hip, and neck circumferences of the children were measured at the onset of the study and body composition (body fat percentage, body fat mass) was determined by a bioelectrical impedance analysis (BIA) using the Tanita model. Anthropometric measurements and body composition determinations were repeated at baseline, and at the first, second, and third months. Body mass index, waist/hip circumference ratio, waist circumference/height ratio were calculated [12].

Statistical analysis

Descriptive statistics were given as number (n) and percentage (%) for categorical variables, mean ($\bar{x}$), standard deviation (SD) and median values for numerical variables. Analyses were performed using SPSS 22 for windows. $P<0.05$ was considered significant. The suitability of the variables for normal distribution was tested using the Shapiro-Wilk test. The student's t-test was used two independent groups for normally distributed variables and the Mann-Whitney U test compared non-normally distributed variables in two groups. The paired t-test was used to compare normally distributed dependent measurements, and the chi-square test compared categorical variables. The Computer Assisted Nutrition Program, Nutrition Information Systems Package Program (BEBIS) computer version was used in the evaluation of food consumption [14].

Results

Energy and Nutrient Intakes of Children

When children in both age groups were analyzed in terms of nutrient consumption, the consumption of foods in the milk and yogurt group increased in both the 4-6 and 6-9 age groups in the third month of nutrition education compared to the baseline. Likewise, there was an increase in meat and cheese consumption compared to baseline.

In the legume group, a decrease was observed in both age groups in the third month. The number of oilseeds decreased in the 4-6 age group and increased in the 6-9 age group.

Similarly, bread consumption decreased in the 4-6 age group and increased in the 6-9 age group (Table 2).

Table 2: Energy and Nutrient Intakes of Children for 4-6 years

		Startup			3.months	
Nutrients	**average**	**SD**	**median**	**average**	**SD**	**median**
Milk and dairy products						
Milk	86.7	17.69	97.5	104.5	66.94	100.0
Yogurt	26.7	17.45	31.0	24.6	21.75	23.0
Cheese-cottage cheese	6.5	3.59	8.0	6.4	4.03	8.5
meat, eggs, legumes, oilseeds						
Red meat	6.1	8.06	2.5	12.5	12.78	9.0
Chicken, turkey, etc.	9.0	13.67	0.0	4.8	7.45	0.0
Fish meat	0.0	0.00	0.0	0.0	0.00	0.0
Offal	1.7	2.61	0.0	1.5	3.35	0.0
Egg	18.6	4.89	21.0	22.3	6.29	26.0
Dried legumes	14.0	13.25	9.5	8.0	9.19	5.5
Oilseeds	2.1	3.58	0.5	1.4	1.26	1.0
Bread and cereals						
Bread	29.1	5.44	32.0	19.4	12.79	14.5
Other cereals	0.0	0.00	0.0	0.0	0.00	0.0
Fresh vegetables and fruits						
Green leafy vegetables	5.3	7.50	2.5	5.9	5.02	4.5
Other vegetables	0.2	0.37	0.0	2.0	3.21	0.5
Potato	14.5	15.27	9.0	21.5	15.28	25.0
Citrus fruits	1.5	1.71	1.0	11.5	16.24	5.0
Other fruits	24.1	24.40	17.5	26.9	24.40	24.0
Fats and sugars						
Total oil	13.0	2.21	14.0	18.4	5.83	21.0
Total solid fat	4.6	1.83	5.0	3.9	0.94	4.0
Margarine	1.3	1.80	0.5	3.2	1.26	3.5
Butter	3.4	1.97	3.5	0.8	0.69	1.0
Sugar	5.0	1.12	6.0	8.8	5.59	8.5
honey jam molasses	5.0	1.12	6.0	6.3	3.65	5.0
Drinks						
Water	659.1	122.65	677.0	635.9	129.95	710.0

Assessment in Terms of Energy and Nutrients

For the 4-6 year group:

Children's energy and nutrient intakes were assessed using seven-day food consumption records at both the beginning and the end of the third month of the study. Children's average daily energy intake at the start of the study was 971.8±197.49 kcal, while at three months, it was 954.5±209.83 kcal. These intakes represented 64.7% and 63.6% of the recommended daily energy intake.

At both baseline and three months, the recommended daily intake of protein, vitamins A, E, B2, B6, B12, and zinc were adequate for the children. However, the requirements for energy, vitamins D, B1, niacin, folic acid, vitamin C, calcium, and iron were unmet (Table 2).

For the 6-9 year group:

At the beginning of the study, the mean daily energy intake of the children was 845.9±192.24 kcal, which met 56.4% of the recommended daily energy consumption. By the third month of the study, the mean daily energy intake had decreased slightly to 833.9±144.37 kcal, meeting 55.6% of the recommended intake.

Both the daily recommended intake of protein and vitamins A, E, B2, B6, and B12 were met at baseline and after three months. However, the requirements for vitamins D, B1, niacin, folic acid, vitamin C, and minerals such as calcium, iron, and zinc were not met (Table 3).

Table 3: Energy and Nutrient Intakes of Children for 6-9 years

		Startup			3.months	
Nutrients	**average**	**SD**	**median**	**average**	**SD**	**median**
Milk and dairy products						
Milk	88.5	35.72	86.0	64.1	37.25	58.0
Yogurt	16.6	13.61	15.5	23.2	28.99	9.0
Cheese-cottage cheese	5.7	7.40	2.0	7.1	5.49	7.5
meat, eggs, legumes, oilseeds	5.5	6.26	3.0	6.0	6.21	5.0
Red meat	3.5	5.02	0.0	3.9	5.49	0.0
Chicken, turkey, etc.	0.00	0.00	0.0	0.0	0.00	0.0
Fish meat	0.5	1.32	0.0	0.8	1.64	0.0
Offal	24.2	10.36	23.0	25.3	8.28	29.0
Egg	12.0	15.98	6.5	8.1	8.87	7.5
Dried legumes	1.0	1.32	0.5	1.7	2.38	0.5
Oilseeds						
Bread and cereals	28.1	8.84	34.0	33.2	9.25	34.0
Bread	0.00	0.00	0.0	0.0	0.00	0.0
Other cereals						
Fresh vegetables and fruits	3.6	2.90	3.5	1.6	1.32	1.5
Green leafy vegetables	0.1	0.33	0.0	0.2	0.43	0.0
Other vegetables	15.9	16.36	13.5	24.4	14.93	28.0
Potato	1.8	2.32	1.0	4.8	9.62	1.0
Citrus fruits	21.8	13.58	22.5	42.8	35.24	43.0
Other fruits						
Fats and sugars	16.5	9.14	15.0	12.2	5.29	12.5
Total oil	3.9	2.71	3.5	6.3	2.54	6.5
Total solid fat	2.3	1.65	2.0	2.7	1.36	2.5
Margarine	1.7	1.92	1.5	3.7	2.09	4.0
Butter	7.1	6.34	6.0	7.1	5.12	7.5
Sugar	7.1	6.34	6.0	5.6	4.31	5.0
honey jam molasses						
Drinks	714.8	102.82	783.0	682.3	190.9	720.5

Anthropometric Measurements

According to the results of the study, significant changes were observed in height ($P<0.001$; $P=0.011$) and body weight ($P=0.002$; $P=0.021$) at the first, second, and third months for the 4-6 years and 7-9 years age groups compared to the baseline values. No significant changes were found between the mean baseline values of BMI and the other months of measurements ($P=0.261$; $P=0.652$) When compared with the baseline values, a significant ($P=0.006$; $P<0.001$) change was observed in hip circumference values in both the 4-6 and 7-9 age groups. When waist hip ratio baseline values were compared with other months, no significant change was observed in the 4-6 age group ($P=0.628$), but a significant change was observed in the 7-9 age group ($P=0.04$). When the mean values of waist-height ratios at baseline were compared with the other months, no significant change was observed in either age group ($P=0.797$; $P=0.608$). The mean neck circumference when compared with baseline values with first, second, and third month values ($P=0.002$) and head circumference ($P=0.001$; $P=0.004$) change values were found to be significant.

The mean values of body fat percentage were compared with the values of the other months and significant changes were observed in both age groups ($P<0.001$ and $P=0.002$, respectively). The mean baseline values of body fat mass were the same as the other months and significant changes were observed in both age groups ($P<0.001$ and $P<0.001$, respectively) (Table 4).

Table 4: On the 3rd Month: Distribution of Anthropometric Measurements of Children According to Z-Score Values (%)

Age Group (years)	n	Very weak/ stunted	Weak/ Stunted	Normal	Overweight/ long	Obese/ very long
		<-2SD	≥ -2SD - <-1SD	≥ -1SD – <1SD	≥1SD – <2SD	≥2SD
Body weight for age (%)						
4-6	6	-	-	1	5	-
7-9	8	-	2	4	2	-
Total	14	-	2	5	7	-
Height for age (%)						
4-6	6	-	-	1	3	2
7-9	8	1	-	3	3	1
Total	14	1	-	4	6	3
Body mass index for age (%)						
4-6	6	-	1	2	3	-
7-9	8	-	3	4	1	-
Total	14	-	4	6	4	-

Body Weight for Age, Height for Age, and BMI for Age

At the beginning of the study, we evaluated the body weight, height, and BMI according to the age of all participating children. Initially, one child was classified as very underweight (below -2 SD); two were underweight (greater than or equal -2 SD); five were of average weight; and six were slightly obese based on body weight z-score values. In terms of height z-scores, one child was found to be very short (stunted), five were short, seven were average, and one was tall. According to BMI values for age, one child was underweight, seven were average, and six were slightly obese (Table 1).

At the end of the third month, we reassessed all the children. According to the updated body weight z-score values, two children were underweight, five were average, and seven were slightly obese. For height z-scores, one child remained very short, three were average, five were tall, and five were very tall. Finally, based on BMI values for age, four children were underweight, six were average, three were slightly obese, and one was classified as obese (Table 5).

In this study, nutritional education was provided to the children and their families for three months. In autistic children, families have difficulties in directing their children toward healthy nutrition. It is necessary to change food selectivity in children. When compared with the baseline values at the first, second, and third months in all children, in the 4-6 and 7-9 year age groups, the study assessed height at (P<0.001); body weight (P=0.006; P<0.001); hip circumference (P=0.002; P=0.021); neck circumference (P=0.002); head circumference (P=0.001; P=0.004); and body fat percentage (P<0.001). When waist-hip ratio baseline values were compared with other months, no significant change was observed in the 4-6 age group (P=0.628), but a significant change was observed in the 7-9 group (P=0.04

No significant change was found between the mean baseline values of BMI (P=0.261; P=0.652) and the waist-height ratio (P=0.797; P=0.608) in the 4-6 and 7-9 age groups, respectively, compared with the baseline values in the first, second, and third months in all children.

Gastrointestinal Severity Index (GI Severity Index) According to the Gastrointestinal Severity Index results of the study, 53.1% of the children had at least one GI system symptom. The mean GI system score was 5.6 points per child (≥7 points for severe conditions). The most common symptoms in children were diarrhea (64.3%), flatulence (57.1%), abdominal pain (50.0%), and constipation (35.7%) (Table 5).

Table 5: Statistical Evaluation of Changes in Anthropometric Measurements of Children at Baseline and 1st, 2nd and 3rd Months According to Age Groups

Anthropometric measurements	Boy-Girl	
	4-6 years	7-9 years
	P-value	*P*-value
Height length		
Start - Month 1	<0.001	<0.001
Start - Month 2	<0.001	<0.001
Start - Month 3	<0.001	<0.001
Body Weight		
Start - Month 1	0.002	0.021
Start - Month 2	0.002	0.021
Start - Month 3	0.002	0.021
BKI		
Start - Month 1	0.261	0.652
Start - Month 2	0.261	0.652
Start - Month 3	0.261	0.652
Waist Circumference		
Start - Month 1	<0.001	0.002
Start - Month 2	<0.001	0.002
Start - Month 3	<0.001	0.002
Hip Circumference		
Start - Month 1	0.006	<0.001
Start - Month 2	0.006	<0.001
Start - Month 3	0.006	<0.001
Waist / Hip Ratio		
Start - Month 1	0.628	0.040
Start - Month 2	0.628	0.040
Start - Month 3	0.628	0.040
Waist to Height Ratio		
Start - Month 1	0.797	0.608
Start - Month 2	0.797	0.608
Start - Month 3	0.797	0.608
Neck Circumference		
Start - Month 1	0.002	0.002
Start - Month 2	0.002	0.002
Start - Month 3	0.002	0.002
Head circumference (cm)		
Start - Month 1	<0.001	0.004
Start - Month 2	<0.001	0.004
Start - Month 3	<0.001	0.004
Body Fat Percentage		
Start - Month 1	<0.001	<0.001
Start - Month 2	<0.001	<0.001
Start - Month 3	<0.001	<0.001
Body Fat Mass		
Start - Month 1	<0.001	<0.001
Start - Month 2	<0.001	<0.001
Start - Month 3	<0.001	<0.001

The mean GI score was 5.6 points. The most common symptoms in children were diarrhea (64.3%), flatulence (57.1%), abdominal pain (50.0%), and constipation (35.7%). The proportion of children with 0-1 bowel movements per day was 35.7%, and the proportion with 2-3 bowel movements per day was 64.3%. None of the children had four or more bowel movements per day.

The proportion of children with normal stool density was 78.6%; the proportion of children with watery stools was 21.4%; and none of the children had very watery stools. The proportion of children with normal fecal odor was 14.3%, 64.3% had foul odor, and none had very foul odor. Abnormal odors were determined in 21.4% of the children.

The percentage of children with normal flatulence was 42.9%. Those with flatulence more than three days a week was 42.9%, and the proportion of children with daily flatulence was 14.2%. Fifty percent of the children had no complaints of abdominal pain, 42.9% had moderate pain, and 7.1% had moderate to severe pain. While 35.7% of the children had no complaints of unexplained daytime irritability, 57.2% of the children reported having this one to two times weekly, while 7.1% of the children indicated having this three or more times a week. While 78.6% of the children never woke up at night, the proportion of those who woke up one to two times a week was 21.4%. A total of 14.2% of the children had problems with abdominal cramps (Table 6).

Table 6: Gastrointestinal Severity Index Scoring of Children and Distribution of Children according to Symptoms

Gastrointestinal Severity Index		Score	Number of children	%	Score
Symptoms					
Constipation	>5 times stool/week	0	1	7.1	0.0
	3-4 times stool/week	1	8	57.2	0.6
	0-2 stools/week	2	5	35.7	0.7 1.3
Diarrhea	Average	0	5	35.7	0.0
	Stool 0-1 times daily	1	9	64.3	0.6
	Stool 2-3 times daily	2	0	0	0.0 0.6
Average fecal density	4 or more stools per day	0	11	78.6	0.0
	Average	1	3	21.4	0.2
	Normal	2	0	0	0.0 0.2
Fecal odor	Watery	0	2	14.3	0.0
	Very watery diarrhea	1	9	64.3	0.6
	Average	2	3	21.4	0.4 1.0
Stomach gas	Normal	0	6	42.9	0.0
	Scented	1	6	42.9	0.4
	Abnormal odor	2	2	14.2	0.3 0.7
Abdominal pain	Average	0	7	50.0	0.0
	Normal	1	6	42.9	0.4
	More than 3 days a week	2	1	7.1	0.2 0.6
Unexplained daytime irritability	Frequency per day	0	5	35.7	0.0
	Average	1	8	57.2	0.5
	Nothing.	2	1	7.1	0.2 0.7
Night awakening	Moderate pain	0	11	78.6	0.0
	Moderate to severe pain	1	3	21.4	0.2
	Average	2	0	0.0	0.0 0.2
Abdominal stiffness	Nothing	0	12	85.8	0.0
	1-2 times/week	1	2	14.2	0.1
	3 or more/week				0.1
Severity Index		0	60	46.9	0.0
		1	54	42.2	3.7
		2	14	10.9	1.9
Total			128	100.0	5.6

Since the GI Severity Index questionnaire was administered only once at the beginning of the study, no statistical interpretation could be made about how gastrointestinal complaints had changed by the end of the study. Considering the opinions of parents, especially the mothers, it can be said that diarrhea and vomiting decreased in children after nutrition education; accordingly, food rejection disappeared, and food diversity increased.

Children's Eating Behavior Inventory (CEBI)

The CEBI shows the distribution of eating and meal-related problems. According to CEBI scoring, children often and always had eating problems. The proportion of those who stated that they were not able to receive the program was determined to be 30.5%. The total score was 102.8 points.

The mean CEBI scores of girls were higher than boys in terms of negative eating behaviors during meals, but this difference was not statistically significant (t= -1.426; *P*=0.179). In terms of negative eating behavior outside mealtimes, the mean scores of girls were higher than boys, but this difference was not statistically significant (t=-0.287, *P*=0.779). In regard to maternal opinions and behaviors, the mean scores of girls were higher than boys, but this difference was not statistically significant (t=-0.381; *P*=0.710). In terms of children's behavior during meal preparation, the mean scores of girls were higher than boys, but this difference was statistically significant (t=-0.769; *P*=0.457). The mean score of girls in terms of negative situations occurring during meals was significantly higher than the mean score of boys (t=2.718; *P*=0.019).

According to Table 2 regarding the relationship between nutrients and CEBI, there was no statistically significant relationship between energy and CEBI scores. However, there was a statistically significant correlation between the percentage of energy from protein and positive eating behavior (r=-0.632, P<0.05) and negative eating behaviors during meals (P=0.632, P<0.05). There was a statistically significant inverse relationship between vitamin B_{12} and positive eating behavior (r=-0.614, P<0.05) (Table 7).

In terms of positive eating attitude, the mean score of the 7-9 age group was higher than that of the 4-6 age group, but this difference was not statistically significant (t=- 0.574; *P*=0.576). In regard to negative eating behaviors during meals, the mean score of the 4-6 age group was higher than the 7-9 age group, but this difference was not statistically significant (t=0.349; *P*=0.733).

In terms of negative eating behavior outside mealtimes, the mean scores of the 4-6 age group were higher than the 7-9 age group, but this difference was not statistically significant (t=0.349; *P*=0.733) (Table 7).

Table 7: Comparison of CEBI Scores of Children According to Age Groups

	Age (year)	n	median	SD	t test	*P*-value
Positive eating behavior	4-6	6	3.50	0.713	-0.574	0.576
	7-9	8	3.75	0.867		
Negative eating behavior during meals	4-6	6	1.83	0.667	0.349	0.733
	7-9	8	1.73	0.454		
Negative eating behavior outside mealtimes	4-6	6	2.33	0.333	0.395	0.700
	7-9	8	2.25	0.427		
The mother's opinion and behavior	4-6	6	3.14	0.488	0.622	0.546
	7-9	8	2.98	0.467		
Preparing the child's food	4-6	6	2.83	0.279	0.661	0.521
	7-9	8	2.58	0.886		
Behavior during	4-6	6	1.50	0.548	0.473	0.645*
	7-9	8	1.38	0.443		

t test, **P*<0.05

Table 8 displays the correlation between nutrients and CEBI sub-dimensions, as well as the GI severity index. Based on the information provided in the table, it is evident that there is no statistically significant relationship between energy intake and CEBI scores. However, there are statistically significant relationships between the percentage of energy derived from protein and both positive eating behavior (r=-0.632, P<0.05) and negative eating behavior during meals (r=0.632, *P*<0.05). Additionally, there is an inversely significant relationship between vitamin B12 intake and positive eating behavior (r=-0.614, *P*<0.05) as shown in Table 8.

Table 8: Relationship Between Nutrients and CEBI Sub-dimensions and GI Severity Index

Nutrients	Positive Eating Behavior	Negative eating behavior during meals	Negative behaviors outside of mealtime	Mother's views and behaviors	Child's food preparation behaviors	Negative situations that occur during meals
Energy	-0.225	-0.066	-0.064	0.029	-0.181	-0.124
Protein	-0.422	0.199	0.057	0.210	-0.219	0.002
Protein %	-0.632*	0.621*	0.454	0.429	-0.039	0.235
Fat	-0.382	0.203	-0.103	0.213	-0.269	0.009
Fat %	-0.131	0.186	-0.358	0.231	-0.242	0.122
CHO	-0.016	-0.337	0.023	-0.303	-0.124	-0.284
CHO %	0.358	-0.452	0.129	-0.402	0.363	-0.225
Fiber	-0.377	-0.109	-0.277	-0.055	-0.341	-0.054
Vıtamin A	-0.281	0.235	0.410	0.509	-0.097	-0.174
Vıtamin E	-0.257	-0.122	-0.377	-0.258	-0.405	-0.249
Vıtamin D	-0.136	-0.106	-0.253	0.067	-0.080	-0.365
Thiamin	-0.372	-0.136	-0.242	-0.011	-0.270	-0.040
Riboflavin	-0.660*	0.202	0.028	0.082	-0.413	-0.061
Niacin	-0.373	0.099	-0.060	0.190	-0.163	0.080
Vıtamin B6	-0.375	-0.016	-0.178	0.131	-0.167	0.157
Folate	-0.377	-0.122	-0.365	-0.044	-0.355	-0.113
Vıtamin B12	-0.614*	0.484	0.030	0.332	-0.389	0.084
Vıtamin C	-0.288	0.063	0.002	0.370	-0.052	0.239
Calcium	-0.364	-0.029	0.250	0.115	-0.337	-0.230
Magnesium	-0.404	-0.093	-0.158	0.029	-0.224	-0.002
Iron	-0.451	-0.029	-0.153	0.109	-0.271	0.089
Zinc	-0.518	0.190	0.125	0.1510.	-0.298	0.014

Spearman Coefficient of Rho, * *P*<0.05

Discussion

Numerous studies have been conducted to evaluate the anthropometric measurements, eating habits, and diet quality of children diagnosed with autism spectrum disorder (ASD) [3,8,13]. Nutritional therapies, as well as alternative and complementary therapies, are often utilized to address autism and its associated symptoms in children [15-23]. However, there has been no research focused on the eating habits and anthropometric measurements of autistic children in Gaziantep.

This study aimed to assess the food consumption patterns and anthropometric measurements of children aged 4 to 9 years with autistic disorder who attend a special education center in Gaziantep Province. Additionally, a three-month nutrition education program was provided to the families of these children to help define their nutritional status and evaluate the impact of the instruction.

Nutrition education for both the child and their family is crucial for children with autism [24]. This research is significant as it serves as a preliminary study to identify the nutritional challenges faced by autistic children in Turkey.

Energy and Nutrient Intakes of Autistic Children

Various studies have been conducted to determine the intake of macro and micronutrients, which have separate functions in the functioning of the human body [25-32]. In this study, children's energy and nutrient intakes were evaluated by using seven-day food consumption records, at the beginning and at the end of the third month.

Milk and yogurt consumption at baseline and at three months were 113.4 mL and 129.4 mL, respectively, in children aged 4-6 years. The consumption of cheese was very low. In the 7-9 age group, it was 105.1 and 87.3 mL, respectively. Cheese consumption was also very low in children aged 7-9 years. Consumption of fresh vegetables and fruits were inadequate in children aged 4-6 and 7-9 years according to Türkiye Nutrition

Guide (TUBER) [13]. According to the TUBER recommendations, children aged 4-6 and 7-9 years should consume 2.5 and 3 portions of milk and milk products, respectively; meat and meat products, eggs and legumes, 1.0-1.5 and 1.5 servings, respectively; vegetables, 2 and 2-2.5 servings, respectively; and fruits 1.5 and 2 servings, respectively. It is also recommended that children consume 2.5-3 and 3-4 servings of bread and cereals daily. In this study, all age groups' food consumption were below the daily recommended amounts.

Cermak et al. [24], in a systematic review, reported that early childhood is a period of recognizing new foods, tastes, and foods with structural differences. It has also been stated that parents of autistic children often describe their children as "picky eaters", that is, they refuse to consume various foods. It has also been emphasized that this selectivity in children with autism is even stricter in early childhood. Zimmer et al. [25] found that the selective attitudes of autistic children toward food had a statistically significant effect on nutrient deficiency. When healthy developing children are compared with autistic children, it is stated that food intake and inadequate nutrient intake are affected by many factors in autistic children. They found that the consumption of protein, calcium, vitamin D and vitamin A in autistic children was insufficient for their needs, and their magnesium intake was above the need compared to healthy children. Selective nutrition was considered insufficient in food variety, consumption of energy-dense foods, intake of fresh vegetables and fruits, and excessive in consumption of sugar-sweetened beverages. Sun et al. [26] conducted a study on 53 controls and 53 autistic children aged 4-6 years and determined that the intake of vitamins A, B6, zinc, and calcium was 80% less than the requirement in both groups of children. Although vitamin C and calcium consumption were insufficient in both groups, it was found to be significantly lower in autistic children than in healthy children. Serum zinc levels were found to be lower than average in both groups. Serum calcium, vitamin A and folate levels were also significantly lower in children with autism than in the control group.

Herndon et al. [27] conducted a study in children with autism and control group. They reported that children with autism consumed less vitamin B6 and E, less milk and dairy products, and less calcium. It was suggested that intake was especially low when a gluten-free, casein-free (GFCF) diet was applied. In both control and autistic children, it was reported that they could not meet the daily requirement especially in this case and their daily intake of fiber, calcium, vitamin B6, iron, vitamin E, and vitamin D was low. These data concur with the results of this study.

In a study conducted by Attlee et al. [28] with 23 autistic children, it was determined that 84.2% of the children were malnourished according to dietary reference intake (DRI) in terms of energy, 42.1% protein and iron, 73.7% carbohydrate, 84.2% fat, 94.7% fiber and vitamin A, 100.0% vitamin D and calcium, and 78.9% vitamin C intake. All study data are similar to the results of this study.

Bat [29] found that zinc deficiency was not observed in 50 autistic children between the ages of 6 and 15 in Turkey, and that zinc intake was more than needed for children aged 7-9 (171.0%). It was 84.0% for ages 10-13 and 87.0% for ages 14-15. Calcium deficiency was mostly seen in girls aged 9-13 years, while 74.0% of calcium requirements were met in children aged 7-9 years. Johnson et al. [30] found that autistic children consumed significantly insufficient vitamin K compared to the control group in their study with 19 autistic and control groups. Bandini et al. [31] conducted a study with 53 autistic children and found that the children's consumption of vitamin D, vitamin E and calcium was insufficient. They found a significant deficiency in calcium and vitamin D levels compared to healthy children. In their study, Bauset et al. [32] determined that autistic children consumed significantly more vitamin E than healthy children. In their research, Bicer and Alsaffar [33] found that most children aged 4-18 years consumed less calcium, zinc, vitamin B6 and folate. It is thought that the vitamin-mineral levels of individuals with autism are lower than average individuals and the cause of this deficiency may be related to gastrointestinal problems, chronic diarrhea/constipation, dietary restrictions, or the immune system. In addition, it was observed that both cellular methylation and glutathione-mediated antioxidant defense system were deficient in these individuals. Therefore, it is thought that vitamin B_{12} supplementation, which is an important cofactor in transmethylation and transsulfuration metabolism, will increase this capacity. Increased oxidative stress in autism has made the use of antioxidant vitamins, such as vitamins C and E widespread in the treatment process [17].

Anthropometric Measurements of Children

In his study, Bhattacharjee [34] found height, body weight, and body mass index values as 162.96 cm, 62.56 kg, and 23.14 kg/m2 for the control group, respectively, and 153.6 cm, 40 kg, 16.82 kg/m2 for autistic children. When the control group and autistic children were compared, significantly lower body mass index and body weight were found in autistic children. Bauset et al. [35] found that the mean body mass index value of the children was 15.85±2.07 kg/m2 in their study on 40 autistic children. When these values were compared with healthy children, it was determined to be significantly lower. Mills et al. [36] compared autistic children with healthy children and determined the body weight z-scores of autistic children as 0.91±1.13 and a ratio of 0.41±1.11 in the control group. Autistic children had a statistically significant higher weight than healthy children. The body mass index z-score values of the control group and autistic children were determined as 0.24±1.17 and 0.85±1.19, respectively. Sun et al. [26] conducted a study with 53 autistic children, 45 boys and 8 girls, aged 4-6 years, and their mean body mass index z-score values were found to be 1.06, which was significantly higher than those with average development. In this study, nutrition training was given to children and families for three months. In autistic children, there are difficulties in directing families to a healthy diet. It is necessary to be able to change food selectivity in children.

Wang et al. [37] found that gastrointestinal problems were seen in 42.0% of children in their study conducted with 589 autistic children. When this ratio was compared with the control group, it was found to be statistically significant. In these studies, the most common gastrointestinal problems were constipation (20%) and chronic diarrhea (19%). Mazefsky et al. [38] reported that 61% of the children experienced gastrointestinal symptoms at least once, and emotional and behavioral problems were common in children, although this varied greatly. Ericson et al. [39]

reported that constipation was the most common gastrointestinal health problem in children (42%) in their study of 100 autistic children. Molloy et al. [40] investigated gastrointestinal health problems in their study of 137 autistic children and found that the rate of those with at least one GI problem was 24 to 81%. The most common GI problem was diarrhea at a rate of 17%. In this study, the symptoms seen due to the small number of samples showing differences. A symptom score of ≥7 points is considered severe. In this study, the score was found to be lower than the severe value of 5.6.

It was observed that the boys' scores were higher than the girls in terms of positive eating attitude, but this difference was not statistically significant. Girls' behavior scores on food preparation were higher than boys. Although there was no significant difference in terms of gender regarding food preparation in the original scale, it is thought that the emergence of this difference in the study is due to cultural differences. As required by the Turkish family structure, Turkish girls are more active in setting the table and helping their mothers than Turkish boys, as the work done at home is mostly done by women. The mean scores of girls were higher than boys' in terms of negative eating behaviors during meals, but the difference was not statistically significant. The mean scores of girls were higher than boys but were not statistically significant in terms of negative eating behavior outside mealtime, mother's opinions and behaviors, and child's behavior during food preparation. The mean score of the girls was significantly higher than the average score of the boys in terms of the negative situations that occurred during the meal.

While mothers' positive attitudes, beliefs, and behaviors about healthy eating enable children to consume healthy food, their negative behaviors enable children to consume unhealthy foods. Children who frequently encounter healthy foods in the family environment will increase their healthy food consumption habits. The mother's level of education can affect her awareness of positive eating behavior and choosing healthy foods.

Children and adolescents with a high level of maternal education take in more carbohydrates, protein, fiber, vitamin A and calcium, and consume more vegetables and dairy products. The level of education of mothers is inversely proportional to the excess sugar intake of preschool children and the energy that young people get from excess fats. While the use of fatty milk is higher in families with parents whose education level is lower than high school, the use of low-fat milk is more common among children of university-educated parents. One study determined that young and low-educated mothers preferred relatives and friends as a source of information [41]. This situation causes the formation of poor feeding behaviors in the child. Among the causes of inadequate and unbalanced nutrition in children, the education level of the parents has a significant effect. Eating habits formed in preschool significantly affect future eating habits, and the most important models for children are parents.

The positive and negative behaviors of the parents during and outside mealtime are taken as an example by the children; the eating behavior of the child develops within the framework of the parents' behaviors. In this sense, the table setting, food rules, and food choices that mothers with a high level of education create at home will be more appropriate than for mothers with a lower level of education, and this will ensure that the child creates positive behaviors and has adequate and balanced nutrition. In the original test, according to the results of this comparison, it was seen that children diagnosed with autism had more eating behavior problems than those with typical development. However, children with autism who participated in the study ranged in age from 2 to 12 years [42]. Malhi et al. [43] studied 63 ASD and 50 normally developing (NG) children in northern India. Seventy-nine percent of families of children with ASD and 64% of families with NG stated that there was a problem with their child's eating behavior. Children with ASD had high CEBI scores (97.28) and the mean eating problem was 6.42 points. It was found that children with ASD consumed less food, especially fruit and vegetables, compared to NG children. Protein potassium, copper, and folate intakes were also low.

It was further determined that the average nutrient needs of children with ASD did not meet the 83 recommendations, especially in terms of thiamine, vitamin C and copper. In this study, according to the CEBI scores, the rate of those who stated that they had frequent or constant eating problems was determined as 30.5%. The total score was 102.8 points. In this study, children with autism were 6-9 years old and received inclusive education. It is thought that the narrowing of the age range may create a different result. The age of six is the period when the child can comfortably exhibit the behavior of eating on his own. When the fact that children with autism included in the study were also at this age is associated with the fact that they were diagnosed with mild autism, it is thought that it is a typical result that they do not have more eating behavior problems than children with average development.

Limitations

The sample size of the study and the absence of a control group can be considered limitations of the study.

Conclusion

This study was conducted on 14 children aged 4-9 years with autism spectrum disorder attending the Special Education and Research Centre of Hasan Kalyoncu University, Gaziantep, as well as their families. The average age of the children was 7.2 years; 71.4% were boys and 28.6% were girls. Half of the mothers were high school graduates, while 42.6% of the fathers were university graduates. The adequacy of children's diets in meeting energy, vitamin, and mineral requirements varied by age group. Although all children received breast milk, they did not receive vitamin D and iron supplements, although national supplementation programs exist in Turkey. This indicates a gap in compliance with the health guidelines. The adequacy of children's diets to meet energy, vitamin and mineral requirements varies depending on the age group of the child, suggesting a potential nutritional concern or the need for more targeted interventions based on age-specific needs.

This research also encompasses the physical development of children. Significant changes in height and body weight were observed in the 4-6 age group by the third month. In the 7-9 age group, while certain changes were noted, significant differences were found in the waist-to-hip ratio. Gastrointestinal symptoms were observed in 53.1% of the children, with diarrhea, gas, and abdominal pain being the most common symptoms. Regarding eating behaviors, the average scores of girls were found to be higher than those of boys, but these differences were not statistically significant. This study sheds light on the nutritional and developmental processes of children with autism spectrum disorder. The further studies are needed to evaluate the nutritional status of autistic children in Turkey.

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