Nutrient status, diet quality and growth parameters of children with autism spectrum disorder in Northern Cyprus

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Summary. *Background:* There is no literature on the nutritional status and growth parameters of autistic children in Northern Cyprus. This study is the first to provide information about them. The aim of this study is to determine the nutritional status, anthropometric measurements, and healthy eating indices of autistic children who are studying at private educational centers in Northern Cyprus. *Method:* All children with Autism Spectrum Disease who were educated in Northern Cyprus were included in the study. The universe of research included 48 autistic children in all private educational centers. Food record method and healthy eating index were used to determine nutritional status. Nutrient inadequacy was determined by dietary reference intake. The growth parameters were evaluated by means of anthropometric measurements. *Results:* The study was completed with 40 children as 8 children refused to participate in the study. The 82.5% of children were male and 17.5% were female. The 45.0% of children with autism were also diagnosed with a different disease. According to the eating habits of children, 30% of autistic children were skipping meals and the most missed meal was breakfast. Consequently, 70% of the children were selective against some foods and the most omitted food group is vegetables. The most inadequate intake was calcium, iodine, vitamin D and fiber. In addition, 28.2% of the children have a poor diet quality and 47.5% were obese. *Conclusions:* It was determined that appropriate medical nutrition treatment and nutrition education were needed for children. There is also a need for further research.

Keywords: Autism, Nutrient Adequacy, Diet Quality, Growth Parameters, Food Selectivity

Introduction

Autism was first described by Leo Kanner in 1943 after observing the same behavioral model in 11 children (1). According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (2) and International Classification of Diseases (ICD-10) (3), autism is defined as a disease characterized by a lack of three behavioral areas. These areas are i) social interaction, ii) language communicate and imaginary play, iii) balance between interest and activity (4). In 2014 report published by Center for Disease Control and Prevention (5), the prevalence of Autism Spectrum Disorder (ASD) was 1/68 (or 14.7/1000). This ratio was 30% higher than the prevalence of 2008 (1/88); 60% higher than in 2006 (1/110); 120% higher than in 2000 − 2002 years (1/150) It was found to be 5 times more common in males than females (5). Recent studies show that autism has increased throughout the world (6).

ASD is mainly of genetic origin. However, environmental factors affect the phenotype changes and increase the incidence (7). Environmental factors that increase the risk of developing autism are examined under three groups: prenatal, perinatal and neonatal risk factors (8). As a result, there is no single reason for

development of ASD and genetic and environmental factors play significant role (6).

When the feeding behaviors of autistic children were examined, it was determined that eating behavior disorders occurred at an early age. These problems include difficult eating behaviors, nutritional selectivity and gastrointestinal system dysfunction. As a result, difficulties in food consumption times due to food rejection and behaviors to disrupt food consumption cause nutritional deficiencies (9). Carbohydrate, protein and fat intake of autistic children were evaluated considering all these factors and compared with healthy children (10-15). Thus, scurvy, rickets, vision loss and iron deficiency anemia were reported in children who had high nutritional selectivity and did not meet nutrient requirements. In addition, studies have investigated whether nutritional selectivity in autistic children is associated with overweight and obesity. As a result, it was argued that the consumption of processed foods, snacks and sweets might be related to the rejection of consumption of vegetables and fruits (16).

This study is the first study on autistic children who were educated in Northern Cyprus and has an important place in evaluating the nutritional status of children. The purpose of this study is to investigate nutrient selectivity, nutrient status, diet quality and growth parameters of children who were educated in Northern Cyprus. The obtained results were evaluated and discussed with other studies.

Materials and Methods

Patient Selection and Settings

This is a cross- sectional and descriptive study. All children with ASD who were educated in Northern Cyprus were included in the study. The universe of research included 48 autistic children in all private educational centers. The study was completed with 40 children as 8 children refused to participate in the study. In addition, one child refused to record food consumption after completing the survey. General information, nutritional status, diet quality and anthropometric measurements were investigated with survey form. The data were collected by the researcher via a single interview.

Nutritional Adequacy and Diet Quality

In this study, the food groups that were omitted for consumption, the most consumed food and beverages and meal skips were questioned with a questionnaire. In addition, nutrient intake was determined by food record method. Food consumption record was taken for three days (2 days on weekdays, 1 day on weekend) and all consumed food and beverages were recorded in the 3-day food record. The level of energy and nutrient consumption was calculated by Computer Aided Nutrition Program Nutrition Information System (BEBIS-6). The 3-day food record reported consumption amounts for 13 nutrients: vitamins A, B_{12}, C, D and E, zinc, calcium, iron; folate; protein; fiber, carbohydrate; and total energy. These nutrients were preferred because previous studies have used these nutrients to determine nutrient status in children diagnosed with ASD. Nutrient inadequacy was determined by dietary reference intake (DRI). Level of nutrient adequacy was evaluated with <67% as inadequate, between 67% and 133% as sufficient and >133% as higher.

The dietary qualities of the children were evaluated through the Healthy Eating Index-2010 (HEI-2010). HEI-2010 calculations for dietary diversity and diet quality index obtained as a result of 3-day food record method. HEI- 2010 scores categorized ≤50 as poor, 51 to 80 as needs improvement and >80 as good.

Anthropometric Parameters

Body weight, height, body mass index (BMI), body fat percentage ratio, waist/height ratio and mid-upper arm circumference were determined in order to evaluate the growth status of children with ASD. In this study, body weight was measured using a precision digital scale. The height (cm), waist circumference (cm) and mid-upper arm circumference (cm) were measured using a non- flexing brace. As a result of these values, BMI (kg/m^2), body fat percentage (%) and waist/height ratio (cm) were determined. Body weight was measured with light clothes and by removing shoes, and the height was measured by holding the feet side by side and keeping the head in the Frankfort plane. The BMI percentile values were calculated using the WHO anthro and WHO anthro-plus program. The percentile values were evaluated according to WHO growth curves and references. BMI categories

defined <5th percentile as malnutrition, 5th to 15th percentile as underweight, 15th to 85th percentile as normal weight, 85th to 95th percentile as overweight and ≥95th percentile as obese. The body fat percentage was calculated with the formula developed by Deurenberg et al. (1991). The body fat (%) formula is 1.51 x BMI − 0.70 x age − 3.6 x sex (males = 1, females = 0) + 1.4 (17).

Statistical Analysis

Quantitative data were evaluated with arithmetic mean (±), standard deviation (SD), median and lower-upper values. Qualitative data obtained are stated as frequency and percentage (%). Statistical Package for Social Sciences (SPSS, Version 21.0) statistical package program was used to calculate the data storage, processing and descriptor criteria.

Results

General Information

The study was conducted with 40 autistic children aged between 3 to 18 years. The average age of children is 10±4.1. Among autistic children under education, 82.5% were male and 17.5% were female. The 45.0% of children with autism were also diagnosed with a different disease. The most common health problem among the autistic children participated in the study was hyperactivity disorder. This is followed by epilepsy (16.7%) and iron deficiency anemia (16.7%). 30.0% of the autistic children had constipation and 32.5% of the children had various gastrointestinal problems (Table 1).

Nutritional Adequacy and Diet Quality

According to the eating habits of children with autism, 30% of autistic children were skipping meals and the most missed meal was breakfast. The reasons for skipping meals is the presence of disliked foods (%30,8) and lack of appetite (%23,1). When the general eating habits of autistic children are examined, 70% of the children were selective against some foods. The nutrients that children with nutritional selectivity omitted to consume were vegetables (57.1%), fruits (32.1%), meat and meat products (28.5%) and dairy products (17.9%), respectively. The most consumed

Table 1. Distribution of Autistic Children in Northern Cyprus According to Their Characteristics and Diseases

| Characteristics	Participant Data	
	N	%
Sex		
Male	33	82.5
Female	7	17.5
Constipation		
Yes	10	25.0
No	30	75.0
Presence Of Various Gastrointestinal Problems		
Yes	13	32.5
No	27	67.5
Health Problems Other Than Autism (n:18)		
Hyperactivity Disorder	9	50.0
Epilepsy	3	16.7
Iron Deficiency Anemia	3	16.7
Malnutrition	2	11.1
Speech Difficulties	2	11.1
Celiac Disease	1	5.5
Food Allergies	1	5.5

foods were pasta, potato chips, rice, meatballs and cookies/pie. The consumption rates of these foods were 42.5%, 35.0%, 17.5%, 15.0% and 15.0% respectively. The most popular drinks were cola (42.5%) and juice (25.0%) (Table 2).

Energy and nutrient adequacy cases obtained from the 3-day food consumption records of autistic children are indicated in Table 3. It was seen that the energy intake of most children was sufficient. It was found that 17.9% of children had more energy intake than their daily needs (Table 3). The ratio of the energy obtained from carbohydrate, protein and fat were 50%, 16% and 34% respectively. The contribution of poly-unsaturated fatty acid (PUFA), monounsaturated fatty acid (MUFA) and saturated fatty acid (SFA) were 9.5%, 11.6% and 12.9% (Figure 1).

Among the children, vitamins that were consumed inadequately were vitamin D (100%), folate (17.9%), vitamin B_{12} (17.9%), vitamin C (15.4%) and vitamin A (2.6%), respectively. In addition, 97.4% of autistic children consumed higher vitamin A than they needed. This was followed by vitamin C (56.4%) and

Table 2. Distribution of Autistic Children in Northern Cyprus According to Their Eating Habits, Food Group Rejection and Most Preferred Foods and Beverages

Characteristics	Participant Data	
	N	%
Meal Skips		
Yes	12	30.0
No	28	70.0
Skipped Meal		
Breakfast	6	50.0
Lunch	4	33.3
Dinner	2	16.7
Food Group Omitted		
Yes	28	70.0
No	12	30.0
Distribution of Omitted Food Groups		
Vegetables	16	57.1
Fruits	9	32.1
Meat and products	8	28.5
Dairy Products	5	17.9
Most Preferred Foods		
Pasta	17	42.5
Potato chips	14	35.0
Rice	7	17.5
Meatball	6	15.0
Cookies/Pie	6	15.0
Meat	4	10.0
Most Preferred Beverages		
Cola	17	42.5
Fruit Juice	10	25.0
Water	9	22.5
Milk	7	17.5
Tea	5	12.5
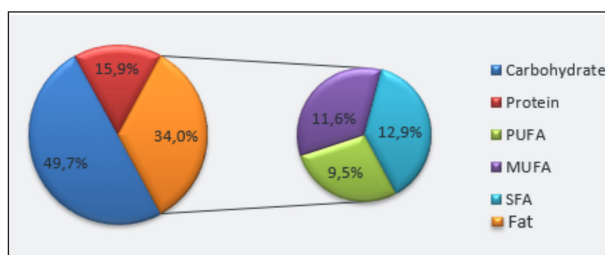
Figure1. Distribution of energy consumed by autistic children in Northern Cyprus according to macronutrients.

vitamin B_{12} (59.0%). Inadequately taken minerals were iodine (56.4%), calcium (41.0%), zinc (10.3%) and iron (5.1%). The minerals with excessive intake were zinc (61.5%) and iron (35.9%). The consumption of fiber was found to be insufficient in 30.8% of children, sufficient in 48.7% and in excess in 20.5% of children (Table 3, Figure 2).
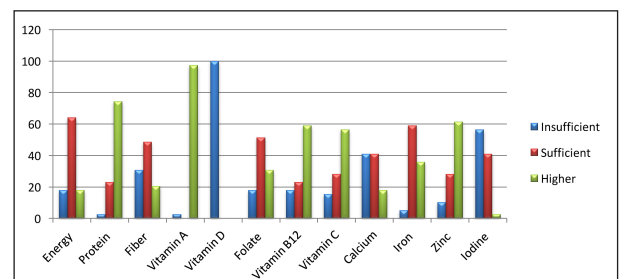
The healthy eating index score of autistic children were 57.2 ± 14.6 with a ratio of 7.7%, 64.1% and 28.2% for good, needs improvement and poor, respectively (Table 4).

Anthropometric Parameters

In our study, the mean weight (kg), height (cm), upper middle arm circumference (cm), BMI (kg/m^2),

Table 3. Distribution of energy and nutrient consumption of children with autism in Northern Cyprus according to DRI (insufficient <67%, sufficient 67-133%, higher >133%)

	Insufficient		Sufficient		Higher	
	N	%	N	%	N	%
Energy and Nutrients						
Energy (kcal)	7	17.9	25	64.1	7	17.9
Protein (g)	1	2.6	9	23.1	29	74.4
Fiber (g)	12	30.8	19	48.7	8	20.5
Vitamin A (mcg)	1	2.6	0	0.0	38	97.4
Vitamin D (mcg)	39	100.0	0	0.0	0	0.0
Folate (mcg)	7	17.9	20	51.3	12	30.8
Vitamin B_{12} (mcg)	7	17.9	9	23.1	23	59.0
Vitamin C (mg)	6	15.4	11	28.2	22	56.4
Calcium (mg)	16	41.0	16	41.0	7	17.9
Iron (mg)	2	5.1	23	59.0	14	35.9
Zinc (mg)	4	10.3	11	28.2	24	61.5
Iodine (mcg)	22	56.4	16	41.0	1	2.6

Figure 2. Distribution of energy and nutrient consumption of children with autism in Northern Cyprus according to DRI (insufficient <67%, sufficient 67-133%, higher >133%)

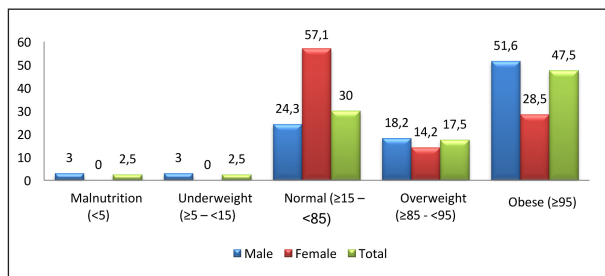**Table 4.** Distribution of Autistic Children according to Healthy Eating Index Scores in Northern Cyprus

	N	%
Classification of Healthy Eating Index Scores		
Poor (<51)	11	28.2
Good (51 – 80)	25	64.1
Needs improvement (>80)	3	7.7
Total	**39**	**100.0**

body fat percentage (%), waist circumference (cm) and waist to height ratio (cm) of children were 44.28 ±29.5 kg, 131.78±23.57 cm, 23.11±7.66 cm, 22.69±7.91 kg/m², 26.45±10.77 %, 72.83±24.81 cm and 0.53±0.11, respectively (Table 5).

Figure 3 shows the distribution of autistic children in Northern Cyprus according to their percentiles. Among autistic children under education, 47.5% were obese, 30.0% were of normal weight, 17.5% were overweight, 2.5% were underweight, and 2.5% had malnutrition. There was a serious malnutrition rate of 3.0% in male autistic children, but not in girls. More

Table 5. Maximum, Minimum, Mean and Standard Deviation Values of Anthropometric Measurements of Autistic Children in Northern Cyprus

	Minimum	Maximum	Mean (± SD)
Weight (kg)	14.3	115.2	44.28±29.5
Height (cm)	92.0	190.0	131.78±23.57
Upper Middle Arm Circumference (cm)	7.0	41.0	23.11±7.66
Body Mass Index (kg/m²)	14.1	45.6	22.69±7.91
Body Fat Percentage (%)	9.9	58.5	26.45±10.77
Waist Circumference (cm)	21.0	127.0	72.83±24.81
Waist to Height Ratio	0.21	0.83	0.53±0.11

Figure 3. Distribution of body mass index according to percentile values of autistic children in Northern Cyprus

than half of the male autistic children (51.6%) were obese and 24.3% were normal. Among the female autistic children, 57.1% were normal and 28.5% were obese.

Discussion

In this study, 82.5% of autistic children were male and %17.5 were female. In epidemiological studies, the incidence of autism in males was higher than in females (18). ASD was found to be 5 times higher in males than females. According to CDC's 2014 report the prevalence of ASD was 1/42 in males and 1/189 in females (5). Considering this difference between genders, it is understood that the number of males is higher in autistic children. Similar results were found in other studies (19-22). Kantzer et al. determined the ratio of autism prevalence in males to females to be 3.8:1 (23).

Our results show that, 45.0% of the autistic children had a different disease other than autism and the most common health problem besides autism is hyperactivity disorder (%50). Olsson et al. obtained similar results. They found the frequency of hyperactivity and attention deficit, speech and language disorder and behavioral disorders as %80, %75, %94 (24). In other study, the rate of these diseases accompanied by autism was found to be 22% and in addition, 6% of children had epilepsy (23). Adams et al., have pointed out that different diseases such as eating too much food, being obsessed with certain objects, limitation of food consumption, screaming, voice sensitivity, sleep problems and hyperactivity disorder are accompanied by autism (25).

In addition, 30.0% of the autistic children had constipation and 32.5% of the children had various gastrointestinal problems. In some studies on this subject, 31-32% of children with autism were diagnosed with GIS diseases (26; 27). Among the GIS symptoms of 9-70% in autistic individuals, abdominal pain, constipation, diarrhea and gastrointestinal reflux are the most common (9). Dermott et al. found in their study with 50 autistic children that 70% experienced at least one or more GIS problems in their lives. The most common of these problems are constipation (44%), abnormal stool pattern (18%), vomiting (18%), abdominal pain (6%) (28). Wang et al. found in their

study that 42% of children had gastrointestinal problems. When this ratio was compared with the control group, it was found statistically significant (p<0.001). The most common gastrointestinal problems in that study were constipation (20%), chronic diarrhea (19%) and other gastrointestinal health problems like colic, chronic abdominal pain and vomiting (29). Chaidez's study has achieved results that support these results (30). Mazefsky et al., have similar results with other studies and they found in their study on 95 autistic children that 61% of children had at least one gastrointestinal problem. The most common gastrointestinal problem is 41.1% abdominal pain (31). Ibrahim et al., investigated rates of gastrointestinal health problems in children with autism compared to healthy children. They found the most common gastrointestinal problem is constipation and the incidence is between 33.9% and 17.6% and these rates were statistically significant (32). In other studies, the incidence of gastrointestinal health problems is 20% to 60% in autistic children. The most common GIS problems were diarrhea abnormal stool pattern, constipation, abdominal distention and/or gastroesophageal reflux (33- 36).

In this study, 70% of children have food selectivity and most common foods they refused to consume were vegetables (57.1%) and fruits (32.1%). Bicer and Alsaffar in their study on 164 Turkish autistic children found the rate of food selectivity as 30% (37). In their study with 158 children, Postorino et al. found the rate of food rejection in children to be 92.4% (38). In another study, this rate was 41.7% (39). Evan et al., with 58 children with ASD, had results supportive to our study and found that most rejected food groups were vegetables and fruits (40). Many studies conducted in autistic children found that the most rejected foods were vegetables and fruits (41). In another study, this rate was found to be 57% and it was determined that autistic children prefer to consume carbohydrate foods the most (42). Evan et al., found that children with ASD preferred to consume foods with high energy density. At the same time, they showed that the amount of consumption of fruit juice or sweetened beverages was higher than recommended in addition to high energy snacks during the day (40). Cermark and colleagues have achieved similar results in their studies (43). In our study, children consumed pasta, potato chips, rice

and cookies/pie with high carbohydrate and energy density during the day. The most popular drinks by the children were cola and fruit juice.

Some studies have shown that the selective attitudes of autistic children towards nutrients significantly affect nutritional deficiency (15). In our study, it was seen that the energy intake of most of the children was sufficient and 74.4% of participants had higher protein intake levels. The ratio of the energy obtained from carbohydrate, protein and fat were 50%, 16% and 34% respectively. The contribution of PUFA, MUFA and SFA were 9.5%, 11.6% and 12.9%. In a study conducted with Turkish autistic children, the contribution of children's protein, carbohydrate and fat consumption to daily energy intake was 14.0-16.7%, 30.2- 37.9% and 46.5-50.4%, respectively (37). Aghaeinejad et al., in their study with 62 autistic children and control group, found significantly different energy, fat and carbohydrate consumption between the two groups. They did not find a significant difference in the percentage of energy from protein (13). Souza et al. found that autistic children consumed fat and protein higher than their daily needs. They found that the ratio of energy and energy from carbohydrates were higher compared to control group (44). On the other hand, Xia et al., found that the energy and protein consumption of the 111 autistic children were sufficient and the rate of energy from fat was low (45). Some studies found no significant difference in the consumption of macronutrients between control group and autistic children (46; 47).

Our results showed that, 30.8% of the children had inadequate, 48.7% had adequate, and 20.5% of the children had excessive fiber consumption. In their study of Bicer and Alsaffar, they found that the daily consumption of diets was insufficient in all gender and age groups (37). In a study of 53 autistic children by Bandini et al., similar results were obtained and found that fiber intake in children was below the daily requirement (39). Similar results were also obtained in other studies (48).

In this study, it was found that the consumption of calcium and iron was insufficient and the consumption of vitamin D and iodine was insufficient and the consumption of folate, vitamin A, vitamin B_{12}, vitamin C and zinc was higher than needed. In their study, Xia

et al., found that 80 – 90% of the daily iron consumed was inadequately covered the vitamin A, vitamin C, folic acid and zinc daily requirements (45). In other studies, it was found that the autistic children with nutritional selectivity were low in vitamin D, vitamin B$_{12}$ and vitamin D consumption compared to the children without nutrient selectivity. In addition, when compared with healthy children, protein, calcium, vitamin D and vitamin A consumption were found to be inadequate (15;16). Sun et al., determined that the consumption of vitamin A, calcium and zinc in autistic children and healthy children aged between 4 and 6 years was insufficient and their iron consumption was adequate. Although vitamin C and calcium consumption was insufficient in both groups, it was found to be significantly lower in autistic children than in healthy children (p<0.05) (46). In a study performed by Herndon et al., with 46 children with ASD and control group, they found that the autistic children were significantly lower in calcium than the control group. At the same time, calcium iron and vitamin D consumption levels were found to be insufficient compared to DRI values (12). In other studies, the consumption of vitamin A., vitamin B$_{12}$, and folic acid in children with autism were found to be adequate, while vitamin D, iron, calcium, vitamin C and zinc consumption were inadequate (39; 41; 49). In a meta-analysis study, 17 prospective studies were evaluated and as a result, it was determined that calcium and protein consumption of autistic children were significantly insufficient (16).

In our study, the healthy eating index score of autistic children were 57,2 ± 14,6 with a ratio of 7.7%, 64.1% and 28.2% for good, needs improvement and poor healthy eating index scores, respectively. Johnson et al. reported a mean HEI score of 59.69±12.03 among 256 autistic children aged 2 to 11 years (50). In a study of 40 autistic children by Bauset et al., the mean HEI score was 65±10.75 (49). These results are similar to the results of this study.

The results of this study showed that the mean weight (kg), height (cm) and body mass index (kg/m^2) of the children were 44.28 ±29.5 kg, 131.78±23.57 cm, and , 22.69±7.91 kg/m^2, respectively. Bhattacharjee et al. found in their study that the weight (kg), height (cm) and body mass index (kg/m^2) values for autistic children were 40, 153.6 and 16.82 and when

compared with the control group, autistic children had significantly reduced body mass index and weight (51). In another study, mean body mass index value was reported as 15.85 ±2.07 kg/m^2 on 40 autistic children and this value was found to be significantly lower when compared with healthy children (49).

Among the autistic children who were educated in Northern Cyprus, 2.5% were malnourished, 2.5% were underweight, 30.0% were normal weight, 17.5% were overweight and 47.5% were obese when evaluated according to body mass index classification. In their study, Aghaeinejad et al. found that the 10.0% of autistic children were underweight, 47.0% were normal, 11.0% were overweight and 32.0% were obese (13). Evans et al., in their study with 53 autistic children, found that 2.0% of the children were underweight, 26.0% were overweight and 17% were obese and according to the control group, significantly more obese children were found in autistic children (40). In a study conducted on Turkish autistic children, the children were 5.5% underweight, 30.5% normal, 26.2% overweight and 32.3% obese (37). In another study, 20% of autistic children were reported as underweight, 70.0% normal and 10.0% were overweight (49).

Conclusion

This study is the first study to determine the nutritional status, dietary quality and growth parameters of autistic children studying in Northern Cyprus. It has been found that the nutritional habits of the children have a significant nutritional selectivity. This leads to insufficient energy and nutrients a significantly reduces the quality of the diet. Nutritional problems increase the risk of long-term complications and increase of anthropometric measurements outside the desired reference ranges. For this reason, parents / carers of autistic children should be informed about feeding habits and nutritional problems of children. Seminars should be organized on the importance of medical nutrition therapy in the treatment of the problems. In addition the nutritional status and growth of children should be improved. Finally, similar studies focusing on nutrient status, diet quality and growth parameters of autistic children should be done.

References

1. Kanner, L. Autistic disturbances of affective contact. Nervous Child 1943; 2 (1943): 217-250.

2. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-IV) (Fourth Edition). The Journal of The American Medical Association 1994; 272 (10): 828-829.

3. World Health Organization. (1993) . The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines. Geneva: World Health Organization. http://www.who.int/iris/handle/10665/37958, Accessed 22.03.2019

4. Hoppenbrouwers, M., Vandermosten, M., Boets, B. Autism as a disconnection syndrome: A qualitative and quantitative review of diffusion tensor imaging studies. Research in Autism Spectrum Disorders 2014; 8 (4): 387-412

5. Centers for Disease Control and Prevention Center. Community report from the autism and developmental disabilities monitoring (ADDM) network, prevalence of autism spectrum disorder among children aged 8 years, United States, 2010. Morbidity and Mortality Weekly Report 2014; 63 (2): 1-21.

6. Siddiqi, S., Urooj, A., D'Souza, M. Dietary patterns and anthropometric measures of Indian children with autism spectrum disorder. Journal of Autism and Developmental Disorders 2018; doi.org/10.1007/s10803-018-3850-0.

7. Banerjee, S., Riordan, M., Bhat, M. Genetic aspects of autism spectrum disorders: insights from animal models. Frontiers in Cellular Neuroscience 2014; 58 (8): 1 −18.

8. Kinney, D., Barch, D., Chayka, B., Napoleon, S., & Munir, K. Environmental risk factors for autism: Do they help cause de novo genetic mutations that contribute to the disorders?. Medical Hypotheses 2010; 74 (1): 102 − 106.

9. Kral, T., Eriksen, W., Souders, M., Martin, J. Eating behaviors, diet quality and gastrointestinal symptoms in children with autism spectrum disorders: A brief review. Journal of Pediatric Nursing 2013; 28 (6): 548-556.

10. Emond, A., Emmett, P., Steer, C., Golding, J. Feeding symptoms, dietary patterns, and growth in young children with autism spectrum disorders. Pediatrics 2010; 128(2): 338-342.

11. Moore, E., Crook, T., James, J., Gonzales, D., Hakkak, R. Nutrient intake among children with autism. Journal of Nutritional Disorders and Therapy 2012; 2(3): 1-3.

12. Herndon, A., DiGuiseppi, C., Johnson, S., Leiferman, J., Reynolds, A. Does nutritional intake differ between children with autism spectrum disorders and children with typical development. Journal of Autism and Developmental Disorders 2013; 39 (2): 212-222.

13. Aghaeinejad, M., Djafarian, K., Mahmoudi, M., Maskooni, M. Comparison of energy and macronutrients intake between children with autism and healthy children. International Research Journal of Applied and Basic Sciences 2013; 5 (6): 667-670.

14. Hyman, S., Stewart, S., Cain, U., Lemcke, N., Foley, J., Peck, R., et al. Nutrient intake from food in children with autism. Pediatrics 2012; 130 (2): 145-153.

15. Zimmer, M. H., Hart, L. C., Manning, P., Murray, D. S., Bing, N. M., Summer, S. Food variety as a predictor of nutritional status among children with autism. Journal of Autism and Developmental Disorders 2012; 42(4): 549-556.

16. Sharp, W., Berry, R., McCracken, C., Nuhu, N., Marvel, E., Saulnier, C., et al. Feeding Problems and nutrient intake in children in autism spectrum disorders: A metaanalysis and comprehensive review of the literature. Journal of Autism Developmental Disorders 2018; 43 (9): 2159 − 2173.

17. Deurenberg, P., Weststrate, J., Seidell, J. Body mass index as a measure of body fatness: age- and sex specific prediction formulas. British Journal of Nutrition 1991; 65 (2): 105 − 114.

18. Giarelli, E., Wiggings, L., Rice, C., Levy, S., Kirby, R., Martin, J., et al. Sex differences in the evaluation and diagnosis of autism spectrum disorders among children. Diability and Health Journal 2010; 3 (2): 107 − 116.

19. Gockley, J., Willsey, J., Dong, S., Dougherty, J., Constantino, J., Sanders, S. The female protective effect in autism spectrum disorder is not mediated by a single genetic locus. Molecular Autism 2015; 6 (25): 1 − 10.

20. Lai, M., Cohen, S., Buxbaum, J. Understanding autism in the light of sex/gender. Molecular Autism 2015; 6 (24): 1 − 5;

21. Lai, M., Lambardo, M., Auyeung, B., Chakrabarti, B., Cohen, S. Sex/Gender Differences and Autism: Setting the Scene for Future Research. Journal of the American Academy

of Child and Adolescent Psychiatry 2015; 54 (1): 11 – 24.

22. Dermott, M., Hottinger, K., Seijo, R., Shulman, L. Age at diagnosis of autism spectrum disorders. *The Journal of Pediatrics* 2012; 161 (3): 554 – 556.

23. Kantzer, A., Fernell, E., Gilberg, C., Miniscalco, C. Autism in community preschoolers: developmental profiles. *Research in Developmental Disabilities* 2013; 34 (9): 2900 – 2908.

24. Olsson, M., Westerlund, J., Lundström, S., Giacobini, M., Fernell, E., Gillberg, C. Recovery from the diagnosis of autism – and then?. *Neuropsychiatric Disease and Treatment* 2015; (11): 999 – 1005.

25. Adams, J., Audhya, T., Means, S., Rubin, R., Quig, D., Geis, E., et al. Nutritional and metabolic status of children with autism vs. neurotypical children and the association with autism severity. *Nutrition and Metabolism* 2011; 8 (34): 1-32.

26. Santhanam, B., Kendler, B. Nutritional factors in autism: An overview of nutritional factors in the etiology and management of autism. *Integrative Medicine* 2012; 11(1): 46-49.

27. Srinivasan, P. A review of dietary interventions in autism. *Annasl of Clinical Psychiatry* 2009; 21(4), 237-247.

28. Dermott, M., Mcvicar, K., Rapin, I., Wershil, B., Cohen, H., Shinnar, S. Frequency of gastrointestinal symptoms in children with autistic spectrum disorders and association with family history of autoimmune disease. *Developmental and Behavioral Pediatric* 2006; 27(2): 128-136.

29. Wang, L., Tancredi, D., Thomas, D. The prevalence of gastrointestinal problems in children across the United States with autism spectrum disorders from families with multiple affected members. *Journal of Developmental and Behavioral Pediatrics* 2011; 32 (5): 351 – 360.

30. Chaidez, V., Hansen, R., Picciotto, I. Gastrointestinal problems in children with autism developmental delays or typical development. *Journal of Developmental Disorders* 2014; 44 (5): 1117 – 1127.

31. Mazefsky, C., Schreiber, D., Olino, T., Minshew, N. The association between emotional and behavioral problems and gastrointestinal symptoms among children with high-functioning autism. *Autism* 2015; 18 (5): 493 – 501.

32. Ibrahim, S., Voigt, R., Katusic, S., Waver, A., Barbaresi, W. Incidence of gastrointestinal symptoms in children: A population- based study. *Pediatrics* 2009; 124 (2): 680 – 686.

33. Molloy, CA., Mannig, Courtney P. Prevalence of chronic gastrointestinal symptoms in children with autism and autistic spectrum disorders. *Autism* 2003; 7(2): 165 –171.

34. Nikolov, R. N., Bearss, K. E., Letting, J., Erickson, C., Rodowski, M., Aman, M. G., et al. Gastrointestinal symptoms in a sample of children with pervasive developmental disorders. *Journal of Autism and Developmental Disorders* 2009; 39 (3): 405 – 413.

35. Brown, R., Lozupune, C., Kang, D., Adams, J. (2015). Gut bacteria in children with autism spectrum disorders: challenges and promise of studying how a complex community influences a complex disease. Microbial Ecology in Health and Disease, http://dx.doi.org/10.3402/mehd.v26.26914.

36. Erickson, C., Stigler, K., Corkins, M., Posey, D., Fitzgerald, J., McDougle, C. Gastrointestinal factors in autistic disorders: A Critical Review. *Journal of Autism and Developmental Disorders* 2005; 35(6): 713 – 727.

37. Bicer, A., Alsaffar, A. Body mass index, dietary intake feeding problems of Turkish children with autism spectrum disorder (ASD). *Research In Developmental Disabilitie* 2013; 34 (11): 3978 – 3987.

38. Postorino, V., Sanges, V., Giovagnoli, G., Fatta, L., Peppo, L., Armando, M., Vicari, S., Mazzone, L. Clinical differences in children with autism spectrum disorder with and without food selectivity. *Appetite* 2015; 92:126 – 132.

39. Bandini, L., Anderson, S., Curtin, C., Cermak, S., Evans, W., Scampini, R., et al. Food selectivity in children with autism spectrum disorders and typically developing children. *Journal of Pediatric* 2010; 157(2): 259-264.

40. Evans, W., Must, A., Anderson, S., Curtin, C., Scampini, R., Maslin, M., et al. Dietary patterns and body mass index in children with autism and typically developing children. *Research in Autism Spectrum Disorders* 2012; 6 (1): 399 – 405.

41. Crasta, J., Benjamin, T., Surresh, A., Alwinesh, M., Kanniappan, G., Padankatti, S., et al. Feeding problems among children with autism in a clinical population in India. I*ndian Journal Pediatrics* 2014; 81 (2): 169 – 172.

42. Schreck, K., Williams, K. Food preferences and factors influencing food selectivity for children with autism spectrum disorders. *Research in Developmental Disbilities* 2005; 27 (4), 353 – 363.

43. Cermark, S., Curtin, C., Bandini, L. Food selectivity and sensory sensitivity in children with autism spectrum disorders. *Journal of the American dietetic Association* 2010; 110 (2): 238 – 246.

44. Souza, N. C., Mendonca, J. N., Portari, G. V., Jordao, A. A., Marchini, J. S., Chiarello, P. G. Intestinal permeability and nutritional Status in developmental disorders. *Alternative Therapies in Health and Medicine* 2012; 18 (2): 19 – 24.

45. Xia, W., Zhou, Y., Sun, C., Wang, J., Wu, L. A preliminary study on nutritional status and intake in Chinese children with autism. *European Journals of Pediatrics* 2010; 169 (10): 1201 – 1206.

46. Sun, C., Xia, W., Zhao, Y., Li, N., Zhao, D., Wu, L. Nutritional status survey of children with autism and typically developing children aged 4 – 6 years in Heilong Ji- and Province, Chine. *Journal of Nutritional Science* 2013; doi:10.1017/jns.2013.9.

47. Schimitt, L., Heiss, C. Campbell, E. A comparison of nutrient intake and eating behaviors of boys with and witout autism. *Topics in Clinical Nutrition* 2008; 23 (1), 23 – 31.

48. Grondhuis, S.N., Aman, M. G. Overweight and obesity in youth with developmental disabilities: A call to action. *Journal of Intellectual Disability Research* 2014; 58 (9): 787 – 799.

49. Bauset, S., Zazpe, I., Mari, A. Are there anthropometric differences between children with autism and healty children?. *Journal of Child Neurology* 2015; 28 (10): 1226 –1232

50. Johnson, C., Turner, K., Stewart, P., Schmidt, B., Shui, A., Macklin, E., et al. Relationships between feeding problems, behavioral characteristics and nutritional quality in children with ASD. *Journal of Autism and Developmental Disorders* 2014; 44 (9): 2175 – 2184.

51. Bhattacharjee, S. Study of antropometric parameters along with postural changes in blood pressure ın children with autistic spectral disorders. *International Journal of Basic and Applied Psyiology* 2012; 1(1): 88–92.

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