Impact of Dietary Habits on Children with Autism Spectrum Disorder

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Abstract
Background: Autism Spectrum Disorder (ASD) is a condition characterized by difficulty in social interaction, in addition to affecting the development of language and communication. Food selectivity was common problem among children with ASD and this would lead to macro- and micronutrient deficiencies. This study was done to identify the dietary habits and assess the effects of consumed food on autistic behavior. Methods: A cross-sectional study was conducted in National Center of Autism in Children Welfare Teaching Hospital in Baghdad for three months. Fifty children aged between 2 and 10 years were collected randomly by simple random method. Anthropometric measurements were recorded and general questionnaire, Food Frequency Questionnaire (FFQ) and The Childhood Autism Rating Scale (CARS 2) forms were filled in by dietitian and the psychologist. Results: The rates of being overweight and obese were 22% and 8%, respectively. Food selectivity was observed in 64% of the children, there was statistical association between autistic behavior and low consumption of certain foods (cheese, red meat, white meat and egg), and high oily seeds consumption ($p<0.05$). Conclusion: Our results showed that children with ASD had different dietary habits, food selectivity and their effect on autistic behavior.
Keywords: Autism spectrum disorder; dietary habits; food selectivity; obesity

1. Introduction

Autism Spectrum Disorder (ASD) is a condition characterized by difficulty in social interaction, affecting the development of language and communication. Other characteristics are also present in the disorder, such as restricted, repetitive, and stereotyped behavior patterns in addition to sensory changes and eating problems. [1, 2] The incidence of ASD is worldwide, and recent epidemiological data estimated it to be higher than 1/100 [3].

Childhood obesity is one of the most serious public health problems [4]. Some studies show that children with ASD have greater rates of overweight or obesity than typically developing ones, and this fact could be related to unusual dietary patterns and decreased opportunities for physical activity [5, 6]. Furthermore, a normal body mass index (BMI) might hide nutritional inadequacies [5, 7].

The most common feeding problem is food selectivity [8]. The origin of eating behavior alterations is not entirely clear. Among some of the theories that can explain this phenomenon, the following stand out: cognitive/behavioral alterations; sensory alterations [9, 10]; and gastrointestinal disturbances [9, 11].

The nutritional management of children with ASD is a great challenge [12]. These children frequently have restricted diets limited to foods with specific tastes or textures or to specific types of foods [12, 13], the dietary intakes of macronutrients and some micronutrients in children with autism have been found to be lower, higher, or similar compared with the recommended amounts [12]. There is evidence that children with ASD consume fewer fruits and vegetables and have a lower intake of calcium and protein, compared to their typically developing peers [14, 15]. Moreover, children with ASD prefer foods with high carbohydrate, content such as white bread, pizza, cakes, cookies, ice-cream, or "fatty" foods [14]. Finally, children with ASD, because of false myths, sometimes undergo to non-intentional and dangerous dietary restrictions protocols (e.g., casein and/or gluten-free) based on non-evidence-based attempt to improve behavioral disturbances or gastrointestinal symptoms [16].

2. objectives of the study

1. To identify the dietary habits among children with ASD.
2. To assess the effects of consumed food on autistic behavior.

3. Patients and methods

A cross-sectional study was conducted in National Center of Autism in Children Welfare Teaching Hospital in Baghdad from the first of September to the end of November 2022. The sample was chosen from those children with ASD aged between 2 and

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10 years who attended the center for follow up and whose mother or caregiver had agreed for interview. Fifty children were collected randomly by simple random method; children with chronic diseases, genetic diseases, or on a restricted diet were excluded. Height and weight were measured using standard procedures; the BMI-for-age values were calculated, and were evaluated based on the World Health Organization (WHO) guidelines for the calculation of z-score (2-5 years) [17] and z-score (5-19 years) [18].

The questionnaire form consisted of 3 parts: 1- general questionnaire which included age, gender, appetite status, swallowing and chewing function status, food selection, preferred food forms, number of meals per day, meal omitting, skipped meal and self-feeding status. 2- Food Frequency Questionnaire (FFQ) which was modified and filled for the last month. 3- The Childhood Autism Rating Scale (CARS 2) that is commonly used as a diagnostic scale and for assessing severity, it consists of 15-items. In this study, we used the three – factor solution: Social Communication, Stereotyped Behaviors and Sensory Sensitivities, and Emotional Reactivity which was obtained by loadings from principal axis factor analysis with promax rotation of CARS item [19]. The first two parts of the questionnaire were filled by the investigator (dietitian) and the third part by the psychologist. The consent was taken prior to direct interview.

Statistical analyses were performed using SPSS version 20.0. Chi square test and Independent Student's t-test were applied. A P-value less or equal to 0.05 was considered significant.

4. Results

The participants of our study were divided into 2 age groups: 2-5 years (72%) and 6-10 years (28%), Most of the participants were males. Table 1 shows BMI classifications, appetite status, swallowing and chewing function, preferred food forms, number of meals per day, meal omitting, skipped meal, self-feeding status by age groups.

Sixty percent of children had normal BMI, overweight and obesity was higher in 6- 10 years age group than in 2-5 years, 64% of children with ASD were food selective, 72% preferred all forms of food, 74% feed themselves, 58% of children had good appetite and 24% with bad appetite.

Although two third of children consumed 3-6 meals per day, breakfast was skipped by most of them (86.4%). There was no significant difference according to the above factors (p >0.05) except for appetite status (p=0.033).

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

	2-5 years N= 36 (%)	6-10 years N= 14 (%)	Total N= 50 (%)	P value
Gender Male Female	29 (80.6) 7 (19.4)	10 (71.4) 4 28.6)	39 (78.0) 11 (22.0)	0.484
BMI Classification Severe wasting Wasting Normal Overweight Obese	1 (2.8) 3 (8.3) 23 (63.9) 7 (19.4) 2 (5.6)	0 1 (7.1) 7 (50.0) 4 (28.6) 2 (14.3)	1 (2.0) 4 (8.0) 30 (60.0) 11 (22.0) 4 (8.0)	0.722
Appetite Status Bad Moderate Good	10 (27.8) 9 (25.0) 17 (47.2)	2 (14.3) 0 12 (85.7)	12 (24.0) 9 (18.0) 29 (58.0)	0.033
Swallowing and chewing function Normal Dysfunction	26 (72.2) 10 (27.8)	8 (57.1) 6 (42.9)	34 (68.0) 16 (32.0)	0.305
Food Selection status Selective Non-selective	24 (66.7) 12 (33.3)	8 (57.1) 6 (42.9)	32 (64.0) 18 (36.0)	0.529
Preferred food forms Solid Mashed Liquid All forms	5 (13.9) 6 (16.7) 1 (2.8) 24 (66.7)	1 (7.1) 1 (7.1) 0 12 (85.7)	6 (12.0) 7 (14.0) 1 (2.0) 36 (72.0)	0.587
Number of meals per day < 3 3-6 > 6	12 (33.3) 20 (55.6) 4 (11.1)	1 (7.1) 11 (78.6) 2 (14.3)	13 (26.0) 31 (62.0) 6 (12.0)	0.165
Meal omitting Yes No	18 (50.0) 18 (50.0)	4 (28.6) 10 (71.4)	22 (44.0) 28 (56.0)	0.171
Skipped meal Breakfast Lunch Dinner	16 (88.9) 1 (5.6) 1 (5.6)	3 (75.0) 1 (25.0) 0	19 (86.4) 2 (9.1) 1 (4.5)	0.437
Self-feeding status Yes No	25 (69.4) 11 (30.6)	12 (85.7) 2 (14.3)	37 (74.0) 13 (26.0)	0.239

0.05) as shown in table 2.

We found no significant difference between the three – factor solution of CARS items (Social Communication, Stereotyped Behaviors and Sensory Sensitivities, and Emotional Reactivity) according to the age groups (p >

The data in Table 3 shows food frequency of children with ASD. We found that 92% of children had high consumption of grain and cereals, while consuming milk, egg, fresh vegetables and fresh fruits was 46%, 54%, 64% and 78% respectively. The largest percentage of children consumed yogurt, white

meat and legumes 1- 2 per week. About third of children never ingested cheese, red meat and nuts. Packaged foods and oily seeds had never been taken by 80%, 58% respectively. Twenty eight percent of children had ingested sweets and unhealthy snacks almost all the days and the others less frequently.

Table 2: The three – factor solution of CARS items in children with ASD				
The factors	2-5 years (n=36) Mean+ SD	6-10 years (n=14) Mean+ SD	Total (n=50) Mean+ SD	P value
Social communication	15.88 +2.260	16.14 + 2.299	15.95 + 2.250	0.710
Emotional reactivity	6.014 + 0.9746	6.286 +1.0869	6.090 + 1.0035	0.395
stereotyped behaviors and sensory sensitivities	8.681 +1.4049	8.679 +1.6006	8.680 + 1.4455	0.997

Table 3: Frequency of food consumptions of children with ASD							
Food Frequency n (%)	Everyday	5-6 per week	3-4 per week	1-2 per week	1 in 15 days	1 per month	Never
Milk	23 (46)	-	6 (12)	4 (8)	-	-	17 (34)
Yogurt	9 (18)	2 (4)	4 (8)	17 (34)	-	3 (6)	15 (30)
Cheese	16 (32)	1 (2)	5 (10)	8 (16)	1 (2)	-	19 (38)
Red meat	5 (10)	3 (6)	10 (20)	14 (28)	3 (6)	-	15 (30)
White meat	-	10 (20)	13 (26)	17 (34)	-	-	10 (20)
Egg	27 (54)	2 (4)	8 (16)	5 (10)	-	-	8 (16)
Legumes	4 (8)	-	12 (24)	20 (40)	6 (12)	-	8 (16)
Fresh vegetable	32 (64)	-	4 (8)	-	-	-	14 (28)
Fresh fruit	39 (78)	-	6 (12)	-	-	-	5 (10)
Grain & cereals	46 (92)	-	4 (8)	-	-	-	-
Oily seeds	3 (6)	-	3 (6)	5 (10)	7 (14)	3 (6)	29 (58)
Nuts	7 (14)	1 (2)	6 (12)	9 (18)	6 (12)	2 (4)	19 (38)
Packaged food	-	3 (6)	-	-	7 (14)	-	40 (80)
Sweets and unhealthy snacks	9 (18)	14 (28)	-	14 (28)	10 (20)	-	3 (6)

Table 4 shows the three – factor solution of CARS items of children with ASD according to their food consumption. There was significant association between low social communication and decreased consumption of cheese (p=0.040, 0.030), no consumption of white meat (p=0.017) and egg (p=0.040) and increased consumption of oily seeds (p=0.042, 0.005). Features that increased Stereotyped Behaviors and Sensory Sensitivities were not consuming red meat (p=0.030), white meat (p=0.026) and egg (p=0.035) and high oily seeds consumption. Emotional Reactivity was higher in those children who were not consuming red meat (p=0.039).

Table 4: Comparison of the three – factor solution of CARS items regarding to frequency of food consumption of children with ASD					
The factors	Food	Frequency	N	Score mean ± SD	P value
Social communication	cheese	5-6 per week	1	11	0.040
		1-2 per week	8	16.75 ± 2.155	
		5-6 per week	1	11	0.030
		Never	19	16.03 ± 2.078	
	White Meat	5-6 per week	10	15.15 ± 2.042	0.017
		Never	10	17.30 ± 1.585	
	Egg	Everyday	27	15.19 ± 2.296	0.040
		Never	8	17.06 ± 1.657	
	Oily Seeds	Everyday	3	17.50 ± 1.000	0.042
		1-2 per week	5	14.30 ± 1.956	
		Everyday	3	17.50 ± 1.000	0.005
		1 per month	3	14.17 ± 0.289	
Emotional reactivity	Red Meat	Everyday	5	5.400 ± 0.6519	0.039
		Never	15	6.533 ± 1.0601	
stereotyped behaviors and sensory sensitivities	Red Meat	5-6 per week	3	7.167 ± 0.2887	0.030
		Never	15	9.100 ± 1.3654	
	White Meat	5-6 per week	10	8.050 ± 1.1168	0.026
		Never	10	9.300 ± 1.1832	
	Egg	Everyday	27	8.278 ± 1.4566	0.035
		Never	8	9.500 ± 1.0690	
		5-6 per week	2	7.500 ± 0.0000	0.035
		Never	8	9.500 ± 1.0690	
	Oily Seeds	Everyday	3	9.833 ± 0.2887	0.038
		1-2 per week	5	7.500 ± 1.4577	

5. Discussion

In this cross-sectional study, we examined the relationship between eating habits, other behavioral features and diet pattern in autistic children. We found that sixty percent of children had normal BMI, while overweight and obesity were (22%), (8%) respectively. This was close to the study of Raspini et al. (overweight 23% and obesity 6%) [20]. According to ŞENGÜZEL et al., obesity is more common among children with ASD than general population [8]. However, the percentages of our study were lower than in previous studies examining overweight and obesity in children with ASD (de Vinck-Baroody et al. [21], Criado et al.[22] , Curtin et al.[23]) ,which reported rates between 30% and 42% for overweight and 17% and 25% for obesity.

In addition, Hyman et al. had found that children with ASD aged 5–11 were underweight, whereas those aged 2–5 years have higher incidences of overweight and obesity [24]. This was on the contrary of our study. Its discrepancy with our results may be due to the small sample size of the population we studied.

In children with ASD, food selectivity was the most common feeding problem because of sensory sensitivity and persistence in routine [8]. Our study showed that 64 % of children with ASD had food selectivity and this agreed with ŞENGÜZEL et al. [8], Teixeira et al. [1], Raspini et al. [20] and SHARP et al. [25].

In our study, most of children consumed more grain and cereals (92%); this result was agreed with ŞENGÜZEL et al. [8], Dubourdieu et al. [5], Plaza-Diaz et al. [9]. In contrast, Raspini et al. [20] and Hill et al. [26] found that children with ASD displayed a lower intake of fiber-rich foods, including raw vegetables and cereals.

Although the daily consumption of fresh vegetables and fresh fruits in our sample was 64% and 78% respectively, some of the children were selective regarding the types of fruit and vegetables. That might be possibly due to their high sensitivity to taste or dislike of texture. Previous studies showed lower intake of vegetables and fruits among children with ASD as Raspini et al. [20], Plaza-Diaz et al. [9], Hill et al. [26], whereas Herndon and colleagues identified significantly higher consumption of fruit in children with ASD aged 4–8 years than in typically developing peers [27].

One of the major findings of our study was the lower consumption of red meat and white meat, and about one third of children rejected them. These results were agreed with Dubourdieu et al. study regarding fish intake [5] and Plaza-Diaz et al. regarding lean meat [9] and disagreed with Raspini et al. who observed that children with ASD had higher annual consumption of protein rich food such as milk, yogurt, and red meat compared to typically developing peers [20].

Our results revealed that the consumption of dairy products was low. Although Milk consumption was by 46% of children, 34% of them never consumed it. Low consumption, or even the elimination, of milk and other dairy products could result in calcium deficiency due to an intake below recommended levels. Previous studies approved our results, they were carried out by Dubourdieu et al. [5], Herndon et al. [27]. Of note, Diolordi et al. showed a higher rate of children with ASD never consuming dairy products compared to typically developing peers [28]. Two Studies were against our results like Raspini et al. [20] and Plaza-Diaz et al. [9].

We found that 28% of children had ingested sweets and unhealthy snacks almost all the days and the others less frequently. This opposite to what was found by Plaza-Diaz et al. [9], Raspini et al. [20] who showed higher levels of consumption of energy-dense foods, particularly "unhealthy food" such as snacks, puddings, crackers and breadsticks, French fries, soft drinks, and sweetened fruit juices by children with ASD. Our result might be due to the instructions of psychologists during follow up visits.

The present study showed significant association between low social communication and lower consumption of cheese, no consumption of white meat and egg and increased consumption of oily seeds. Stereotyped Behaviors and Sensory Sensitivities were increased by not consuming red meat, white meat and egg and high oily seeds consumption. Emotional Reactivity was higher in those children who were not consuming red meat. No study applied the same scale as ours but previous one used Autism Behavior Checklist (ABC) in which consumption of oily seeds had increased ABC sensorial scores, no consumption of fresh fruit had increased ABC relating scores and ABC language scores were increased by no yoghurt consumption [8], Dubourdieu et al. found that children with ASD who presented a higher sensory sensitivity had a lower intake of total dairy products and a higher intake of total cereals and protein foods [5].

All the previous studies including our study demonstrated the impact of dietary habits on children with autism spectrum disorder. Some studies agreed with our study, while others did not.

As mentioned earlier in the discussion, the findings of the present study may not be directly comparable to some of the previous studies because of differences in the type of the study design, presence or absence of control group, and the scales that were used for assessing autistic behavior.

The limitations of this study included small sample size and problems with using FFQ; it is not a specific tool. Quantities of consumed food are often estimated by caregivers rather than accurately measured, and reporting by parents might be biased.

6. Conclusions

This study identified the dietary habits in children with ASD and the association between autistic behavior and low consumption of certain foods (cheese, red meat, white meat and egg). Food selectivity was common problem among children with ASD and this would lead to limited variety of

foods and macro- and micronutrient deficiencies. Further researches with a larger sample size are needed.

7. Ethical Clearance

The Research Ethical Committee at scientific research by ethical approval of Council of Arab Board of health Specializations, the National Center of Autism, Children Welfare Teaching Hospital/Medical City Directorate/ Baghdad and the Ministry of Health in Iraq.

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