

The Effect of Food Selectivity on Nutritional Adequacy for Autistic Children in Western Region, Saudi Arabia

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Abstract: Objectives: To investigate the association of Food Selectivity domain (FR), high frequency single food intake (HFSFI), and limited food repertoire (LFR), restricted diets, and appetite-affecting medications with nutritional adequacy in autistic children aged 6-12 years in the Western region of Saudi Arabia (SA).

Methods: thirty-two autistic children from six autistic centres participated in the study. Height and weight measured for each child and body mass index were calculated. Mothers of autistic children provided diet information by completing 3-day food records and a food frequency questionnaire.

Results: only three children were taking appetite-affecting medications and two children were on restricted diet. Most of the autistic children had adequate intake of carbohydrate (87.5%), protein (93.8%), and fat (93.8%). However, the adequacy of fiber and micronutrients (iron, folate, calcium, zinc, vitamin A, vitamin D and vitamin E) appeared in less than 50% of autistic children, but vitamin C and vitamin B12 adequacy appeared in $\geq 50\%$ of autistic children. The FR and LFR were not associated ($P= 0.091$ and $P= 0.706$ respectively) with nutritional adequacy. The HFSFI was significantly associated ($P=0.021$) with nutritional adequacy.

Conclusion: Food Selectivity is a frequent problem in autistic children in the Western region in SA, which affects their nutritional adequacy. Therefore, in SA further studies are needed related nutrition with autism, to improve the nutritional status of autistic children.

Keywords: autistic children, Food Selectivity, nutritional adequacy.

تأثير انتقائية الغذاء على كفاية التغذية على أطفال التوحد في المنطقة الغربية بالمملكة العربية السعودية

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المخلص: الأهداف: فحص ارتباط جوانب انتقائية الغذاء: رفض الطعام (FR)، زيادة تكرار تناول غذاء واحد (HFSFI)، مجموعة الغذاء المحدودة (LFR)، الحميات الغذائية المقيدة، والأدوية التي تؤثر على الشهية على كفاية التغذية عند أطفال التوحد الذين تتراوح أعمارهم بين 6 إلى 12 سنة في المنطقة الغربية من المملكة العربية السعودية (SA).

الطرق: شارك في الدراسة 32 طفلاً مصاباً بالتوحد من ستة مراكز توحد. تم قياس الطول والوزن وتم حساب مؤشر كتلة الجسم لكل طفل. سجل الأمهات المعلومات الغذائية لأطفالهم من خلال تعبئة استبيان تكرار الطعام وسجلات الطعام لمدة 3 أيام.

النتائج: ثلاثة من الأطفال فقط كانوا يتناولون الأدوية التي تؤثر على الشهية، وطفلان كانوا يتبعون حمية مقيدة. معظم أطفال التوحد كان لديهم كفاية في تناول الكربوهيدرات (87.5%)، والبروتين (93.8%)، والدهون (93.8%). وكانت كفاية المتناول من الألياف، الحديد، الفولات، الكالسيوم، الزنك، فيتامين أ، فيتامين د، وفيتامين هـ ظاهرة في أقل من 50% من أطفال التوحد، أما كفاية المتناول من فيتامين ج وفيتامين ب12 ظهرت في $\geq 50\%$ من أطفال التوحد. FR و LFR كانا غير مرتبطين ($P=0.097$ و $P=0.706$ على التوالي) مع كفاية التغذية، بينما HFSFI كان مرتبط بشكل معنوي ($P=0.021$) مع كفاية التغذية. التوصيات: انتقائية الغذاء هي مشكلة متكررة تؤثر على كفاية التغذية في أطفال التوحد في المنطقة الغربية في SA. لذلك نحتاج لدراسات مستقبلية حول ارتباط التغذية بالتوحد، لتحسين الحالة الغذائية لأطفال التوحد.

الكلمات المفتاحية: أطفال التوحد، انتقائية الغذاء، كفاية التغذية.

I. INTRODUCTION

I.1. Autism Spectrum Disorder

Autism spectrum disorder refers to neuro-developmental disorders of varying clinical presentation that share core features of pervasive and qualitative impairments. It characterized by impairments in three domains of functioning: social interaction, communication abilities, and restricted repetitive patterns of behavior (Centers for Disease Control and Prevention 2006).

In Saudi Arabia (SA), "Autism Research and Treatment Centre" in Riyadh city, estimated the number of autistic individuals to be 120,000 in SA (King Saud University 2009). Moreover, the prevalence of autism varies widely by gender, as the incidence of autism has increased remarkably especially among boys (Al-Zahrani 2013).

I.2. Nutritional Adequacy

Nutritional adequacy defined as the sufficient intake of essential nutrients, needed to fulfil nutritional requirements for optimal health; it emerges from the comparison between the dietary requirement and the intake of a certain individual or population (Castro-Quezada, Román-Viñas, and Serra-Majem 2014, 232).

I.3. Eating Problem among Children with Autism

Eating habits is a challenge in autistic child; as most autistic children have several problems in eating practices leading to food elimination or selective eating. The prevalence of eating problems in autistic children increases noticeably compared to normal children.

I.3.1. Food Selectivity

One factor of eating problem is "Food Selectivity" and it is a prevalent situation among children with Autism. Selective eating is "An expression of eating without diversity and insufficient intake of foods such as eating only ten foods or fewer, sometimes food of special colour, or brand, avoidance or refusal of new foods" (Råstam 2008, 33).

Food Selectivity expressed by three domains including: Food Refusal (FR), High Frequency Single Food Intake (HFSFI), and Limited Food Repertoire (LFR) (Bandini et al. 2010). The FR is “the number of foods that the child does not eat” (Bandini et al. 2010). The HFSFI defined as “The single foods eaten 4-5 or more than 6 times daily” (Bandini et al. 2010). The LFR is an expression of the number of narrow ranges of food and beverage types a child consumes repeatedly over a 3-day period (Bandini et al. 2010).

I.3.2. Restricted Diets

Another factor of eating problem is restricted diets that described as exclusion of specific nutrients such as protein, which has an impact on some autistic children. Restricted diets play an important role in the treatment of autism (Carr and LeBlanc 2007).

I.3.3. Appetite-Affecting Medications

Medication is a possible factor of eating problem. Some children have severe symptoms that drive them to get specific medication to relive or improve their status (National Institute of Health 2011). However, some of these medicines could affect autistic children eating behaviour or may affect their food appetite, which may affect their nutritional adequacy.

I.4. The Research Problem

There is shortage of the researches that investigate the association between nutrition and autism in SA up to the best of our knowledge. No published studies that related autism to food issues on SA conducted. Therefore, the nutritional status of autistic children in SA remains unknown; and the statistics of autism in SA is unclear.

In this study, it focused and illustrated these factors (Food Selectivity domains, restricted diets, and appetite-affecting medications on nutritional adequacy) that faced children with autism aged 6 to 12 years in the Western region in SA.

II. RESEARCH OBJECTIVES

1. To determine the effect of the three domains of Food Selectively: FR, HFSFI, and LFR among children with autism aged from 6-12 years on their nutritional adequacy.
2. To explore the effect of restricted diets use on the nutritional adequacy in autistic children aged 6-12 years.
3. To explore the effect of appetite-affecting medications use on the nutritional adequacy in autistic children aged 6-12 years.

III. RESEARCH METHODOLOGY

III.1. Sample

This research followed a descriptive cross-sectional study design. The data collection lasted approximately four months started from 1 September 2014 to the end of December 2014. Autistic children recruited from six autism centres in two cities in the Western region of SA. Initially the study included 121 autistic children. However, the response rate was 26.4% leaving us with thirty-two complete questionnaires. The inclusion criteria were the child who had autism diagnosed by hospital, attended autistic centre and aged from 6 to 12 years.

III.2. Data Collection

III.2.1. Questionnaire

The main questionnaire was composed of three parts in ten pages. The first page included explanations of the study purpose for autistic children's mothers to obtain their initial approval. The three sections of the questionnaire were personal information, FFQ, and 3-day food records. Restricted diets and appetite-affecting medications measured by two questions in the personal information form.

III.2.1.1. Food Frequency Questionnaire

The FFQ including all food items that commonly consumed by children in SA, contained nine food groups including 77 food items plus 12 spaces allowing mothers to write any food not included in the FFQ.

The FR was measured based on the number of foods on FFQ list that mother indicated that the child would not eat (never). By using the FFQ, we were able to estimate which items more or less refused by each child. Then it was able to estimate which food group was more refused by autistic children than other food groups.

The HFSFI was defined as a high frequency consumption of single food or beverage item on FFQ list which the child eat or drink 4 times or more per day, if this item was marked by the mother.

III.2.1.2. Three Day Food Records

Mothers asked to give all the foods consumed by the child as well as providing the estimated serving sizes for each type eaten, in two weekdays and one weekend day.

The LFR measured by counting the number of the repeated food types that each child consumed in all the 3-days of intake. The nutritional adequacy described by estimating the nutrients levels of all the food the child actually ate, using the Food Processor Structured Query Language (SQL) Elizabeth Stewart Hands and Associates (ESHA) software version 10.11.

The average nutrient intake for the three days compared with the Dietary Reference Intakes (DRI) for the appropriate age group. The nutrients of interest in this study included macronutrients intake as follows: carbohydrates, proteins, calories from fat, and fiber, and nine of micronutrients: vitamin D, vitamin E, vitamin A, vitamin C, folate (vitamin B9), vitamin B12, calcium, iron, and zinc.

The adequacy of nutrient in Recommended Dietary Allowance (RDA) observed and determined, if the mean intake more than 100%, in Adequate Intake (AI) if the mean intake equals or exceeds AI, in Acceptable Macronutrient Distribution Ranges (AMDR) if the mean intake was between the lower and upper bound of the AMDR (Otten, Hellwig, and Meyers 2006; Murphy and Poos 2002).

III.2.2. Anthropometric Measurement

The portable anthropometric measurement equipment used (scale and meter). The height and the current weight measured of each child without shoes and in light clothing during a school day. The body mass index (BMI) calculated by measuring weight in kg and height by meter (kg/m^2)

III.3. Statistical Analysis

All statistical analyses performed using Statistical Package for Social Sciences (SPSS) version 16.0. Spearman correlation coefficients analysis used to test the association between FR, HFSFI, and LFR with nutritional adequacy in autistic children, and to investigate the relation between FR, HFSFI, and LFR with the age of autistic children. As well as to find the interrelationships between Food Selectivity domains.

The Chi square χ^2 used to assess the association between restricted diets and appetite-affecting medications with nutritional adequacy on autistic children. Independent-sample t-test used to examine the difference between restricted diets and appetite-affecting medication with Food Selectivity domains. All statistical analyses conducted at significance level at ≤ 0.05 .

IV. RESULTS AND DISCUSSION

IV.1. Participants' Characteristics

Table 1, described the Demographic information (age, gender, and BMI) for 32 (26.4%) autistic children who participated in the study. The mean age was 8 ± 2.3 . Sixteen autistic children (50%) were 6 years old, 2 children (6.2%) were 7 or 8 years old, 3 children (9.4%) were 10 years old, 7 children (21.9%) were 11 years old, and 2 children were 12 years old.

Table (1) Participants' Characteristics (n = 32)

Characteristics	Autistic Children
Gender	
Boys, n (%)	28 (87.5)
Girls, n (%)	4 (12.5)

Characteristics	Autistic Children
Age (years)	
Mean (\pm SD)	8.0 (\pm 2.3)
Range (min – max)	(6 – 12)
BMI (kg/m^2)	
Mean (\pm SD)	15.9 (\pm 3.2)
Underweight (< the 5 th), n (%)	9 (28.1)
Normal weight (\geq 5 th to < 85 th), n (%)	20 (62.5)
Overweight (\geq 85 th to < 95 th), n (%)	1 (3.1)
Obese (\geq the 95 th), n (%)	2 (6.2)

There were more boys (87.5%) with autism than girls (12.5%) in present study, and this is in line with the general male to female population of autism. A study conducted in Libya found that the prevalence of autism in 38,508 children attending the neurodevelopment clinic between 2005 and 2009, were about 4 in 1000, and the male: female ratio for autism was 4:1 (Zeglam and Maouna 2012).

Also, In present study, found that most autistic children (62.5%) were of normal weight and 28.1% were underweight, 6.2% were obese and 3.1% were overweight, in line with previous study, which found 47% normal weight, 32% obese, 11% overweight, and 10% underweight of autistic children of the same age range (Aghaeinejad et al. 2013).

Only three children were taking appetite-affecting medications, and the remaining 29 autistic children did not take any medication that affects appetite. Only two children were on a restricted diet, while 30 autistic children were not on any restricted diet.

IV.2. Food Selectivity Domains

IV.2.1. Food Refusal

Found that autistic children refused a large number of food items with varying frequency. In addition, autistic children was rejected more items in the "milk & cheese group" than other food groups (Table 2). This finding was similar to pervious findings that children with autism consumed little servings of dairy group than other food groups (Cornish 1998; Herndon et al. 2009; Schreck, Williams, and Smith 2004).

Table (2) Percentages of Food Groups Refused by Autistic Children from Food Frequency

Food Groups	% of Children Refused
Milk & cheese group	64.9
Fat & sauces group	64.0
Fruit group	54.3

Food Groups	% of Children Refused
Legumes & pasta group	49.2
Meat & eggs group	47.6
Vegetables group	42.8
Cereal, bread & rice group	39.5
Beverages group	39.3
Snacks & sweets group	34.0

IV.2.2 High Frequency Single Food Intake

Some autistic children ate 11 foods or beverages 4 times or more every day. It observed that 22 autistic children (68.8%) with HFSFI.

IV.2.3 Limited Food Repertoire

There were 39 repeated types of food and beverages consumed by participants. It appeared in most autistic children (93.7%), compared to previous study result that found (72%) of autistic children with LFR (Schreck, Williams, and Smith 2004). The highest food type repeated during the 3 days period was yogurt and appeared in 7 (21.87%) autistic children.

IV.3. The Relationship between Food Selectivity Domains and Age

In general, a negative relationship found between the FR and age of autistic children ($P=.939$), which is older children with autism (6-12 years), may refuse fewer foods than younger autistic children. This finding is similar to the result from another study that demonstrated a significant difference of age in food refused behavior when Indonesian children (3-6 years) become older; the mean score of refusing food was decreasing (Handayani, Herini, and Takada 2012).

Also, found a negative association between age and the HFSFI ($P=.794$). In addition, a positive relationship was found between the age of autistic children and the LFR ($P=.929$). However, there is no statistical significant difference between age of autistic children and Food Selectivity domains.

IV.4. Interrelationships of Food Selectivity Domains

There were some relationships between the three domains of Food Selectivity, while FR and LFR were insignificant inversely related with HFSFI. However, there was significant direct association between FR and LFR ($P=.011$), which mean autistic children with more repeated food types refused more foods compared to those with fewer repeated food types. In contrast to our finding, Bandini et al, (2010) found an inverse correlation between the FR and the LFR.

IV.5. Nutritional Adequacy

Table 3, described the adequacy of all 13 nutrients in children with autism. There was none of the autistic children had adequate intake of vitamin D and vitamin E. In addition, only one child's fiber intake was adequate. Less than 50% of autistic children had adequate intake of vitamin A, folate, calcium, zinc, and iron. However, 84.4% of children with autism had adequate intake of vitamin C, 50% had adequate intake of vitamin B12.

Our results indicated a higher number of children had adequate intake of macronutrients. That the adequate intake of carbohydrate (87.5%), protein (93.8%), and fat (93.8%) in most children with autism (Table 3). These findings agree with several previous studies that evaluated 3-day food records on children with autism (Aghaeinejad et al. 2013; Herndon et al. 2009; Hyman et al. 2012; Levy et al. 2007).

Table (3) Nutrients Adequacies in Children with Autism (n = 32)

Number (%) of meeting DRI	00 (0%)	00 (0%)	02 (6.2%)	05 (15.6%)	16 (50%)	27 (84.4%)
Min – Max	0.0 – 7.74 µg/d	0.09 – 9.43 mg/d	10.81 – 469.22 µg/d	11.43 – 423.72 µg/d	0.13 – 4.68 µg/d	5.54 – 308.08 mg/d
Mean (±SD)	2.12 µg/d (±1.90)	4.08 mg/d (±2.27)	2.30 µg/d (±127.14)	1.77 µg/d (±83.67)	1.75 µg/d (±1.24)	85.4 mg/d (±64.01)
9 – 12y Female	15µg/d	11mg/d	600µg/d	300µg/d	1.8µg/d	45mg/d
9 – 12y Male	15µg/d	11mg/d	600µg/d	300µg/d	1.8µg/d	45mg/d
4 – 8y	15µg/d	7mg/d	400µg/d	200µg/d	1.2µg/d	25mg/d
DRI	RDA	RDA	RDA	RDA	RDA	RDA
Nutrients	Vitamin D	Vitamin E	Vitamin A	Folate	Vitamin B12	Vitamin C
Category	Fat-soluble Vitamins			Water-soluble Vitamins		

Table (4) Nutrients Adequacies in Children with Autism (n = 32) (Continued)

Number (%) of meeting DRI	03 (9.4%)	03 (9.4%)	12 (37.5%)	28 (87.5%)	30 (93.8%)	30 (93.8%)	1 (3.1%)
Min – Max	1.09 – 8.48 mg/d	8.68 – 1599.14 mg/d	1.88 – 19.90 mg/d	86.87 – 557.08 g/d	21.76 – 92.13 g/d	22.75 – 43.20%	2.05 – 45.37 g/d
Mean (±SD)	3.79 mg/d (±1.86)	5.33 mg/d (±365.67)	8.57 mg/d (±3.98)	2.09 g/d (±89.03)	49.64 g/d (±20.73)	33.64% (±5.94)	12.81 g/d (±7.92)
9 – 12y Female	8mg/d	1300mg/d	8mg/d	130g/d	34g/d	25 – 35%	26g/d

Number (%) of meeting DRI	03 (9.4%)	03 (9.4%)	12 (37.5%)	28 (87.5%)	30 (93.8%)	30 (93.8%)	1 (3.1%)
9 – 12y Male	8mg/d	1300mg/d	8mg/d	130g/d	34g/d	25 – 35%	31g/d
4 – 8y	5mg/d	1000mg/d	10mg/d	130g/d	19g/d	25 – 35%	25g/d
DRI	RDA	RDA	RDA	RDA	RDA	AMDR	AI
Nutrients	Zinc	Calcium	Iron	Carbohydrate	Protein	Fat	Fiber
Category	Minerals			Macro-nutrients			

IV.5.1. The Relationship between Nutritional Adequacy and Food Selectivity Domains

The FR and LFR were not significantly associated with nutrients adequacy ($P=.091$ and $P=.706$ respectively). However, HFSFI was significant positively correlated with the numbers of nutrients adequacy ($P=.021$).

IV.5.2. The Relationship between Nutritional Adequacy and Restricted Diets

The restricted diet was not associated with nutritional adequacy or Food Selectivity domains in autistic children.

IV.5.3. The Relationship between Nutritional Adequacy and Appetite-Affecting Medications

There were no statistical significant differences between autistic children who take appetite-affecting medications or not regarding Food Selectivity domains or nutritional adequacy.

V. CONCLUSION

There is an obvious gap between nutrition and autism in SA, despite the significant increase of autism occurrence in children in the world. Thus, there is an urgent need to find the relationship between autism and food problems in children in SA. Generally, Food Selectivity is a frequent problem in autistic children in Western region in SA. That affects their nutritional adequacy, one aspect of that the probable adversely effect of FR, and probable positively effect of HFSFI and LFR with nutritional adequacy among autistic children in SA.

VI. Recommendations

- In SA, a further studies are need that related nutrition with autism, and therefore it can find solutions and strategies that may contribute to improve the nutritional status of autistic children in SA. In addition, further studies are need to know the factors that influence and control the autistic children choices of foods and made them selective eaters; is it family behavior or getting older or other reasons.

- It recommended conducting future studies in SA, in line with literature reviews that compare children with autism and typical development children in Food Selectivity and nutritional adequacy.
- Make nutritional interventions are recommended, such as nutritional plans and strategies to be developed to improve the adequacy of fiber and 9 micronutrients for autistic child before school age.
- Because autistic children are natural followers of routines, thus their routines cannot remove, but establish new routines that may improve their food habits and their lifestyles can be done. Such as introducing new foods, addressing or changing their choices of food, or use our results of refusing food groups on nutritional intervention by increasing or decreasing their intake of these food groups.
- Strongly recommended to making nutritional educational programs for autistic children' mothers in collaboration with autistic centers presented in SA, to provide nutrition advices for these mothers so they can deal with their children nutritionally.

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LIST OF SYMBOLS AND TERMINOLOGY

AMDR	Acceptable Macronutrient Distribution Ranges
AI	Adequate Intake
BMI	Body Mass Index
DRI	Dietary Reference Intakes
FFQ	Food Frequency Questionnaire
FR	Food Refusal
HFSFI	High Frequency Single Food Intake
LFR	Limited Food Repertoire
RDA	Recommended Dietary Allowance
SA	Saudi Arabia