Medical Science

pISSN 2321–7359; eISSN 2321–7367

Nutritional status among children with autism spectrum disorders in Saudi Arabia

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To Cite:
Alahmari S, Alatawi R, Albalawi R, Albalawi R, Alamri E. Nutritional status among children with autism spectrum disorders in Saudi Arabia. Medical Science, 2022, 26, ms40e1960.
doi: https://doi.org/10.54905/disssi/v26i119/ms40e1960

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Peer-Review History
Received: 29 November 2021
Reviewed & Revised: 01/December/2021 to 16/January/2022
Accepted: 17 January 2022
Published: 24 January 2022

Peer-review Method
External peer-review was done through double-blind method.

URL: https://www.discoveryjournals.org/medicalscience

ABSTRACT

Objective: To compare the nutritional status of Saudi children with autism spectrum disorders (ASD) to Saudi children without ASD. *Methods:* The research was a case control study for children aged between 7 and 12 years. In total, 155 children enrolled (70 children with ASD and 85 children without ASD). Dietary consumption was assessed using a 3-day food record. *Results:* The daily average of energy from carbohydrates was significantly higher among children with ASD than children without ASD. A lower intake of folic acid, vitamin B12, calcium, iron, magnesium, sodium, and selenium was detected among children with ASD, while vitamin B6, vitamin C, and potassium were significantly higher among children with ASD compared to children without ASD. *Conclusion:* Nutrient deficiencies were more present among children with ASD than children without ASD. Thus, nutritional intervention is essential for children with ASD to avoid future complications.

Keywords: nutrient intake, vitamin intake, children with ASD, children without ASD

1. INTRODUCTION

Autism spectrum disorder (ASD) is suffer from“persistent deficits in social interactions andsocial communication across multiple contexts” and “repetitive, restricted patterns ofinterests, behavioror activities” (American Psychiatric Association, 2013). It is estimated that worldwide about one in 160 children has ASD (WHO, 2021). The incidence of ASD has been increased during the last decade (Skalny et al., 2016). This increase could be attributed to several factors, including advances in diagnostic techniques, changes in diagnostic criteriaof ASD (Siddiqi, 2019). However, diet also plays a crucial role in the incidence of ASD (Zhong et al., 2020).

Multiple randomized control trials revealed that people with ASD showed amelioration of some symptoms following dietary intervention (Piwowarczyk et al., 2020; Abraham et al., 2020). However, the amount of nutrients consumed by children with ASD showed conflicting results (Esteban-figuerola, 2019; Barnhill, 2018). The majority of studies demonstrated that the dietary intake of children with ASD is lower than recommended, which could increase the risk of vitamin and mineral deficiency (Sharp et al., 2018; Bandini

et al 2019; Yanagimoto, 2020; GUO, 2019). Food selectivity is considered one of the greatest food difficulties with children with ASD. It is characterized by eating a limited food repertoire, food refusal, and the frequent intake of a single food (Sharp et al., 2013; Marí-Bauset, 2014). Food selectivity could cause nutritional inadequacy due to limited diet (Marí-Bauset, 2014).

Recently, it has been suggested that there a correlation between gut microbiome, diet, and ASD (Li et al., 2019). Introducing nutritional therapy is essential, as well as routine treatment. This is because sufficient nutrition could reduce the symptoms of ASD including metabolic, psychological, and digestive (Ristori et al., 2019; Kawicka et al., 2013). However, it is rare for physicians and nutritionists to monitor the diet ofchildren with ASD. Approximately 25% of autistic children have at least one chronic gastrointestinal tract symptom (Emond et al., 2010; Kushak et al., 2016), which has an impact on the absorption of vitamins and minerals (Stewart et al., 2008). A good quality diet can relieve chronic gastrointestinal symptoms, including gastrointestinal reflux, constipation, abdominal pain, and diarrhea (Kral et al., 2013). However, previous studies showed that children with ASD consumed an insufficient amount of some nutrients and lower than children without ASD (Munira et al., 2020; Canals-sans et al., 2021; Munira et al., 2021). Other studies did not find any deficiency in children with ASD compared to those without (Evans et al., 2012; Herndon et al., 2009), while others found contradictory results (Siddiqi et al., 2019; Ferguson, 2019). Therefore, the current study aims to compare the nutrients and vitamins consumed by children with ASD compared to children without ASD in Saudi Arabia.

2. MATERIALS AND METHODS

The present study is a case-control study conducted among 155 children (70 children with ASD and 85 without). The recruitment was conducted between November 2020 and March 2021 among children aged 7 to12 years' old attending autism centers and one elementary school. Children with ASD met the criteria for ASD according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (APA, 2000). Participation in this study was voluntary and no one received remuneration for participation. The parents or guardian of the children signed the consent form to participate in the study. Children who were following a special diet such as gluten and casein free were excluded from the study, as were children with food allergies and those who had autism associated with genetic syndromes.

Anthropometric Measures

A trained assistant took anthropometric measurements. Participants' body mass index (BMI) (kg/m2) was obtained based on the international World Health Organization Child Growth Standards for children/teenagers 5–19 years of age (WHO, 2000).

Dietary intake

Each child's dietary intake was assessed by using a 3-day food record. It is a valid and reliable method to assess the dietary intake of Children with ASD (Crawford et al., 1994; Holdeman et al., 2010). Food intake was analyzed using ESHA software. Some of the Saudi dishes were not included in the ESHA database. The nutrient contents of these foods were added to the database from the food composition tables of Saudi food.

Data analysis

SPSS softwarewas used to analyze the data. All data were presented as mean and standard deviation. Chi-square was used to compare the differences between children with ASD and children without ASD. Significant differences were defined as $p < 0.05$.

3. RESULTS

Table 1 presents the demographic information related to both children with and without ASD. The average exercise time per day waslower in children with ASD compared to children without, while screen time, paternal age and maternal age were higher among children with ASD. The percentage of overweight and obese children with ASD was higher thanchildren without ASD. The mean intake of total energy and percentage of energy obtained from carbohydrates each day was significantly higher among children with ASD than children without ASD (Table 2). Energy derived from fat and proteins were significantly higher among children without ASD.

Table 1 Demographic data of both groups of Children.

Variables	Children with ASD	Children without ASD
Age (year)	8.5±	8.0±
Exercise (minutes/day)	0.55 ±	90±
Screen time (hours/day)	5.40±	3.10±

Overweight/obese	45%	23%
Consanguinity	30	9
Paternal Age	40 ±6.4	34±5.3
Maternal Age	36±5.3	31±4.2

Table 2 Average intake per day of energy, carbohydrates, fat, and protein of both groups of Children.

Variables	Children with ASD	Children without ASD	p values
Energy (Kilocalories/day)	1522 ±269*	1311±132	0.01*
Carbohydrates (% energy)	65*	58	0.01*
Fat (% energy)	24	28*	0.03*
Protein (% energy)	11	14*	0.02*

Vitamin intakes of both groups of children are presented in Figure 1. Children with ASD showed a significantly lower intake of folic acid and vitamin B12, while, vitamin B6 and vitamin C were significantly higher among children with ASD. Other vitamins A, B1, and B2 did not significantly differ between children with and without ASD.

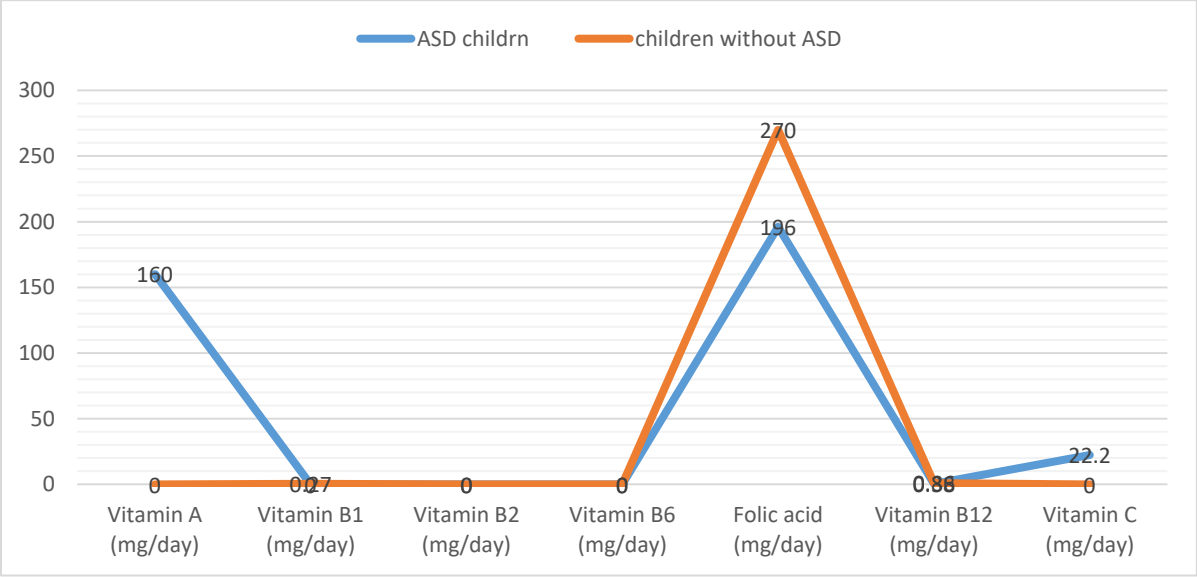

Figure 1 Average intake of vitamins per day for Children with ASD and Children without ASD.

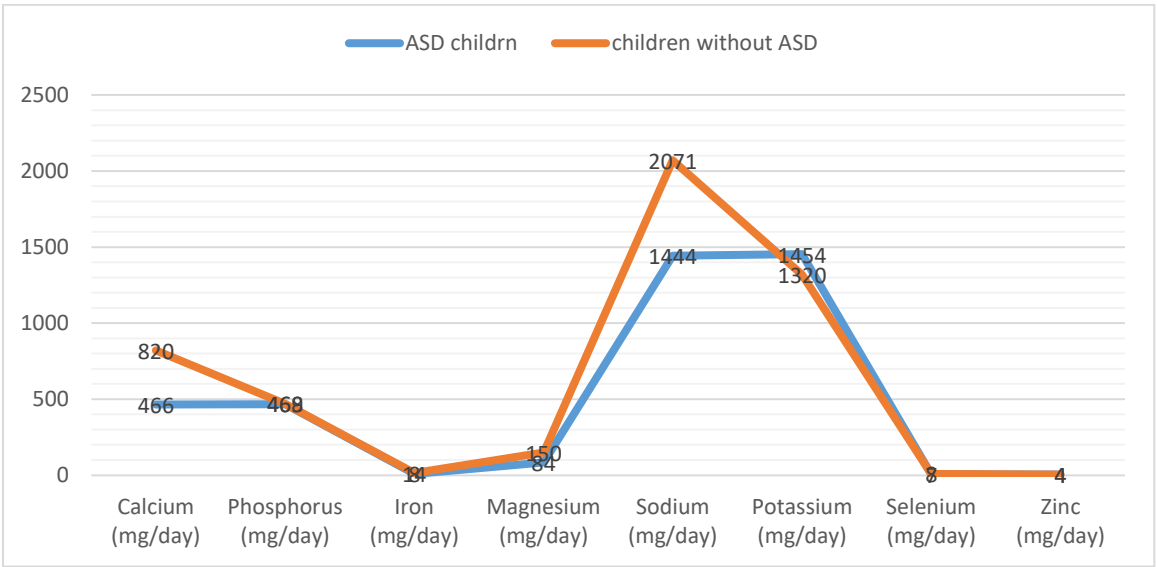

Figure 2 average intakes of minerals per day for Children with ASD and children without ASD.

The amount of mineral intake is depicted in Figure 2. The daily consumption of calcium, iron, magnesium, sodium, and selenium were significantly lower in children with ASD compared to children without ASD. However, the potassium intake was higher in children with ASD.

4. DISCUSSION

The present study aimed to compare the nutrients consumed by children with ASD with the nutrient consumption of children without ASD in Saudi Arabia. The mean intake of total energy and percentage of energy obtained from carbohydrates per day was significantly higher among children with ASD than children without ASD. Children with ASD showed a lower amount of vitamin B12, calcium, iron, magnesium, sodium, and selenium; while, vitamin B6 ,vitamin C, and potassium were significantly higher among children with ASD. These results are in accordance with a previous study which showed that children with ASD consumed less calcium, selenium, vitamin B12 and folic acid (Esteban-figuerola et al., 2019). Children with ASD had a higher consumption of vitamin B6 in the current study, which aligns with a previous study (Marí-Bauset et al., 2017). In terms of vitamin A, no significant difference was found in the present study between children with and without ASD, which is different from another study that showed lower intake among children with ASD (Alkhalidy et al., 2021). Our results are also in contrast to a previous research that showed vitamin B6 was lower among children with ASD in Spain and the USA (Barnhill, 2018; Belardo et al., 2017). Several studies demonstrated that a lower consumption of folic acid among autistic children (Barnhill et al., 2018; Meguid et al., 2017). These results are in line with our study.

In this study, inadequate mineral intake was found for children with ASD, including magnesium, phosphorus, and selenium. A study in Jordan had similar results. However, another study in Egypt found no significant difference between both groups in terms of zinc and phosphorus consumption; yet, selenium and magnesium consumption was lower among autisticchildren (Meguid et al., 2017). Conversely, children with ASD in Spain had higher magnesium and zinc consumption compared to children without ASD (Marí-Bauset et al., 2017). In the USA, autistic children consumed more selenium and a lower consumption of zinc (Barnhill et al., 2018). One other study stated that selenium and phosphorus were comparable between both groups of children (Neumeyer et al., 2018). Prior studies reported a lower consumption of iron and calcium among children with ASD (Barnhill et al., 2018). Similar results were reported by Alkhalidy et al., (2021). In Spain, children with ASD also exhibited a higher intake of iron than children without ASD (Marí-Bauset et al., 2017).

Previously, other studies showed that autistic children consumed lower energy and all macronutrients in comparison to children without ASD (Neumeyer et al., 2018; Liu et al., 2016). In contrast to our study, a case-control study found that carbohydrate intake among children with ASD was lower than children without ASD (Alkhalidy et al., 2021). Similar results were reported among children in Spain (Marí-Bauset et al., 2017).

Children with ASD in Egypt did not meet the recommendation of protein in comparison to children without ASD (Meguid et al., 2017), which is similar to the present study. In contrast, fat intake in children with ASD in Jordan was higher than children without ASD (Alkhalidy et al., 2021). Autistic children had excessive fat consumption compared to healthy children (Marí-Bauset et al., 2017), which is different from the present study. These differences might be attributed to specific eating habits in autistic children (Guo et al., 2019).

5. CONCLUSION

The mean intake of total energy and percentage of energy obtained from carbohydrates per day was significantly higher in autistic children than children without ASD. Children with ASD showed a significantly lower intake of folic acid, vitamin B12, calcium, iron, magnesium, sodium, and selenium, while, vitamin B6, vitamin C, and potassium were significantly higher in autistic children. Future research is needed to identify the roleof other factors, such as gender differences in terms of nutrition and ASD.

Acknowledgement

We thank the participants who contributed samples to the study.

Funding

This study was funded by the Deanship of Scientific Research, University of Tabuk (grant number: 0107-1441-S).

Author Contributions

All authors contributed to the design, implementation of the study, analysis of the data, and writing of the manuscript.

Ethical approval

The present study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee at the University of Tabuk (ethical approval code: 82-08-2019).

Conflict of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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