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Original Article

Nutritional Status and Gastrointestinal Issues in School-Aged Children with Autism Spectrum Disorder

Perfil nutricional y alteraciones gastrointestinales en escolares con transtorno del espectro autista

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ABSTRACT

The relationship between gastrointestinal alterations and the characteristics of children with autism spectrum disorders highlights the importance of a nutritional approach in their multidisciplinary care. The objective of this research was to determine the relationship between nutritional profiles and gastrointestinal alterations. This descriptive, correlational, and cross- sectional study evaluated 55 school-aged children with autism. The nutritional profile was determined using the anthropometric indicator body mass index for age (BMI/age). The dietary assessment included a record of macronutrient, gluten, and casein intake. The clinical evaluation included signs of gastrointestinal alterations and malnutrition. Anthropometric results showed that 63.6% of the children were within the normal range, 1.8 % were underweight, and 34.5 % were overweight. The most frequent gastrointestinal alterations were foul-smelling flatulence, constipation, abdominal pain, and distension. No relationship was found between gastrointestinal alterations and anthropometric diagnosis or macronutrient intake. However, a statistically significant positive relationship ($p<0.01$) was found between gastrointestinal alterations and clinical signs of nutritional deficiencies, gluten consumption, and the degree of autism. Additionally, a positive trend was observed between gastrointestinal alterations and casein consumption. In conclusion, the consumption of gluten- and casein-containing foods directly affects gastrointestinal alterations and, in turn, the severity of autism in children. These findings underscore the need for early nutritional intervention as an effective strategy to improve symptoms associated with autism.

Keywords: Gluten, casein, gastrointestinal issues, autism, ASD.

RESUMEN

La relación entre las alteraciones gastrointestinales y las características de los niños con trastornos del espectro autista resalta la importancia del abordaje nutricional en su atención multidisciplinaria. El objetivo de esta investigación fue determinar la relación entre el perfil nutricional y las alteraciones gastrointestinales. Este estudio descriptivo, correlacional y transversal evaluó a 55 niños escolares con autismo. El perfil nutricional se determinó a través del indicador antropométrico índice de masa corporal para la edad (IMC/edad), la evaluación dietética incluyo un registro de consumo de macronutrientes, gluten y caseína. La evaluación clínica incluyó los signos de alteraciones gastrointestinales y desnutrición, El 63,6 % de los niños se encontraron antropométricamente normales, 1,8 % en déficit y 34,5 % en exceso, las alteraciones gastrointestinales más frecuente fueron flatulencias fétidas, estreñimiento, dolor y distensión abdominal. No hubo relación entre las alteraciones gastrointestinales y el diagnostico antropométrico ni el consumo de macronutrientes, sin embargo, se halló una relación positiva estadísticamente significativa ($p<0,01$) entre las alteraciones gastrointestinales y los signos clínicos de deficiencia nutricional, consumo de gluten y grado de autismo, además se encontró una tendencia positiva entre las alteraciones gastrointestinales y el consumo de caseína. En conclusión, el consumo de alimentos con gluten y caseína tienen un efecto directo en las alteraciones gastrointestinales y a su vez en el grado de severidad de los niños con autismo. Estos hallazgos subrayan la necesidad de una intervención nutricional temprana como estrategia eficaz para mejorar los síntomas asociados al autismo.

Palabras Clave: Gluten, caseína, manifestaciones gastrointestinales, autismo.

INTRODUCTION

Autism spectrum disorder (ASD), also referred to as pervasive developmental disorders, comprises a group of conditions associated with neurodevelopment and feeding, with predominantly cognitive and behavioral manifestations that cause significant limitations in the autonomy of affected children (Ojeda *et al*., 2013). These disorders typically appear in early childhood and tend to persist into adulthood, although in most cases they manifest within the first five years of life. They are also commonly characterized by comorbid conditions such as epilepsy, depression, anxiety, and attention deficit hyperactivity disorder (ADHD) (WHO, 2023).

According to the World Health Organization (WHO), one in every 100 children is diagnosed with ASD. These figures represent an increase in the prevalence of this condition (WHO, 2023). Research has shown that the prevalence of ASD is alarming in many low-income countries. In this regard, in Latin America there are no studies that allow for an accurate understanding of the current situation of children with ASD; it is estimated that one in every 100 people presents some type of autism spectrum disorder. Likewise, in 2008 in Venezuela, the prevalence of individuals with ASD was 17 per 10,000 children aged 3 to 9 years (Montiel *et al*., 2023).

The role of nutrition in children with ASD is a determining factor in their recovery, as an inadequate diet can cause chronic inflammation of the gastrointesti-

nal tract, from the esophagus to the colon, compromising the integrity of the intestinal wall, which plays an important role in adequate nutrient absorption. In most cases, these children suffer from indigestion and present significant gastrointestinal alterations as a result of consuming foods containing certain proteins whose structure, or parts thereof, are not fully digested and exhibit opioid properties, thereby affecting the nutritional status of these children (Higuera *et al*., 2010).

This situation arises because children on the autism spectrum have a greater tendency to present metabolic errors due to enzymatic deficiencies that prevent proper protein breakdown and/or increased permeability of natural barriers. As a result, these external morphines (exorphins) cross the blood–brain barrier, affecting brain regions related to language development, communication, social relationships, and sensory alterations. These changes disrupt all processes involved in cognition and communication, in addition to causing an inadequate immune response, multiple food allergies, and micronutrient deficiencies (Higuera *et al*., 2010; Audisio *et al*., 2013; Carmenate *et al*., 2023).

There is clear evidence of a relationship between nutritional profile and good health status in children with ASD. Research has shown that this situation worsens during the preschool, school-age, and adolescent stages, as these periods involve higher nutrient demands that support adequate physical, mental, and social health (Rodríguez, 2010).

For this reason, timely nutritional intervention is an effective approach to improving the characteristic symptoms of this disorder, yielding positive results such as reduced hyperactivity and gastrointestinal problems, as well as improvements in language, attention, development, learning, eye contact, cognitive functioning, communication skills, and, consequently, social interaction (Audisio *et al*., 2013).

Scientific evidence has demonstrated that nutritional factors play an important role in autism. Several studies specifically addressing treatment approaches (Audisio *et al*., 2013; Carmenate *et al*., 2023) indicate that nutritional intervention can be an alternative to medical treatments due to its demonstrated benefits on cognitive and behavioral development. Thus, it may be considered a potential solution in the future, without disregarding psychoeducational and language therapies to improve various aspects of social and academic development (Higuera *et al*., 2010).

In this context, malnutrition (resulting from inadequate diet and lifestyle, whether due to excess or deficiency) further aggravates the condition. This is due to multiple factors, including food selectivity, lower physical activity, and medication use, which may lead to abnormal anthropometric measurements (Egan *et al*., 2013).

Therefore, nutritional management is critically important within the multidisciplinary care of children with autism. Consequently, the objective of this study was to determine the relationship between nutritional profile and gastrointestinal alterations in children within the autism spectrum, with the aim of improving signs and symptoms and enhancing quality of life in this age group.

MATERIALS AND METHODS

A descriptive, field-based, correlational, cross-sectional study was conducted (Hernández *et al*., 2014) in a group of children with autism attending the Comprehen-

sive Care Centers for People with Autism (CAIPA and Albatros), located in the city of Maracaibo, Zulia State, Venezuela. Inclusion criteria were boys and girls diagnosed with ASD, attending one of the aforementioned centers, residing in Zulia State, aged 6 to 12 years, and enrolled in school. Children who did not meet these criteria were excluded.

Population and Sample

The sample consisted of all children who attended their appointment with their legal guardians for nutritional evaluation: 55 children aged 6–12 years of both sexes. Given the characteristics of the study population, non-probabilistic (intentional) sampling was used (Hernández *et al*., 2014). Epidemiological data collected included age, sex, anthropometric assessment, and dietary evaluation, provided by the legal guardians. Written informed consent was obtained from all parents or guardians. All procedures complied with the ethical standards of the Declaration of Helsinki and CIOMS.

Measurement Instruments and Techniques

The diagnosis of ASD must be made by a specialized psychologist; therefore, all children evaluated in this study had been previously diagnosed. The nutritional profile of school-aged children with ASD was determined using the following indicators:

Anthropometric Assessment

Weight and height were measured, and the body mass index-for-age (BMI-for-age) indicator was calculated and compared with WHO reference standards. Excess weight was defined as > +1 SD (standard deviation), normal as between +1 SD and −2 SD, and deficit as < −2 SD (de Onis *et al*., 2007).

Clinical–Gastrointestinal Assessment

Clinical-nutritional and gastroenterological evaluations were conducted by a nutritionist and a pediatric gastroenterologist. A physical-clinical examination was performed to identify gastrointestinal alterations, including diarrhea, constipation, vomiting, stools with undigested food, mucus and/or blood, foul-smelling flatulence, and abdominal pain, to determine the presence of gastrointestinal disorders in school-aged children with ASD.

Additionally, signs of nutritional deficiencies were assessed, such as glossitis, papillary atrophy, lingual hypersensitivity, gingival edema and bleeding, xerosis, cheilosis, dermatitis, hyperkeratosis, depigmentation, and hair loss, along with personal and family medical history.

Dietary Assessment

A 24-hour dietary recall was used to assess macronutrient intake. Parents were interviewed about the foods they typically consume during a day. The 24-hour dietary recall instrument consisted of the times at which meals were consumed, the foods eaten, and the quantities of each item Data were recorded and analyzed using the Venezuelan Food Composition Table (National Institute of Nutrition, 2001). Macronutrient adequacy was calculated based on national dietary reference values (National Institute of Nutrition, 2000) using the formula:

% Adequacy = (Daily intake × 100) / Daily recommendation

Adequacy was classified as deficient (<90%), normal (90–110%), or excessive (>110%) (Borno, 2005). After administering the 24-hour dietary recall, a food

frequency questionnaire was also administered to determine dietary patterns.

Data Analysis

Results were analyzed using descriptive statistics, reporting means ± standard error and ranges. Data distribution was assessed using the Shapiro–Wilk test, and the Mann–Whitney U test was applied for nonparametric distributions. Pearson's correlation was used to assess associations between nutritional profile and gastrointestinal alterations. Statistical significance was set at $p < 0.05$, with analyses performed using SPSS version 20.0.

RESULTS AND DISCUSSION

Increasing evidence highlights the impact of gastrointestinal alterations on the characteristics commonly observed in children with ASD. These alterations are associated with a high frequency of intestinal symptoms due to lesions in both the small and large intestine, as demonstrated by endoscopic findings and alterations in the human microbiome. Scientific evidence supports nutritional intervention as an alternative to medical treatments due to its beneficial effects on cognitive and behavioral development. Accordingly, dietary, clinical, and anthropometric indicators were evaluated to relate gastrointestinal alterations to the nutritional profile of school-aged children with ASD (Higuera, 2010; Audisio *et al*., 2013; Carmenate *et al*., 2023; Rodríguez, 2010; González *et al*., 2006; Luna *et al*., 2016; Lovene *et al*., 2017).

Table 1 shows the demographic characteristics of the children, with a mean age of 8.20 ± 2.48 years, weight of 27.96 ± 14.34 kg, height of 127.28 ± 20.92 cm, arm circumference of 17.48 ± 3.62 cm, hip circumference of 66.96 ± 11.39 cm, waist circumference of 59.36 ± 8.76 cm, and BMI of 16.98 ± 2.94 kg/m². No significant differences were observed between sexes ($p > 0.05$).

Table 1.
Demographic and Anthropometric Characteristics of School-Aged Children with ASD

	Total n= 55	**Female n= 13**	**Male n= 42**	**p**
Age (years)	8.20 ± 2.48	7.76 ± 2.04	8.54 ± 2.52	0.336
Weight (Kg)	27.96 ± 14.34	26.16 ± 9.68	30.06 ± 12.58	0.321
Height (cm)	127.28 ± 20.92	122.69 ± 15.51	127.43 ± 27.48	0.250
MUAC (cm)	17.48 ± 3.62	17.50 ± 3.46	17.92 ± 3.85	0.647
Hip circumference (cm)	66.96 ± 11.39	64.15 ± 7.52	67.54 ± 10.91	0.361
Waist circumference (cm)	59.36 ± 8.76	57.00 ± 6.89	59.66 ± 7.95	0.284
BMI (kg/mt^2)	16.98 ± 2.94	16.80 ± 2.51	17.04 ± 3.08	0.921

SD = Standard deviation. MUAC = Mid-upper arm circumference. BMI = Body mass index. Mann–Whitney U test; *significant difference at $p \leq 0.05$.

Table 2 presents anthropometric nutritional diagnoses: 1.8% undernutrition, 63.6% normal, and 34.5% overweight. When classified by gender, a higher incidence of malnutrition, both due to excess and deficiency, was found in males compared with females. The classification of ASD according to severity among school-aged children is presented, showing that 54.5% (n = 30) were classified as having mild autism, 32.7% (n = 18) as moderate autism, and 12.7% (n = 7) as severe autism, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2014).

These results are consistent with those reported in a study conducted in Nuevo León, Mexico, involving children aged 3 to 12 years with ASD, where 54% of the children had a normal anthropometric diagnosis, 27% were obese, 15% were overweight, and 4% were undernourished (Hernández *et al*., 2017). Similar findings were observed in a study carried out in Paraguay, in which 10% of the children were classified as undernourished or at risk of undernutrition, 60% had a normal nutritional status, and 30% were overweight or obese (Ojeda *et al*., 2013).

The frequency of clinical signs of nutritional deficiencies, as well as gastrointestinal alterations, is shown in Table 3. It can be observed that 45.5% (n = 25) of school-aged children with ASD presented irritability, 40% (n = 22) presented pallor, with statistically significant differences between sexes, 34.5% (n = 19) presented apathy, and 36.4% (n = 20) presented dry hair. In addition, 23.6% (n = 13) presented xerosis, 23.6% (n = 13) ascites, 14.5% (n = 8) hair depigmentation, 12.7% (n = 7) spongy gums, 10.9% (n = 6) bleeding gums, 10.9% (n = 6) stomatitis, 10.9% (n = 6) hair loss, 3.6% (n = 2) dermatitis, and 3.6% (n = 2) cheilosis, with no statistically significant differences between sexes (p > 0.05).

Table 2.
Anthropometric Nutritional Diagnoses and Classification of ASD According to Severity Among School-Aged Children

Anthropometric diagnosis (BMI/Age)	Total		Female		Male	
	n	%	n	%	n	%
Undernutrition	1	1.8	0	0.0	1	2.4
Normal Nutritional Status	35	63.6	10	76.9	25	59.5
Overweight	19	34.5	3	23.1	16	38.1
ASD Classification						
Mild	30	54.5	7	53.8	23	54.5
Moderate	18	32.7	5	38.5	13	32.7
Severe	7	12.7	1	7.7	6	12.7

Values are expressed as frequency (n) and percentage (%).

Table 3.
Clinical Assessment and Gastrointestinal Alterations

Clinical assessment	Total		Female		Male		p
	n	%	n	%	n	%	
Apathy	19	34.5	4	30.8	15	35.7	0.743
Irritability	25	45.5	6	46.2	19	45.2	0.954
Stomatitis	6	10.9	2	15.4	4	9.5	0.554
Cheilosis	2	3.6	0	0.0	2	4.8	0.423
Dermatitis	2	3.6	0	0.0	2	4.8	0.423
Pallor	22	40.0	9	69.2	13	31.0	0.014*
Xerosis	13	23.6	1	7.7	12	28.6	0.122
Spongy gums	7	12.7	3	23.1	4	9.5	0.200
Bleeding gums	6	10.9	2	15.4	4	9.5	0.554
Hair depigmentation	8	14.5	2	15.4	6	14.3	0.922
Hair dryness	20	36.4	6	46.2	14	33.3	0.401
Hair loss	6	10.9	1	7.7	5	11.9	0.670
Ascitis	13	23.6	2	15.4	11	26.2	0.423
Gastrointestinal alterations							
Diarrhea	22	40.0	7	53.8	15	35.7	0.244
Stools with undigested food	21	38.2	5	38.5	16	38.1	0.981
Mucus in stools	12	21.8	5	38.5	7	16.7	0.096
Gas	26	47.3	4	30.8	22	52.4	0.173
Foul-smelling flatulence	39	70.9	9	69.2	30	71.4	0.879
Gas (belching)	20	36.4	7	53.8	13	31.0	0.134
Gastric ulcer	7	12.7	2	15.4	5	11.9	0.742
Intestinal dysbiosis	11	20.0	3	23.1	8	19.0	0.751
Gastroesophageal reflux (GERD)	9	16.4	0	0.0	9	21.4	0.068
Fungal infection	8	14.4	2	15.4	6	14.3	0.922
Constipation	32	58.2	9	69.2	23	54.8	0.355
Vomiting	10	10.2	2	15.4	8	19.0	0.765
Abdominal pain	30	54.5	8	61.5	22	52.4	0.562
Abdominal distension	31	56.4	6	16.2	25	59.5	0.396
Infection	18	32.7	5	38.5	13	31.0	0.614

*Values are expressed as frequency (n) and percentage (%). Pearson's chi-square test; statistically significant difference at $p \leq 0.05$.

Nutrient deficiencies have been proposed as a causal factor in the manifestation of autism spectrum disorder (Adams *et al*., 2011). In this regard, a study conducted by Adams *et al*. evaluated metabolic and nutritional deficiency indicators in children aged 5 to 16 years and concluded that there are statistically significant differences in nutritional and metabolic characteristics between neurotypical children and those with ASD, serving as biomarkers indicative of vitamin insufficiency and increased oxidative stress. This leads to reduced capacity for absorption, energy transport, sulfation, and detoxification. Likewise, several biomarker groups were significantly associated with autism severity, which may be related to the presence of gastrointestinal alterations.

Regarding gastrointestinal alterations, it was observed that 40% (n = 22) of the children presented some degree of diarrhea, 38.2% (n = 21) stools with poorly digested food, 21.8% (n = 12) stools with mucus, 47.3% (n = 26) gas, 70.9% (n = 39) foul-smelling flatulence, 36.4% (n = 20) gas (belching), 12.7% (n = 7) gastric ulcer, and 20% (n = 11) intestinal dysbiosis.

Additionally, gastroesophageal reflux disease (GERD) was reported in 16.4% (n = 9), fungal infection in 14.4% (n = 8), constipation in 58.2% (n = 32), vomiting in 10.2% (n = 10), abdominal pain in 54.5% (n = 30), abdominal distension in 56.4% (n = 31), and parasitic infection in 32.7% (n = 18), with no statistically significant differences between sexes ($p > 0.05$). These results are consistent with those reported in a study conducted in 51 children with autism aged 3 to 15 years, which found that 63% of children with autism had moderate to severe chronic diarrhea and/or constipation, demonstrating that gastrointestinal symptoms are common in autism (Adams *et al*., 2011).

These findings play a fundamental role, as these gastrointestinal alterations allow the absorption of potentially harmful toxins, bacteria, allergens, and food-derived peptides, due to alterations in the intestinal microbiota known as dysbiosis (Luna *et al*., 2016; Lovene *et al*., 2017). This condition is characterized by abnormal growth of Gram-negative aerobic bacteria, Helicobacter pylori, flagellates such as Giardia lamblia, overgrowth of fungi and yeasts of the genus Candida (Audisio *et al*., 2013; Rodríguez, 2010; Lovene *et al*., 2017; CANIA, 2009), anaerobic bacteria such as Clostridium difficile, and pro-inflammatory bacteria such as Sutterella sp., leading to increased levels of intestinal inflammation markers such as calprotectin, lactoferrin, eosinophil-derived enterotoxin, and Anti-ASCA antibodies (Montiel *et al*., 2017).

These alterations are also associated with a deficiency in one or more disaccharidase enzymes (Williams *et al*., 2011; Kushak *et al*., 2017), especially lactase and maltase, which prevents the adequate breakdown of carbohydrates and/or leads to increased permeability of natural barriers due to altered zonulin levels (Esnafoglu, 2017). When this occurs, the passage of substances into the systemic circulation can produce the behavioral abnormalities described in autism, such as impairments in language development, communication, social relationships, and sensory processing, which affect the functioning of all processes involved in cognition and communication, in addition to an inadequate immune response and multiple food allergies (Higuera, 2010; Carmenate *et al*., 2023; Knivsberg *et al*., 2001; Johnson *et al*., 2007; Adams *et al*., 2018).

When considering the energy and nutrient recommendations for the Venezuelan population, the average usual energy intake of children with ASD was found to be normal, at 118.85% (2,152 ± 567.80 kcal/day), with no statistically significant differences between sexes ($p < 0.051$). Likewise, the remaining macronutrients showed a similar pattern, with adequate intake of proteins, fats, and carbohydrates being the most prevalent dietary diagnosis among children with ASD, with no differences between sexes. Similar results were reported in a study conducted in Argentina, which found an average caloric intake of 2,051 kcal with a mean adequacy percentage of 104%. In addition, an average protein intake of 85.27 g was reported, highlighting that the entire sample consumed protein levels above the recommended requirement (Audisio *et al*., 2013). Similarly, no relationship was found between macronutrient intake and gastrointestinal alterations.

Based on the aforementioned results and given that several authors have associated the consumption of gluten and casein with the occurrence of gastrointestinal alterations, the intake of these components was evaluated in this group. It was reported that the children included these foods in their diet. Foods such as whole milk, soft white cheese, bread, pasta, cookies, and cakes exceeded 80% inclusion in the diet, which is similar to findings reported in Paraguay, where 94% of the children evaluated consumed cow's milk or its derivatives and 74% consumed foods containing gluten (Ojeda *et al*., 2013). Furthermore, when assessing gluten and casein intake, it was observed that the average consumption of these proteins was higher in boys than in girls, with statistically significant differences in the case of gluten consumption (Table 4).

Table 4.
Energy and Nutrient Intake and Percentage of Adequacy in Children with ASD

	Total	Female	Male	p
Calorie intake (kcal)	2152 ± 567.80	1880 ± 515.10	2236 ± 562.35	0.051
Calorie adequacy (%)	118.85 ± 31.80	113.28 ± 28.74	120.57 ± 32.82	0.782
Protein intake (g)	78.26 ± 22.01	72.01 ± 19.11	80.21 ± 22.70	0.255
Protein adequacy (%)	116.19 ± 36.31	118.73 ± 43.54	115.40 ± 34.33	0.968
Fat intake (g)	64.07± 34.88	55.36 ± 39.36	66.76 ± 33.42	0.201
Fat adequacy (%)	103.95 ± 51.66	96.90 ± 62.52	106.13 ± 48.48	0.342
CHO intake (g)	330.07 ± 100.06	284.80 ± 80.02	344.09 ± 102.29	0.067
CHO adequacy (%)	133.30 ± 44.40	125.38 ± 38.36	135.75 ± 46.26	0.513
Gluten intake (g)	16.12 ± 15.42	8.61 ± 11.24	18.44 ± 15.91	0.044*
Casein intake (g)	18.78 ± 12.43	13.98 ± 13.03	20.27 ± 12.00	0.111

CHO = carbohydrates. Mann–Whitney U test; *statistically significant difference at $p \leq 0.05$.

The relationship between nutritional profile and gastrointestinal alterations (GIA) in children with ASD is shown in Table 5. To evaluate the nutritional profile, each indicator was analyzed separately. From the anthropometric perspective, no relationship was found between anthropometric diagnosis and gastrointestinal alterations in children with ASD ($r = -0.103$, $p = 0.455$).

Following this line of reasoning, a statistically significant positive correlation was found between clinical nutritional signs and gastrointestinal alterations ($r = 0.636$, $p = 0.000$), indicating that greater gastrointestinal alterations are associated with a higher number of clinical signs of nutritional deficiency. However, when correlating dietary assessment with gastrointestinal alterations, no relationship was observed between average macronutrient intake and gastrointestinal alterations (calories $p = 0.354$, proteins $p = 0.186$, fats $p = 0.151$, CHO $p = 0.176$). Likewise, no relationship was observed between macronutrient adequacy and GIA (calories $p = 0.863$, proteins $p = 0.761$, fats $p = 0.176$, CHO $p = 0.456$).

Based on the above results and on scientific evidence regarding the influence of foods containing proteins such as gluten and casein on the occurrence of gastrointestinal alterations in children with ASD (Carmenate *et al*., 2023; Knivsberg *et al*., 2001; Johnson *et al*., 2007; Adams *et al*., 2018), gluten and casein intake were analyzed in relation to gastrointestinal alterations. Although the amounts of gluten and casein were not high, a statistically significant positive correlation was found between gluten intake and GIA ($r = 0.369$, $p = 0.006$), while casein intake showed a positive trend ($r = 0.225$, $p = 0.099$). This indicates that higher consumption of these proteins is associated with greater gastrointestinal alterations in this group, and that high intake is not necessary to observe gastrointestinal symptoms in individuals with ASD.

These findings are consistent with those reported by Adams *et al*. (2011), who found that gastrointestinal alterations are related to gluten and casein consumption and are strongly correlated with autism severity ($r = 0.59$, $p < 0.001$). This agrees with the results of the present study, which showed a statistically significant positive relationship between autism severity and gastrointestinal alterations ($r = 0.648$, $p = 0.000$). Multiple studies (Audisio *et al*., 2013; Adams *et al*., 2011; Adams *et al*., 2018) support the role of a gluten- and casein-free diet as a treatment to improve gastrointestinal alterations and ASD-related behaviors. For example, Hernández *et al*. (2017) concluded that nutritional intervention with a gluten- and casein-free diet (mainly excluding bread, yogurt, and milk) was associated with a reduction in gastrointestinal signs and symptoms related to intestinal permeability, improving nutrient absorption.

Similarly, a randomized controlled study evaluated the effect of a gluten- and casein-free diet on behavior in 20 children with ASD aged 4 to 11 years, of whom 10 followed the diet and 10 served as controls. The results showed a reduction in autism-related behaviors in the diet group (Adams *et al*., 2011). Likewise, a study conducted in Arizona in 2018 evaluated the effect of a gluten-, casein-, and soy-free diet and found a significant improvement in nonverbal intellectual ability in the treatment group compared with the untreated group. This suggests that comprehensive nutritional and dietary intervention is effec-

tive in improving nutritional status, IQ, autism symptoms, and other symptoms in most individuals with ASD. Additionally, the reappearance of ASD-related traits after discontinuation of the diet has been reported (Knivsberg *et al*., 2001; Adams *et al*., 2018).

Table 5.
Pearson Correlation Analysis Between Nutritional Profile and Gastrointestinal Alterations in Children with ASD

	Gastrointestinal Alterations	
	r	**p**
Anthropometric diagnosis	-0.103	0.455
Clinical signs	0.636	0.000*
Calories consumed	0.127	0.354
Proteins consumed	0.181	0.186
Fats consumed	0.196	0.151
CHO consumed	-0.014	0.176
Calorie adequacy	0.024	0.863
Protein adequacy	0.042	0.761
Fat adequacy	0.185	0.176
CHO adequacy	-0.103	0.456
Gluten intake	0.369	0.006*
Casein intake	0.225	0.099
ASD severity	0.648	0.000*

*Correlation is significant at $p \leq 0.01$. r = Pearson correlation coefficient.

CONCLUSIONS

This study shows that specific evaluation of the intake of certain foods, particularly those rich in gluten and casein, has a direct effect on gastrointestinal alterations in children with ASD. Due to underlying metabolic abnormalities, these alterations are associated with increased hyperactivity, behavioral changes, and impaired absorption of essential nutrients, leading to the appearance of clinical signs of nutritional deficiency. Therefore, early nutritional intervention represents an effective approach to improve the characteristic symptoms of this clinical condition, serving as a central component of biomedical treatments and evidence-based nutrition aimed at problem-solving–oriented nutritional care.

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