iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Assessment of Dietary Intake of Zinc and its Association with the Immune Status and Gut Health in Children Diagnosed with Autism Spectrum Disorder (ASD) aged 6-14 Years

Ms. Bushra Gandhi[1], Dr. Nisha Bellare[2]
Sir Vithaldas Thackersey College of Home Science (Autonomous), SNDT Women's University, Juhu, Mumbai

Abstract: Background: Autism Spectrum Disorder (ASD) is often accompanied by immune dysfunction, gastrointestinal disturbances, and selective eating behaviors, which can lead to micronutrient deficiencies, particularly zinc. Zinc is a vital trace element required for immune function, intestinal integrity, and neurodevelopment. Children with ASD are at a heightened risk for zinc deficiency due to restricted diets and poor dietary diversity.

Methods: A cross-sectional observational study was conducted among 30 children aged 6–14 years diagnosed with ASD at a special education institute in Mumbai, India. Data collection involved structured dietary and health assessment tools, including a 24-hour dietary recall, semi-quantitative Food Frequency Questionnaire (FFQ), Immune Status Questionnaire (ISQ), and Gastrointestinal Health Assessment Questionnaire. Dietary intake was analyzed against the ICMR-NIN (2020, updated 2024) Recommended Dietary Allowances (RDA). Statistical analysis was performed using SPSS (version 21).

Results: Zinc intake was found to be inadequate in 73.3% of participants and was significantly associated with lower intake of energy ($p = 0.001$), protein ($p = 0.001$), fats ($p = 0.004$), and carbohydrates ($p = 0.044$). Children with lower zinc intake exhibited a higher prevalence of immune-related symptoms (e.g., recurrent upper respiratory tract infections and diarrhea) and gastrointestinal complaints, although these differences were not statistically significant. Among dietary components, only the consumption of dals (lentils) showed a statistically significant association with better zinc intake ($p = 0.05$). No significant differences in anthropometric parameters were observed between the poor and adequate zinc intake groups.

Conclusion: This study highlights a high prevalence of suboptimal zinc intake among children with ASD, likely driven by dietary selectivity and limited nutritional variety. Although statistical significance was not established for immune and gastrointestinal health outcomes, observed trends reinforce zinc's critical role in these functions. Early dietary interventions and targeted nutritional planning are essential to address zinc deficiency and support overall health in children with ASD.

Keywords: Autism Spectrum Disorder (ASD), Zinc deficiency, Dietary intake, Immune function, Gastrointestinal health, Food selectivity.

I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex, heterogeneous neurodevelopmental disorder characterized by persistent deficits in social communication and the presence of restricted and repetitive behaviors (B. Hodis et al., 2025). The incidence of ASD has steadily risen in the last two decades, prompting worries about its underlying causes, which encompass both genetic and environmental influences. The immunological, gastrointestinal, and neurological systems, all of which are routinely disturbed in people with ASD, need zinc for effective operation. Zinc supports cognitive function, gut health, and immune cell activity. Its deficiency, common in ASD, can lead to immune dysfunction, gut imbalance, and brain issues.

According to the DSM-5, Autism Spectrum Disorder (ASD) is diagnosed based on two main criteria:
(A) persistent deficits in social communication and interaction across settings, and
(B) restricted, repetitive behaviors or interests.
The diagnosis also includes specifiers such as:
(i) intellectual impairment,
(ii) language impairment,
(iii) associated medical, genetic, or environmental factors, and

(iv) co-occurring neurodevelopmental or mental disorders.

Over the past two decades, the prevalence of ASD has shown a consistent increase, raising concerns regarding its underlying causes, which include both genetic and environmental factors. According to studies, worldwide, the prevalence of autism spectrum disorder is estimated to be 1 in 100 children (Zeidan et al., 2022). The CDC reported higher ASD rates among children aged 4–10 years with mild autism. Zinc deficiency is significantly more common in individuals with ASD, with nearly 50% prevalence in the 0–3 age group, highlighting its early onset (G. Vela et al., 2015).

Zinc is a vital micronutrient that supports immune cell function (T-cells, B-cells, NK cells), antioxidant defenses, and intestinal barrier integrity, all of which are often compromised in individuals with Autism Spectrum Disorder (ASD) (Conti et al., 2023; Bezzera do Nascimento et al., 2023). Even mild zinc deficiency can impair immune response and increase susceptibility to infections, potentially worsening behavioral symptoms (Semenova et al., 2024). Zinc supplementation has been associated with reduced rates of diarrhea and respiratory infections. However, food selectivity characterized by repetitive food choices, refusal of certain textures or types of food, and limited diet diversity affects 22.9% to 69.1% of children with ASD, increasing the risk of micronutrient deficiencies (Conti et al., 2023). Additionally, zinc bioavailability is influenced by diet: plant-based sources offer only 20–50% bioavailability, while animal-based sources are more readily absorbed, making dietary diversity and quality essential (Wessels et al., 2021).

Gastrointestinal (GI) issues such as constipation, diarrhea, and reflux affect up to 84% of children with ASD and are strongly linked to zinc deficiency and poor gut health (Wasilewska et al., 2015). Restrictive eating behaviors can lead to gut dysbiosis and nutrient malabsorption, creating a feedback loop that worsens both GI symptoms and core ASD traits. Zinc deficiency may further impair the intestinal barrier and promote inflammation, contributing to dysfunction in the gut–brain axis (Carabotti et al., 2015; Sauer et al., 2021; Al-Beltagi et al., 2023). Studies also report that diets in ASD populations are often high in sugars, lipids, and saturated fats, with insufficient intake of key nutrients such as vitamins D and E (Arija et al., 2023). Moreover, the adoption of gluten-free/casein-free (GF/CF) diets to manage behavioral or digestive symptoms may inadvertently reduce zinc, calcium, and vitamin B12 intake, affecting overall nutritional status (Barnhill et al., 2018).

This study aims to assess the association of dietary intake of zinc with immune status and gut health in children diagnosed with ASD aged 6 - 14 years. It is essential for addressing the gaps in our understanding of the role of zinc in maintaining the health of children with ASD. By investigating the links between zinc intake, immune function and gastrointestinal health, the study could identify potential dietary interventions to improve the overall health and quality of life for children with ASD.

II. METHODOLOGY

A descriptive cross-sectional, observational study was conducted among 30 school going children with Autism Spectrum Disorder, aged 6 - 14 years. The participants were recruited using a randomized sampling method from Jai Vakeel Foundation & Research Centre, Mumbai, India. The inclusion criteria consisted of males and females diagnosed with ASD aged 6 - 14 years, residing in Mumbai. Children with other co-morbidities such as down syndrome, cerebral palsy and children on antiepileptic drugs were excluded from the study.

Ethical clearance was obtained from the Intersystem Biomedical Ethics Committee (ISBEC) prior to data collection, and written informed consent was secured from all participants to ensure voluntary participation and data confidentiality. Data were collected over six months using a structured offline questionnaire, including both self-developed and validated tools.

The tools administered included socio-demographic and lifestyle questionnaires, anthropometric measurements (height, weight, BMI, Mid-Upper Arm Circumference (MUAC), weight-for-age, height-for-age), a 24-hour dietary recall for nutrient intake, the semi-quantitative food frequency questionnaire (FFQ), the Immune Status Questionnaire (ISQ), and the Gastrointestinal Health Assessment Questionnaire. Dietary diversity was assessed based on the FFQ and 24-hour dietary recall. Nutrient adequacy was evaluated by comparing macronutrient & micronutrient intake against ICMR-NIN RDA 2020 (Updated 2024) standards.

Data analysis was performed using SPSS software (version 21). Data presented as Mean ± SD or frequency (percentage). Cross tabulations were computed for categorical data according to dietary intake of zinc and compared using the chi-square test. Age, anthropometry, and dietary data were compared between poor and good zinc intake using the Independent Sample t-test. ANOVA test was done to correlate the dietary intake of the study participants according to the age groups. $p < 0.05$ was considered to be statistically significant.

III. RESULTS

This section presents the key findings of the study, which compared participants based on their dietary zinc intake, categorized as poor or good. The analysis covers demographic characteristics, anthropometric data, dietary intake patterns, eating habits, immune status, and gastrointestinal health. Statistical methods were applied to identify significant differences between the poor and good zinc intake and to explore associations between zinc intake, immune responses, and gut health indicators. The results offer valuable insights into how dietary zinc adequacy influences nutritional status, health outcomes, and dietary behaviors among children with Autism Spectrum Disorder.

TABLE NO. 1 Demographic Characteristics of the Study Participants According to the Dietary Zinc Consumption

Variables	Total (N = 30) (N, %)	Poor Zinc Intake (n = 22) (n, %)	Good Zinc Intake (n = 8) (n, %)	p-value
Age				
(6 - 9 yrs)	22 (73.3)	14 (63.6)	8 (100)	0.472
(10 - 14 yrs)	8 (26.6)	8 (36.4)	0 (0)	
Gender				
Male	27 (90)	19 (86.4)	8 (100)	0.271
Female	3 (10)	3 (13.6)	0 (0)	
Suffering from any disease or health condition?				
Epilepsy	6 (20)	3 (13.6)	3 (37.5)	0.314
Hypothyroidism	1 (3.3)	1 (4.5)	0 (0)	
None	23 (76.7)	18 (81.8)	5 (62.5)	
Family Medical History				
Yes	7 (23.3)	4 (18.2)	3 (37.5)	0.269
No	23 (76.7)	18 (81.8)	5 (62.5)	
Dietary Preference				
Non-Vegetarian	25 (83.3)	18 (81.8)	1 (12.5)	0.664
Vegetarian	3 (10)	2 (9.1)	1 (12.5)	
Ovo-Vegetarian	2 (6.7)	2 (9.1)	0 (0)	
Intake of Supplements				

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Protein and Multivitamin Supplements	7 (23.3)	4 (18.2)	3 (37.5)	0.269
None	23 (76.7)	18 (81.8)	5 (62.5)	
Socio-Economic Status				
Craft & Related Trade Workers	2 (6.7)	2 (9.1)	0 (0)	0.561
Skilled Agricultural & Fishery Workers	1 (3.3)	1 (4.5)	0 (0)	
Skilled Workers & Shop & Market Sales Workers	6 (20)	3 (13.6)	3 (37.5)	
Technicians & Associate Professionals	8 (26.7)	6 (27.3)	2 (25)	
Professionals	10 (33.3)	7 (31.8)	3 (37.5)	
Legislator, Senior Officials & Managers	3 (10)	3 (13.6)	0 (0)	
Education of the Head of the Family				
Middle School Certificate	4 (13.3)	3 (13.6)	1 (12.5)	0.825
High School Certificate	5 (16.7)	4 (18.2)	1 (12.5)	
Intermediate/ Diploma	1 (3.3)	1 (4.5)	0 (0)	
Graduate	13 (43.3)	10 (45.5)	3 (37.5)	
Profession/ Honors	7 (23.3)	4 (18.2)	3 (37.5)	
Interpretation of Kuppuswamy Scale				
Upper Lower	8 (26.7)	6 (27.3)	2 (25)	0.976
Lower Middle	8 (26.7)	6 (27.3)	2 (25)	
Upper Middle	14 (46.7)	10 (45.5)	4 (50)	

Frequency Percentage (N, %)

The demographic characteristics of the children with Autism Spectrum Disorder (ASD) revealed that the majority (73.3%) belonged to the 6–9 years age group, with the remaining in the 10–14 years range. Interestingly, all participants with good zinc intake were within the younger age group, while those with poor intake were distributed across both age categories. The sample exhibited a male predominance (90%), with the male and female ratio of 9:1. Regarding family medical history, the majority reported none, and again, no significant association with zinc intake was observed.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Dietary preferences showed that 83.3% of children followed a non-vegetarian diet, while vegetarian and ovo-vegetarian preferences were less common. Despite these variations, there was no significant relationship between dietary preference and zinc intake. Additionally, 23.3% of the participants reported taking protein or multivitamin supplements, but supplement use did not significantly differ between the intake groups.

TABLE NO. 2 Anthropometric data of Study Participants According to Dietary Zinc Consumption

Variables	Poor Zinc Intake (Mean + SD)	Good Zinc Intake (Mean + SD)	p-value
Weight (in kg)	26.5 + 9.38	26.88 + 8.676	0.922
Height (in cm)	129.2 + 12.82	126.3 + 11.95	0.582
BMI (kg/m^2)	15.64 + 3.55	16.6 + 6.09	0.585
MUAC (in cm)	19.55 + 4.02	18.5 + 2.92	0.508
Weight-For-Age	3.14 + 2.25	3.25 + 1.91	0.90
Height-For-Age	3.32 + 2.29	3.38 + 2.32	0.953

Mean ± Standard Deviation *p < 0.05

Anthropometric data showed no statistically significant differences between the poor and good zinc intake groups across all measures, including weight, height, body mass index (BMI), mid-upper arm circumference (MUAC), and z-scores for weight-for-age and height-for-age. For instance, the BMI was slightly higher in the good zinc intake group (16.6 ± 6.09 kg/m²) compared to the poor intake group (15.64 ± 3.55 kg/m²), but this difference was not significant ($p = 0.585$). Further, weight-for-age classification showed that 40% of children were underweight, predominantly those with poor zinc intake. Similarly, stunting was more common in the poor intake group (75% of stunted children), but again, without statistical significance.

TABLE NO. 3 Dietary Intake of the Study Participants According to Dietary Zinc Consumption

Variables	Poor Zinc Intake (Mean + SD)	Good Zinc Intake (Mean + SD)	t-test value	p-value
Energy (kcal)	887.2+ 218.3	1211+ 181.12	-3.74	0.001*
Protein (g)	26.41+ 11.17	42.13+ 8.56	-3.597	0.001*
Carbohydrates (g)	126.36 + 32.71	153.8 + 27.93	-2.11	0.044*
Fats (g)	30.68 + 13.56	47.38 + 10.11	-3.161	0.004*
Zinc (mg)	2.55+1.625	5.38+ 0.518	-4.79	0.000*

Mean ± Standard Deviation *p < 0.05

The analysis included energy, macronutrient intake (protein, carbohydrates, fats), and zinc. Participants with poor zinc intake consumed an average of 887.2 ± 218.3 kcal, whereas those with good zinc intake consumed 1211 ± 181.12 kcal. Protein intake was 26.41 ± 11.17 g in the poor zinc intake group and 42.13 ± 8.56 g in the good zinc intake group. This difference was also statistically significant ($p = 0.001$). Carbohydrate intake averaged 126.36 ± 32.71 g in the poor zinc intake group and 153.8 ± 27.93 g in the good zinc intake group. Zinc intake was 2.55 ± 1.625 mg in the poor intake group compared to 5.38 ± 0.518 mg in the good zinc intake group, with the difference being highly significant ($p < 0.001$).

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

TABLE NO. 4 Dietary Intake of the Study Participants according to the Age Groups

Variables	Age (6 - 9 yrs)	Age (10 - 12 yrs)	Age (13 - 14 yrs)	p-value
Energy (kcal)	978.9 ± 254.5	785.8 ± 94.95	1247.6 ± 151.2	0.036*
RDA Energy %	57.58 ± 14.97	35.39 ± 4.28	43.62 ± 5.286	
Protein (g)	29.7 ± 12.59	24.88 ± 2.841	45.9 ± 13.38	0.057
RDA Protein %	129.13± 54.74	77.75 ± 8.88	102± 29.73	
Carbohydrates (g)	134.5 ± 34.12	121 ± 17.56	149 ± 51.11	0.522
RDA CHO %	91.58 ± 23.23	102.65 ± 14.89	79.61 ± 27.31	
Fats (g)	35.75 ± 13.17	22.46 ± 12.82	52 ± 10.44	0.015*
RDA Fats %	109.86 ± 40.47	85.73 ± 48.93	125.03 ± 25.1	
Zinc (mg)	3.47 ± 1.89	2.02 ± 1.035	5.23 ± 1.006	0.05*
RDA Zinc %	58.81± 32.15	23.76 ± 12.18	36.59± 7.03	

Mean ± Standard Deviation *$p < 0.05$

Mean dietary intake was compared across three age groups - 6–9, 10–12, and 13–14 years, using ANOVA. Energy intake differed significantly (p = 0.036), with the 13–14 years group having the highest intake (1247.6 ± 151.2 kcal), followed by 6–9 years (978.9 ± 254.5 kcal), and the lowest in 10–12 years (785.8 ± 94.95 kcal). RDA was highest in the 6–9 group (57.58%). Protein intake was highest in the 13–14 years group (45.9 ± 13.38 g) and lowest in 10–12 years (24.88 ± 2.84 g). Carbohydrate intake showed no significant difference, with all groups meeting a moderate portion of RDA. Fat intake was significantly different (p = 0.015), highest in 13–14 years (52 ± 10.44 g), and lowest in 10–12 years (22.46 ± 12.82 g). Zinc intake also differed significantly (p = 0.05), highest in 13–14 years (5.23 ± 1.01 mg), and lowest in 10–12 years (2.02 ± 1.04 mg). The 6–9 years group met the highest percentage of RDA (58.81%).

TABLE NO. 5 Frequency of Zinc Rich Foods Consumption and its Association with Dietary Zinc Intake of the Study Participants

Food Item	Dietary Zinc Intake	Frequency of Zinc Rich Foods Consumption									p-value
		Never	Less than 1 time per month	1 time per month	2-3 time per month	1 time per week	2-4 times per week	5-6 times per week	1 time per day	2+ time per day	
		(N, %)									
Eggs - boiled	Poor Zinc Intake	5 (22.7)	1 (4.5)	0 (0)	4 (18.2)	3 (13.6)	9 (40.9)	0 (0)	0 (0)	0 (0)	0.407
	Good Zinc Intake	3 (37.5)	0 (0)	0 (0)	0 (0)	1 (12.5)	3 (37.5)	0 (0)	1 (12.5)	0 (0)	

Fried egg/ Omelette	Poor Zinc Intake	5 (22.7)	2 (9.1)	1 (4.5)	2 (9.1)	3 (13.6)	9 (40.9)	0 (0)	0 (0)	0 (0)	0.684
	Good Zinc Intake	2 (25)	0 (0)	0 (0)	1 (12.5)	1 (12.5)	3 (37.5)	0 (0)	1 (12.5)	0 (0)	
Chicken	Poor Zinc Intake	6 (27.3)	2 (9.1)	0 (0)	5 (22.7)	4 (18.2)	5 (22.7)	0 (0)	0 (0)	0 (0)	0.941
	Good Zinc Intake	1 (12.5)	1 (12.5)	0 (0)	2 (25)	2 (25)	2 (25)	0 (0)	0 (0)	0 (0)	
Mutton	Poor Zinc Intake	15 (68.2)	1 (4.5)	1 (4.5)	2 (9.1)	1 (4.5)	2 (9.1)	0 (0)	0 (0)	0 (0)	0.611
	Good Zinc Intake	3 (37.5)	0 (0)	1 (12.5)	1 (12.5)	1 (12.5)	2 (25)	0 (0)	0 (0)	0 (0)	
Fish	Poor Zinc Intake	17 (77.3)	1 (4.5)	0 (0)	1 (4.5)	1 (4.5)	0 (0)	0 (0)	0 (0)	0 (0)	0.387
	Good Zinc Intake	4 (50)	2 (25)	0 (0)	0 (0)	2 (25)	0 (0)	0 (0)	0 (0)	0 (0)	
Prawns	Poor Zinc Intake	17 (77.3)	1 (4.5)	2 (9.1)	1 (4.5)	1 (4.5)	0 (0)	0 (0)	0 (0)	0 (0)	0.157
	Good Zinc Intake	4 (50)	2 (25)	0 (0)	0 (0)	2 (25)	0 (0)	0 (0)	0 (0)	0 (0)	
Milk	Poor Zinc Intake	7 (31.8)	4 (18.2)	0 (0)	0 (0)	2 (9.1)	1 (4.5)	1 (4.5)	6 (27.3)	1 (4.5)	0.327
	Good Zinc Intake	3 (37.5)	0 (0)	0 (0)	1 (12.5)	1 (12.5)	2 (25)	0 (0)	1 (12.5)	0 (0)	
Curd	Poor Zinc Intake	10 (45.5)	1 (4.5)	0 (0)	1 (4.5)	7 (31.8)	2 (9.1)	1 (4.5)	0 (0)	0 (0)	0.785
	Good Zinc Intake	5 (62.5)	0 (0)	0 (0)	1 (12.5)	2 (25)	0 (0)	0 (0)	0 (0)	0 (0)	
Paneer	Poor Zinc Intake	5 (22.7)	0 (0)	1 (4.5)	6 (27.3)	9 (40.9)	1 (4.5)	0 (0)	0 (0)	0 (0)	0.759
	Good Zinc Intake	2 (25)	0 (0)	0 (0)	1 (12.5)	5 (62.5)	0 (0)	0 (0)	0 (0)	0 (0)	
Cheese	Poor Zinc Intake	9 (40.9)	2 (9.1)	5 (22.7)	2 (9.1)	3 (13.6)	0 (0)	0 (0)	1 (4.5)	0 (0)	0.789
	Good Zinc Intake	4 (50)	0 (0)	3 (37.5)	0 (0)	1 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)	
Lassi	Poor Zinc Intake	15 (68.2)	2 (9.1)	0 (0)	4 (18.2)	0 (0)	1 (4.5)	0 (0)	0 (0)	0 (0)	0.302

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

	Good Zinc Intake	5 (62.5)	1 (12.5)	0 (0)	0 (0)	1 (12.5)	1 (12.5)	0 (0)	0 (0)	0 (0)	
Buttermilk	Poor Zinc Intake	16 (72.7)	2 (9.1)	0 (0)	3 (13.6)	0 (0)	0 (0)	0 (0)	1 (4.5)	0 (0)	0.37
	Good Zinc Intake	6 (75)	1 (12.5)	0 (0)	0 (0)	1 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)	
Nuts	Poor Zinc Intake	6 (27.3)	2 (9.1)	4 (18.2)	3 (13.6)	1 (4.5)	1 (4.5)	2 (9.1)	3 (13.6)	0 (0)	0.64
	Good Zinc Intake	1 (12.5)	0 (0)	2 (25)	1 (12.5)	1 (12.5)	2 (25)	0 (0)	1 (12.5)	0 (0)	
Dals	Poor Zinc Intake	2 (9.1)	0 (0)	1 (4.5)	0 (0)	0 (0)	6 (27.3)	0 (0)	12 (54.5)	1 (4.5)	0.05*
	Good Zinc Intake	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (25)	3 (37.5)	2 (25)	1 (12.5)	
Legumes	Poor Zinc Intake	6 (27.3)	1 (4.5)	6 (2.3)	4 (18.2)	3 (13.6)	2 (9.1)	0 (0)	0 (0)	0 (0)	0.138
	Good Zinc Intake	0 (0)	1 (12.5)	0 (0)	2 (25)	2 (25)	3 (37.5)	0 (0)	0 (0)	0 (0)	
Sprouts	Poor Zinc Intake	5 (22.7)	1 (4.5)	0 (0)	2 (9.1)	9 (40.9)	5 (22.7)	0 (0)	0 (0)	0 (0)	0.226
	Good Zinc Intake	0 (0)	0 (0)	0 (0)	2 (25)	2 (25)	3 (37.5)	0 (0)	1 (12.5)	0 (0)	

Frequency Percentage (N, %) *$p < 0.05$

Dals showed a statistically significant association with dietary zinc intake ($p = 0.05$); children with good zinc intake consumed dals more frequently (5–6 times/week or daily). Nuts, legumes, and sprouts showed no significant association with zinc intake, though 27.3% of the poor intake group never consumed nuts, and 22.7% never consumed sprouts. Eggs, chicken, mutton, fish, and prawns had no statistically significant association with zinc intake ($p > 0.05$). Overall consumption was low in both groups. Milk and paneer were consumed slightly more regularly in the good zinc intake group. Fermented dairy products like lassi and buttermilk were among the most frequently avoided items by both groups.

TABLE NO. 6 Immune Status of the Study Participants According to Dietary Zinc Consumption

Variables	Total (N = 30) (N, %)	Poor Zinc Intake (n = 22) (n, %)	Good Zinc Intake (n = 8) (n, %)	p-value
Sudden High Fever				
Never	10 (33.3)	6 (27.3)	4 (50)	0.312
Sometimes	13 (43.3)	9 (40.9)	4 (50)	
Regularly	6 (20)	6 (27.3)	0 (0)	

Often	1 (3.3)	1 (4.5)	0 (0)	
Diarrhea				
Never	26 (86.7)	18 (81.8)	8 (100)	0.195
Sometimes	4 (13.3)	4 (18.2)	0 (0)	
Headache (Sinusitis/ Migraine)				
Never	27 (90)	20 (90.9)	7 (87.5)	0.783
Sometimes	3 (10)	2 (9.1)	1 (12.5)	
Allergies				
Never	23 (76.7)	17 (77.3)	6 (75)	0.714
Sometimes	5 (16.7)	4 (18.2)	1 (12.5)	
Regularly	2 (6.7)	1 (4.5)	1 (12.5)	
Common Cough & Cold				
Never	2 (6.7)	2 (9.1)	0 (0)	0.47
Sometimes	7 (23.3)	4 (18.2)	3 (37.5)	
Regularly	19 (63.3)	15 (68.2)	4 (50)	
Often	2 (6.7)	1 (4.5)	1 (12.5)	
Recurrent URTI				
Never	13 (43.3)	11 (50)	2 (25)	0.284
Sometimes	11 (36.7)	8 (36.4)	3 (37.5)	
Regularly	6 (20)	3 (13.6)	3 (37.5)	

Data are given as N, % *$p < 0.05$

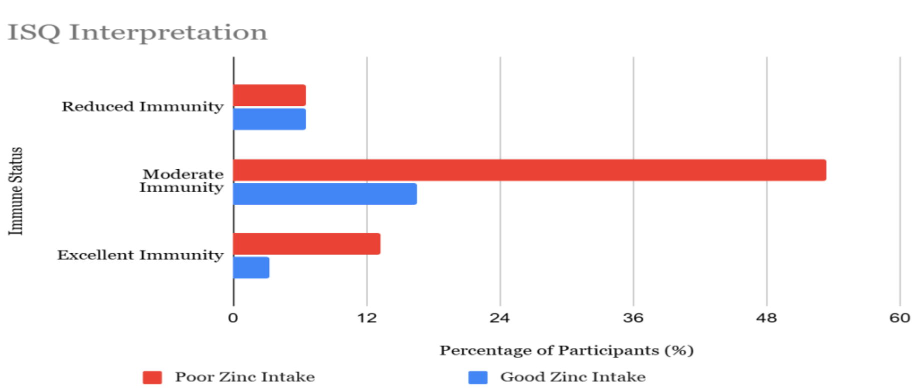


FIGURE NO. 1 Distribution of Participants based on Immune Status Questionnaire (ISQ) According to Dietary Zinc Consumption

Table no. 6 presents the immune status of children with Autism Spectrum Disorder (ASD) based on their dietary zinc intake. Among all participants (N = 30), 70% (n = 21) demonstrated moderate immunity, 13.3% (n = 4) had reduced immunity (ISQ score < 6), and 16.7% (n = 5) exhibited excellent immunity. In the poor zinc intake group, 6.6% (n = 2) had reduced immunity, 53.3% (n = 16) had moderate immunity, and 3.33% (n = 1) had excellent immunity. In the good zinc intake group, 6.6% (n = 2) also had reduced immunity, 16.6% (n = 5) had moderate immunity, and 13.3% (n = 4) showed excellent immunity.

Assessment of immune status revealed no statistically significant differences between groups for symptoms like fever, diarrhea, sinus headaches, allergies, cough, and recurrent infections. However, descriptive data showed that children with good zinc intake experienced fewer frequent or regular infections. ISQ scoring revealed that 70% of participants had moderate immune function, 13.3% had low immune scores, and only 16.7% had excellent immune health. Notably, excellent immune scores were more common among children with good zinc intake.

TABLE NO. 7 Gastrointestinal Health of the Study Participants According to Dietary Zinc Consumption

Variables	Total (N = 30) (N, %)	Poor Zinc Intake (n = 22) (n, %)	Good Zinc Intake (n = 8) (n, %)	p-value
Indigestion, food repeats on you after you eat				
Never	24 (80)	19 (86.4)	5 (62.5)	0.148
Occasionally	6 (20)	3 (13.6)	3 (37.5)	
Feel hungry an hour or two after eating a good-sized meal				
Never	17 (56.7)	14 (63.6)	3 (37.5)	0.201
Occasionally	13 (43.3)	8 (36.4)	5 (62.5)	
Diarrhea				
Never	26 (86.7)	18 (81.8)	8 (100)	0.195
Occasionally	4 (13.3)	4 (18.2)	0 (0)	
Constipation				
Never	13 (43.3)	9 (40.9)	4 (50)	0.514
Occasionally	3 (10)	3 (13.6)	0 (0)	
Often	14 (46.7)	10 (45.5)	4 (50)	
Excessive burping, belching and/or bloating following meals				
Never	25 (83.3)	19 (86.4)	6 (75)	0.457
Occasionally	4 (13.3)	2 (9.1)	2 (25)	
Often	1 (3.3)	1 (4.5)	0 (0)	
Stomach spasms and cramping during or after eating				
Never	28 (93.3)	21 (95.5)	7 (87.5)	0.44

Occasionally	2 (6.7)	1 (4.5)	1 (12.5)	
Stomach pain, burning and/or aching over a period of 1-4 hours after eating				
Never	29 (96.7)	21 (95.5)	8 (100)	0.54
Occasionally	1 (3.3)	1 (4.5)	0 (0)	
Feel a sense of nausea when you eat				
Never	29 (96.7)	21 (95.5)	8 (100)	0.54
Occasionally	1 (3.3)	1 (4.5)	0 (0)	
Difficulty or pain in swallowing				
Never	29 (96.7)	21 (95.5)	8 (100)	0.54
Frequently	1 (3.3)	1 (4.5)	0 (0)	
Lower abdominal discomfort is relieved with the passage of gas				
Never	28 (93.3)	21 (95.5)	7 (87.5)	0.44
Occasionally	2 (6.7)	1 (4.5)	1 (12.5)	

Data are given as N, % *$p < 0.05$

The gastrointestinal health of the participants was evaluated using a structured questionnaire. Constipation emerged as the most common symptom, with 46.7% experiencing it often and 10% occasionally. It was slightly more frequent in the poor zinc intake group, though the difference was not statistically significant. Indigestion was reported occasionally by six children—three from each zinc intake group. Hunger soon after meals was reported by 43.3% of participants and was more common in the poor zinc group. Diarrhea occurred occasionally in four children, all from the poor zinc group. Most participants (83.3%) did not experience post-meal bloating or gas. Stomach cramps were reported by one child from each group, while stomach pain or burning after meals, nausea during meals, and difficulty swallowing were each reported by only one child from the poor zinc intake group. Across all symptoms, no statistically significant differences were observed between the groups.

IV. DISCUSSION

This study explored the link between dietary zinc intake and health outcomes such as nutritional status, immune function, and gut health in children with Autism Spectrum Disorder (ASD). Most participants were male, consistent with the global 4:1 male-to-female ASD ratio (Lord et al., 2022). While age and gender weren't significantly associated with zinc intake, all children with good intake were aged 6–9 years, possibly due to increased parental focus on nutrition after early diagnosis (Vela et al., 2015). A family history of ASD may also influence dietary attentiveness (Herbert & Buckley, 2013).

Anthropometric measures like BMI, MUAC, and growth charts showed no significant differences between zinc intake groups, aligning with studies suggesting zinc deficiency's impact on growth may not be immediately evident, especially in well-nourished populations (Bezzera do Nascimento et al., 2023). However, subtle trends like increased underweight and stunting in low-zinc groups highlight zinc's role in growth and development through its effect on growth hormones and skeletal formation (Prasad et al., 2008).

Children with poor zinc intake also had significantly lower energy and macronutrient intake. As per ICMR-NIN (2020, updated 2024), children aged 7–14 years need 1700–2860 kcal/day. The significantly reduced energy intake can compromise growth, immune function, and overall metabolic processes (Martínez Steele et al., 2016). This likely correlates with limited food variety and appetite disturbances commonly observed in ASD.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Poor protein intake further highlights the link between zinc and protein metabolism. Additionally, Low fat intake may reduce taste appeal, satiety, and nutrient absorption, worsening appetite and sensory feeding issues (Evans et al., 2012).

Zinc intake varied with age, older children (13–14 years) consumed more zinc overall but still fell short of age-specific needs, likely due to persistent food selectivity (Bandini et al., 2017). Children aged 10–12 showed the lowest intake of energy, protein, fats, and zinc, a concern given their rapid growth and cognitive demands. Food frequency analysis showed that over half the participants excluded fruits, despite their richness in fiber, vitamin C, and antioxidants. Dals showed a significant association which suggests that plant-based sources, when consumed regularly and prepared using methods that reduce anti-nutritional factors (e.g., soaking or fermenting), can meaningfully contribute to zinc intake even in the absence of meat-based foods (Gibson et al., 2010). However, phytates present in legumes and grains may reduce zinc bioavailability, indicating that food preparation techniques and dietary diversity play an essential role in optimizing nutrient absorption (Wessels et al., 2021). The high avoidance of dairy, fermented foods, and zinc-rich animal products may reflect adherence to gluten-free/casein-free (GF/CF) diets, commonly used in ASD. While some families report behavioral benefits, these diets can lead to micronutrient deficiencies, such as zinc, calcium, and vitamin B12 (Barnhill et al., 2018). Sensory sensitivities in ASD may also cause avoidance of nutrient-dense foods with strong textures, colors, or smells (Chistol et al., 2018).

Although not statistically significant, children with good zinc intake showed favorable trends such as fewer episodes of fever, diarrhea, and respiratory infections. This aligns with findings that zinc supports immune function through T-cell maturation, cytokine regulation, and anti-inflammatory pathways (Conti et al., 2023; Sanabria-Barradas et al., 2021). Zinc supplementation has also been shown to reduce the incidence and severity of infections in children (Lazzerini &Wanzira, 2016; Hemilä et al., 2011). Higher ISQ scores in this group further support better immune status.

Gastrointestinal symptoms like indigestion, constipation, and abdominal discomfort were more common in children with poor zinc intake, though not statistically significant. This supports zinc's role in gut barrier integrity, mucosal immunity, and inflammation control (Tomaszek et al., 2025; Sauer et al., 2021). Constipation was the most frequent issue, echoing previous findings in children with ASD, likely linked to low fiber, inadequate fluids, and gut dysbiosis (Wasilewska & Klukowski, 2015; Holingue et al., 2018).

V. CONCLUSION

This study highlights a significant association between dietary zinc intake and the immune status and gastrointestinal health of children with Autism Spectrum Disorder (ASD). The majority of participants exhibited poor zinc intake, which correlated with increased immune-related symptoms and gastrointestinal disturbances. Despite normal anthropometric measures in most children, subclinical micronutrient deficiencies were evident, driven by food selectivity and unbalanced dietary patterns common in ASD. These findings emphasize the critical role of adequate zinc consumption in supporting immune function and gut integrity, emphasizing the need for early dietary assessment and targeted nutritional interventions to improve the overall health and quality of life in children with ASD.

REFERENCES

[1] Conti MV, Santero S, Luzzi A, Cena H. Exploring potential mechanisms for zinc deficiency to impact in autism spectrum disorder: a narrative review. Nutrition Research Reviews. 2024;37(2):287-295. doi:10.1017/S0954422423000215

[2] Conti, M.V., Breda, C., Basilico, S. et al. Dietary recommendations to customize canteen menus according to the nutritional and sensory needs of individuals with autism spectrum disorder. Eat Weight Disord 28, 66 (2023).

[3] Nascimento, Priscila & Silva, David & Morais, Tássia& Rezende, Adriana. (2023). Zinc Status and Autism Spectrum Disorder in Children and Adolescents: A Systematic Review. Nutrients. 15. 3663. 10.3390/nu15163663.

[4] Vela, G., Stark, P., Socha, M., Sauer, A. K., Hagmeyer, S., &Grabrucker, A. M. (2015). Zinc in gut-brain interaction in autism and neurological disorders. Neural plasticity, 2015, 972791. https://doi.org/10.1155/2015/972791

[5] Semenova, A., Semenov, D., Pytkova, V., &Salmina, A. (2025). CURRENT UNDERSTANDING OF AMMONIA NEUROTOXICITY AND THE DEVELOPMENT OF AUTISM SPECTRUM DISORDERS. Authorea Preprints.

[6] Tomaszek, N., Urbaniak, A. D., Bałdyga, D., Chwesiuk, K., Modzelewski, S., & Waszkiewicz, N. (2025). Unraveling the Connections: Eating Issues, Microbiome, and Gastrointestinal Symptoms in Autism Spectrum Disorder. Nutrients, 17(3), 486. https://doi.org/10.3390/nu17030486

[7] Wasilewska, J., & Klukowski, M. (2015). Gastrointestinal symptoms and autism spectrum disorder: links and risks - a possible new overlap syndrome. Pediatric health, medicine and therapeutics, 6, 153–166.https://doi.org/10.2147/PHMT.S85717

[8] Carabotti, M., Scirocco, A., Maselli, M. A., & Severi, C. (2015). The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems. Annals of gastroenterology: quarterly publication of the Hellenic Society of Gastroenterology, 28(2), 203.

[9] Sanabria-Barradas, B., Gallardo-Beatriz, L. S., Palma-Jacinto, J. A., & Calderón-Garcidueñas, A. L. (2021). The pathogenesis of autism spectrum disorder. Revistamexicana de neurociencia, 22(6), 248-255.

[10] Hodis, B., Mughal, S., &Saadabadi, A. (2025). Autism Spectrum Disorder. StatPearls.

[11] Zeidan, J., Fombonne, E., Scorah, J., Ibrahim, A., Durkin, M. S., Saxena, S., ... &Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. Autism research, 15(5), 778-790.

[12] Al-Beltagi, M., Saeed, N. K., Bediwy, A. S., Elbeltagi, R., &Alhawamdeh, R. (2023). Role of gastrointestinal health in managing children with autism spectrum disorder. World journal of clinical pediatrics, 12(4), 171–196. https://doi.org/10.5409/wjcp.v12.i4.171

[13] Arija, V., Esteban-Figuerola, P., Morales-Hidalgo, P., Jardí, C., & Canals-Sans, J. (2023). Nutrient intake and adequacy in children with autism spectrum disorder: EPINED epidemiological study. Autism, 27(2), 371-388.

[14] Barnhill, K., Gutierrez, A., Ghossainy, M., Marediya, Z., Devlin, M., Sachdev, P., ... & Hewitson, L. (2018). Dietary status and nutrient intake of children with autism spectrum disorder: A case-control study. Research in Autism Spectrum Disorders, 50, 51-59.

[15] Wessels, I., Fischer, H. J., & Rink, L. (2021). Dietary and physiological effects of zinc on the immune system. Annual review of nutrition, 41(1), 133-175.

[16] Herbert, M. R., & Buckley, J. A. (2013). Autism and dietary therapy: case report and review of the literature. Journal of child neurology, 28(8), 975-982.

[17] Hemilä, H. (2011). Zinc lozenges may shorten the duration of colds: a systematic review. The open respiratory medicine journal, 5, 51.

[18] Lazzerini, M., &Wanzira, H. (2016). Oral zinc for treating diarrhoea in children. Cochrane database of systematic reviews, (12).

[19] Prasad, A. S. (2008). Zinc in human health: effect of zinc on immune cells. Molecular medicine, 14, 353-357.

[20] Evans, E. W., Must, A., Anderson, S. E., Curtin, C., Scampini, R., Maslin, M., & Bandini, L. (2012). Dietary patterns and body mass index in children with autism and typically developing children. Research in autism spectrum disorders, 6(1), 399-405.

[21] Martínez Steele, E., Popkin, B. M., Swinburn, B., & Monteiro, C. A. (2017). The share of ultra-processed foods and the overall nutritional quality of diets in the US: evidence from a nationally representative cross-sectional study. Population health metrics, 15, 1-11.

[22] Bandini, L. G., Curtin, C., Phillips, S., Anderson, S. E., Maslin, M., & Must, A. (2017). Changes in Food Selectivity in Children with Autism Spectrum Disorder. Journal of autism and developmental disorders, 47(2), 439–446. https://doi.org/10.1007/s10803-016-2963-6

[23] Gibson, R. S., Bailey, K. B., Gibbs, M., & Ferguson, E. L. (2010). A review of phytate, iron, zinc, and calcium concentrations in plant-based complementary foods used in low-income countries and implications for bioavailability. Food and nutrition bulletin, 31(2_suppl2), S134-S146.

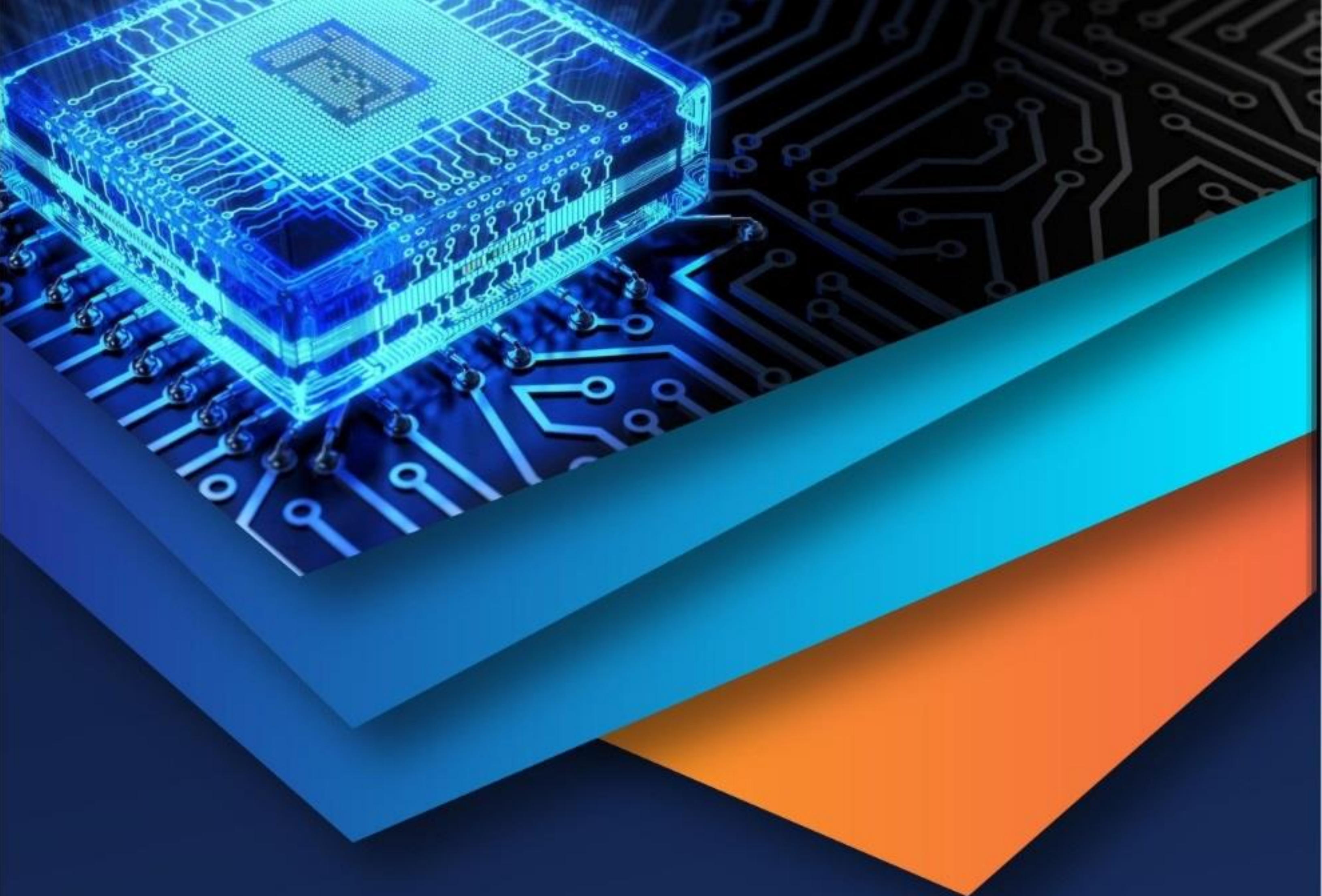
[24] Sauer, A. K., Stanton, J., Hans, S., &Grabrucker, A. (2021). Autism spectrum disorders: etiology and pathology. Exon Publications, 1-15.

[25] Holingue, C., Newill, C., Lee, L. C., Pasricha, P. J., & Daniele Fallin, M. (2018). Gastrointestinal symptoms in autism spectrum disorder: A review of the literature on ascertainment and prevalence. Autism Research, 11(1), 24-36.

[26] Elias, R., & Lord, C. (2022). Diagnostic stability in individuals with autism spectrum disorder: insights from a longitudinal follow-up study. Journal of Child Psychology and Psychiatry, 63(9), 973-983.

[27] Maares, M., & Haase, H. (2020). A guide to human zinc absorption: general overview and recent advances of in vitro intestinal models. Nutrients, 12(3), 762.

[28] Chistol, L. T., Bandini, L. G., Must, A., Phillips, S., Cermak, S. A., & Curtin, C. (2018). Sensory Sensitivity and Food Selectivity in Children with Autism Spectrum Disorder. Journal of autism and developmental disorders, 48(2), 583–591. https://doi.org/10.1007/s10803-017-3340-9



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY