**NUTRITIONAL STATUS AFFECTING CHILDREN WITH AUTISM SPECTRUM DISORDER AND THEIR GASTRO INTESTINAL COMPLICATIONS**



**DISSERTATION SUBMITTED**

**In partial fulfillment of requirement for the award of the degree of**

**MASTER’S PROGRAMME IN**

**CLINICAL NUTRITION AND DIETETICS**

**By**

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**APRIL 2025**

**CERTIFIED AS BONAFIDE RESEARCH WORK**

**Signature of Internal Examiner** **Signature of External Examiner**

**DECLARATION**

I hereby declare that the project entitled **‘”NUTRITIONAL STATUS AFFECTING CHILDREN WITH AUTISM SPECTRUM DISORDER AND THEIR GASTRO INTESTINAL COMPLICATIONS “** submitted in partial fulfilment of the requirement for the award of the degree of Master’s Programme in Clinical Nutrition and Dietetics is a record of original research work done by me under the supervision and guidance of **Ms. ANI THOMAS THOTTATHIL**, Assistant Professor, Department of Clinical Nutrition and Dietetics, Women’s Study Centre, St. Teresa's College (Autonomous), Ernakulam and has not been submitted in part or full of any other degree/diploma/fellowship or the similar titles to any candidate of any other university.

Place: (NANDANA)

Date:

**CERTIFICATE**

I here certify that the dissertation entitled **" NUTRITIONAL STATUS AFFECTING CHILDREN WITH AUTISM SPECTRUM DISORDER AND THEIR GASTRO INTESTINAL COMPLICATIONS”** submitted in partial fulfilmentof the requirement for the award of the degree of Master’s Programme in Clinical Nutrition and Dietetics is a record of original work done by Ms. **Nandana P** during the period of the study under my guidance and supervision.

 **Signature of the HOD Signature of the Research Guide with designation**

**ACKNOWLEDGEMENT**

**I thank God , the almighty and my immense belief on him which helped me in each and every step for enabling me to undertake this programme and to complete my dissertation to my optimal satisfaction .**

**I would like to express my deep gratitude to Rev Dr. Sr. Nilima Manger , and Dr. Alphonse Vijaya Joseph ,principal , St Teresa’s college , Ernakulam for providing me the facilities for the academic performance.**

**I would like to express my sincere gratitude to Dr. Lekha Sreenivas, Center Co- Ordinator of women study center, St Teresa’s college, Ernakulam for her constant support , engagement and advice. I extend my gratitude to Ms. Surya M kottaram , Head of the department of clinical nutrition and dietetics for the timely suggestions and support.**

**I owe deep sense of gratitude to my guide, Ms. Ani Thomas Thottathil for her timely advice ,patience and guidance that enabled me to complete my thesis. Her constructive criticism , sound advice and personal guidance have helped me to develop scientific skills and rationale. I would also like to thank all the teachers in the department of clinical nutrition and dietetics.**

**I express my utmost gratitude to Greeshma C Ravindran, Scientist- C ( biostatistics) , ICMR- NIREH Bhopal, MP for helping me to provide the statistical result of my thesis work.**

**I extend my deep gratitude to the teachers of special school for mental disability for providing and helping me to obtain the data for the thesis work. Without their constant support my thesis would me incomplete.**

**Its my pleasure to express my gratitude to thank all non-teaching staffs for help. I cannot end without thanking my family members and friends for their constant love , support ,and encouragement.**

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**ABSTRACT**

Autism spectrum disorder is a complex condition that affects individual’s ability’s to communicate effectively ,engage in social interactions , communications and exhibits a range of behaviors. The world health organization (WHO) states that this syndrome can be identified in children younger than three year old. This research is to determine the nutritional status and gastro intestinal complications of children with an age 5-19 years old. The study examines the demographic profile, types of GI complications, specific food preference and dietary patterns and the symptoms of GI complications. Through a convenient sampling method the sample group was selected. The data was collected from a sample group of 52 autistic children through self designed questionnaire using google form.

Data were analyzed statistically using chi- square test. The results indicated that most of the autistic student were Vitamin D deficient and constipation was the common gastrointestinal discomfort they possessed among those who preferred variety of food in the diet and among picky eater. Occurrence and the frequency of GI discomforts were added in the data. A recipe was formulated after the evaluation of nutritional status and GI discomfort as an intervention tool. Sensory evaluation was conducted based on texture , appearance and overall accessibility of the product and it was acceptable.

**CHAPTER 1**

**INTRODUCTION**

Nutritional status is a complex interplay of various elements, primarily influenced by the quantity and quality of food consumed, as well as the overall health of individuals and the healthcare practices they engage in. The nutritional health of women and children is intricately linked to various social and cultural factors. Cultural beliefs and practices can influence food preferences, dietary restrictions, and meal preparation methods. Healthcare practices also play a vital role in determining nutritional status. Access to healthcare services, education about nutrition, and the availability of resources for healthy eating can significantly influence dietary habits (Girma et al., 2002).

Autism spectrum disorder (ASD) is a complex developmental condition that manifests in various ways, influencing an individual's ability to engage in social interactions, communicate effectively, and exhibit a range of behaviors. The term "spectrum" reflects the wide variety of symptoms and levels of impairment that individuals with ASD may experience, which can vary significantly from one person to another (2). The World Health Organization (WHO) states that this syndrome can be identified in children younger than three years old. While the exact cause is still unclear, it is understood that various factors, including environmental, genetic, and epigenetic influences, play a role in its development (3). Autism is diagnosed based on specific behavioral signs, and right now, experts in many countries rely on the guidelines found in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) (4). To meet these requirements, the child needs to show at least six symptoms from a total of twelve listed in the DSM-V. It's important that at least two of these symptoms relate to social interaction, and at least one must involve restricted, repetitive, or stereotyped behaviors (Silva et al., 2024). Many autistic kids often struggle with nutritional deficiencies because they tend to eat a limited variety of foods. This can be due to things like being picky eaters or having a fear of trying new foods. As a result, research shows that autistic children are two to three times more likely to be obese compared to kids without autism (Caetano et al., 2018). Children's eating habits have a big impact on their nutritional health. If kids prefer sugary snacks and processed foods and eat a lot of them, they might end up being overweight. On the other hand, if a child is very picky and only eats small amounts of low-calorie foods, they could become underweight (Marí-Bauset et al., 2016).

People with autism spectrum disorder (ASD) face a higher risk of mental health issues throughout their lives. This includes increased rates of behaviors like anxiety, aggression, and self-harm. Finding medical conditions that contribute to these mental health challenges can help us understand how these issues develop and provide new ways to help. Gastrointestinal (GI) problems are especially important to consider because they are common in individuals with ASD, may have similar genetic or brain-related causes as ASD itself, and are associated with mental health issues in the wider population (Emily Neuhaus et al.,2018).

Many studies that have been published on the link between autism traits and feeding issues have primarily focused on examining feeding behaviors, such as food preferences, mealtime routines, and the types of foods children are willing to eat. However, these studies have often overlooked critical aspects such as the quantity of food consumed and the overall quality of the diet. This gap in research is significant, as understanding not just what children with autism eat, but also how much and how nutritious their diets are, could provide a more comprehensive view of their feeding challenges (Adams et al., 2022).

Interestingly, the relationship between the severity of autism traits and feeding behaviors appears to be influenced by the methods used to assess these behaviors. For instance, when parents were asked to report on their children's eating habits using the Autism Diagnostic Interview-Revised (ADI-R), they noted a positive correlation between the severity of autism traits and food selectivity. This suggests that as autism traits become more pronounced, children may become increasingly selective about the foods they are willing to eat, potentially leading to a limited diet. In contrast, when clinicians utilized the Autism Diagnostic Observation Scale-Calibrated Severity Scale (ADOS-CSS) to observe the same feeding behaviors, they did not find a similar correlation. This discrepancy raises important questions about the reliability and validity of different assessment tools in capturing the nuances of feeding issues in children with autism. It suggests that parental reports may reflect subjective experiences and perceptions that differ from clinical observations, highlighting the need for a multi-faceted approach to understanding feeding behaviors in this population (Page et al., 2022).

The "second brain" refers to the enteric nervous system, a complex network of neurons in the gastrointestinal tract that operates independently from the central nervous system. Known as the "gut brain," it manages digestion, including food movement, enzyme release, and nutrient absorption. The gut-brain axis facilitates two-way communication between the brain and gut, involving the enteric nervous system, gut microbiota, immune system, and autonomic nervous system. This communication influences digestion, metabolism, cognitive functions, and behavior through various mechanisms, including neurocrine and endocrine pathways. The digestive system hosts trillions of microorganisms known as gut microbiota.

Microorganisms play a crucial role in keeping the gut healthy, aiding digestion, absorbing nutrients, and supporting the immune system. They also have a significant effect on human health, including brain development and function. The gut microbiota is an essential part of the gut-brain connection, facilitating communication between the gut and the brain. The brain can influence the gut microbiota’s makeup through neurotransmitters like serotonin and dopamine, as well as by controlling gut movements and responding to stress hormones. Conversely, the gut can affect the brain through the vagus nerve, neuropeptides, and neurotransmitters such as leptin and serotonin. It also communicates immune signals and maintains the integrity of the gut barrier.

Children with Autism Spectrum Disorder (ASD) face various changes that disrupt their gut-brain connection. A key issue is an imbalance in gut microbiota, referred to as dysbiosis. This imbalance can interfere with normal gut functions and may contribute to ASD symptoms. Studies indicate that children with ASD often have lower microbial diversity, an overgrowth of harmful bacteria, and an altered ratio of beneficial to harmful bacteria compared to neurotypical children. These changes can affect the production of important metabolites and neurotransmitters, as well as how the brain processes sensory information, ultimately influencing behavior and brain development. (Al-Beltagi et al., 2023).

This project aims to examine how dietary habits, nutrient deficiencies, and GI issues interact in children with ASD and explore interventions to address these challenges.

The main objectives of this study are:

1. To assess the nutritional status of children with ASD, including common nutrient deficiencies.

2. To analyze the prevalence and types of gastrointestinal complications in children with ASD.

3. To examine the relationship between dietary habits and GI complications in ASD.

4. To evaluate the impact of GI complications and to formulate a intervention tool .

**CHAPTER 2**

**REVIEW OF LITERATURE**

The review of literature pertaining the study entitled **' Nutritional status affecting children with autism spectrum disorder and their gastrointestinal complication'** is discussed under the following headings:

**2.1 NUTRITIONAL STATUS**

A good quality of life involves getting enough nutrition and staying active. This mix helps lower the chances of many chronic diseases and boosts physical performance. An individual's nutritional status is determined by the balance between what they eat and their nutritional needs, which should support nutrient use to keep reserves and make up for losses. Nutritional status is important for children with autism spectrum disorders (ASD).

ASD is a complex brain disorder that includes challenges in behaviour and thinking. Key symptoms include cognitive difficulties, poor social skills, and repetitive behaviours, which usually appear after a certain age. It is one of the fastest-growing disabilities. Early diagnosis and treatment of ASD can be aided by neuroanatomical, neurochemical, and neuroimaging markers. This paper reviews the different types of autism, their causes, early detection methods, and treatment options.

Autism spectrum disorder (ASD) includes a range of neurodevelopmental disorders. These disorders are marked by difficulties in social interactions and communication, as well as limited activities and interests. ASD describes people who show a unique mix of challenges in social communication, repetitive actions, and very focused interests or sensory behaviours that start in early childhood (Lord et al., 2020)

Recent estimates indicate that 1 in 88 children are affected by ASDs, showing a 78% rise since 2002, and they are nearly 5 times more prevalent in boys than in girls. Various genetic, environmental, and immune factors contribute to its development. Studies reveal that individuals with ASDs often face nutritional challenges due to selective eating habits and sensory sensitivities, leading to limited food intake. This issue is worsened by dietary restrictions, like gluten-free or casein-free diets, that parents or caregivers may impose to try to improve behaviour or gastrointestinal issues (Ranjan & Nasser, 2015).

Many children with ASD face various nutrition-related challenges, including issues like poor digestion, difficulty absorbing nutrients, and problems with fatty and amino acid metabolism. They often have food preferences and may refuse to try new foods, which can lead to either too much or too little nutrition. Studies have shown that these children may lack several important nutrients. This range of digestive symptoms indicates that nutritional interventions could help reduce some ASD symptoms linked to improper nutrient intake or use. The first step in addressing these nutrition-related issues is to assess their nutritional status, which can help guide effective interventions to improve their health (Alkhalidy et al., 2021).

Both genetic and environmental factors play a role in ASD. Environmental influences include exposure to harmful substances during pregnancy, such as maternal thyroid issues, low blood pressure, gestational diabetes, stress, and certain medications like valproic acid and thalidomide. Other risks during birth include prematurity, low birth weight, and lack of oxygen during delivery. Additionally, complications after birth, like respiratory distress and brain bleeding, can also be factors. Interestingly, some mothers with autism have been found to have antibodies that affect foetal brain proteins, which can disrupt brain development and lead to ASD (Zaky, 2017).

**2.2 NUTRITIONAL STATUS OF CHILDRENS WITH AUTISM SPECTRUM DISORDERS**

A study was conducted to assess the nutritional status of children with autism spectrum disorder (ASD) in the Middle East North Africa (MENA) region. The focus was on children aged 2 to 19 years with ASD. The findings revealed a significant issue with malnutrition, showing both high weight and BMI alongside undernutrition. There were also deficiencies in important micronutrients, including low levels of serum iron, calcium, and vitamins B12, B9, and D. Additionally, higher levels of homocysteine and an imbalance in omega-6 to omega-3 fatty acids were noted among these children. Many children had low intakes of protein and omega-3 fatty acids. The study also highlighted frequent mealtime challenges, disordered eating habits, and selective eating behaviours, with a tendency to consume more sweet and starchy foods while eating fewer eggs, milk, vegetables, proteins (like poultry and seafood), and fruits (Kittana et al., 2023).

Another study conducted to analyse the nutritional status of people with Autism Spectrum Disorders. It examined anthropometry, biochemical, clinical, dietary, and environmental factors. Children with ASDs tend to prefer foods that are low in texture and high in energy. Difficulties in understanding, communicating, and remembering make it hard for individuals with ASDs to recall, note, and estimate food amounts, which creates challenges in gathering accurate dietary information.(Ranjan & Nasser, 2015).

A detailed review and meta-analysis of studies on feeding issues and nutrient levels in children with autism spectrum disorders (ASD) was conducted. The systematic search found 17 studies that included a comparison group. Using strict meta-analysis methods, researchers calculated the standardized mean difference (SMD) along with standard error and the odds ratio (OR) with 95% confidence intervals (CI). The findings showed that children with ASD had significantly more feeding difficulties compared to their peers, with an overall SMD of 0.89 (0.08) and an OR of 5.11, 95% CI 3.74–6.97. Nutrient analysis revealed that children with ASD had a significantly lower intake of calcium (SMD: −0.65 [0.29]; OR: 0.31, 95% CI 0.11–0.85) and protein (SMD: −0.58 [0.25]; OR: 0.35, 95% CI: 0.14–0.56) (Sharp et al., 2013).

A cross-sectional study was conducted in by the Neurology Centre of Curitiba in Paraná, Brazil, studied 34 preschool-aged children (2–6 years). Selective eating was identified as refusing to eat, having fewer meals each day, limited food variety, and consuming the same food three or more times daily. An analysis of food intake over three days showed a lack of calcium, iron, zinc, folic acid, and vitamins A, D, and E, with none of the children meeting the daily fiber recommendation. The eating habits of these children indicated poor nutrition among those with ASD in early childhood. In summary, the findings highlight the dietary and nutritional needs of this group, suggesting that more research is needed to enhance the diets of children with ASD to support their growth and development (Natércia et al., 2021).

A case control study was conducted to compare the intake of macro and micronutrients as well as body mass index in children with autism spectrum disorder (ASD) and typically developing (TD) children. Research has frequently shown that there are minimal or no significant differences in macronutrient intake between these two groups. Some children with ASD may not follow a balanced diet, so it is important to further explore the extent and seriousness of potential deficiencies or excesses. This will help in managing their diet to reduce the risk of chronic or degenerative health issues (Marí-Bauset et al., 2015).

Another study was conducted to examine the nutrition of children with ASD and how their behaviours relate to what they eat. The research included all children with ASD from six training centres in Chongqing, a city in southwestern China. This cross-sectional study assessed the nutritional health, mealtime behaviours, and gastrointestinal symptoms of these children, along with the connections between vitamin A, vitamin D, vitamin B12, ferritin, haemoglobin, and folate levels and ASD symptoms. The findings showed that many children with ASD had growth problems, mealtime behaviour challenges, constipation, lower daily nutrition intake, and reduced vitamin A levels (Liu et al., 2016).

Childhood overweight and obesity is a global concern. Research indicates that these issues are common in Malaysia. This study took place at an autism intervention centre in Kuala Lumpur, focusing on preschoolers aged 3 to 7 years. The findings revealed that children with autism spectrum disorder (ASD) often had unhealthy body weight. The rate of underweight among these children was 9.3%, which is higher than the rates in the United States (1.9%), China (2.6%), Oman (3.9%), Iran (8.7%), and Turkey (11%). These variations may be linked to differences in socioeconomic conditions across countries. The children with ASD in this study also had low intake of important nutrients such as fibre, thiamine, vitamins C, D, E, B12, folate, calcium, and zinc, contributing to their poor body weight status. It is important for healthcare professionals to recognize the unhealthy weight and inadequate nutrition in children with ASD (Eow et al., 2021).

**2.3 AUTISM SPECTRUM DISORDER AND THEIR GI COMPLICATION**

Children with ASD are more likely to experience digestive issues. They face a higher chance of general gastrointestinal problems, such as constipation, diarrhoea, and stomach pain. These digestive symptoms can sometimes resemble the main symptoms of ASD due to various reasons. The most frequent digestive issues include excessive gas (60%), bloating (38%), stomach pain (37%), diarrhoea (28%), burping (25%), symptoms of acid reflux (16%), and constipation (Jolanta Wasilewska & Klukowski, 2015).

Food selectivity is when children refuse certain foods, eat only a few types, or often choose just one food. This behaviour is common in kids. Some studies show that food selectivity is linked to poor diet quality, which can lead to being overweight or obese. These children tend to eat fewer fruits and vegetables and more unhealthy snacks and drinks. A meta-analysis compared the diets of children with autism spectrum disorder (ASD) to those of typically developing (TD) children. It found that children with ASD generally consume less protein, calcium, phosphorus, selenium, and important vitamins like D and B, as well as omega-3 fatty acids, compared to TD children. However, they had higher intakes of vitamin E and polyunsaturated fatty acids (PUFA) (Esteban-Figuerola et al., 2019).

Children with ASD often have various gastrointestinal symptoms, such as stomach pain, diarrhoea, and constipation. This is linked to their selective eating habits, which include frequent refusals of food, a limited variety of foods, and a high intake of only a few preferred items. These children struggle with healthy eating skills, making mealtimes difficult. Autistic children tend to be very picky, usually eating a narrow selection of foods based on type, texture, or appearance. They often prefer starchy and fatty foods, simple carbs, snacks, and processed items. Some studies indicate that taking multivitamin and mineral supplements might help improve sleep and alleviate digestive problems in autistic children (Önal et al., 2023).

 There is increasing proof that gastrointestinal (GI) issues may be linked to genetic and environmental factors related to autism spectrum disorder (ASD). The studies reviewed show that children with ASD are much more likely to have GI symptoms compared to control groups and typically developing children. Recent research has concentrated on the connection between GI symptoms and factors like developmental regression, language and communication skills, severity of ASD, difficult behaviours, other mental health issues, sleep disturbances, and sensory problems. More research is necessary to better understand the causes and how to recognize and treat these symptoms (Leader et al., 2022).

Research has shown that factors in the gut, like gut bacteria, their byproducts, and other gut-related chemicals, may play a key role in ASD. Both genetic and environmental factors that influence the development and function of the brain and gut have been identified as possible causes of the gastrointestinal issues seen in ASD. Some research suggests that changing the gut bacteria or their byproducts could provide new treatment options for certain ASD traits (Hung & Margolis, 2024).

Gastroesophageal reflux, bloody stools, vomiting, and gas are more common in some autistic people. They may also show signs of gastrointestinal (GI) inflammation, like lymphoid nodular hyperplasia, complement activation, and higher levels of pro-inflammatory cytokines. Conditions such as enterocolitis, gastritis, and esophagitis can also occur. Functional GI disorders are closely related to GI inflammation, changes in gut permeability, and differences in gut microbiota. Many immune system issues have been found in the GI tracts of autistic individuals, including white blood cell infiltration, complement activation, lymphoid hyperplasia, and pro-inflammatory cytokine responses. GI problems that cause pain or discomfort may lead to challenging behaviours, such as self-injury or repetitive movements. For instance, an autistic person with stomach pain might show unusual mouthing or posturing, hurt themselves to distract from the pain, or make groaning or screaming sounds (Hsiao, 2014).

Patients with ASD often face gastrointestinal (GI) issues, with studies showing that between 46% and 84% of children with ASD are affected. Certain genetic mutations in these individuals may influence how their GI system develops and functions. Additionally, some children with ASD have immune system problems, which can cause gut inflammation and worsen GI issues. Food sensitivities, especially to gluten and casein, are also more frequent in these children, leading to symptoms like stomach pain, diarrhoea, and constipation. Some may lack digestive enzymes, affecting how well they break down food, which can result in malabsorption and GI disturbances. A key factor is the imbalance in gut microbiota, known as dysbiosis, which disrupts the gut-brain connection. Children with ASD often show reduced diversity in their gut bacteria, an overgrowth of harmful bacteria, and an imbalance between good and bad bacteria compared to neurotypical peers. These changes can affect the production of important metabolites and neurotransmitters, influencing brain development and behaviour. Research into the gut-brain link in children with ASD offers new possibilities for diagnosis and treatment (Al-Beltagi et al., 2023).

Gastrointestinal issues are often reported in individuals with autism spectrum disorder (ASD), though not everyone agrees on this. Symptoms like constipation, diarrhoea, bloating, and abdominal pain have been linked to various challenging behaviours in children with ASD, including irritability, social withdrawal, repetitive behaviours, hyperactivity, and even loss of language skills. The gut microbiota consists of many bacterial species that have a beneficial relationship with the host, helping to maintain a stable environment under normal conditions and forming specific human enterotypes. These helpful bacteria aid in nutrient absorption and immune function, creating a barrier against harmful pathogens. Changes in the environment can lead to harmful bacteria that disrupt digestive health and affect brain function and behaviour. Studies of the gut microbiota in ASD patients with gastrointestinal issues, using stool or biopsy samples, have shown higher levels of potential pathogens like Clostridia C. boltae, C. histolyticum, C. perfringens, and Sutter Ella sp., which is usually found only in human faeces, along with significantly lower levels of Bifidobacterium. (Lefter et al., 2019).

It can be hard to evaluate symptoms like pain, discomfort, heartburn, or nausea due to the communication challenges and different pain perceptions associated with ASD. Additionally, gastrointestinal symptoms can sometimes mimic the main symptoms of ASD in various ways (Jolanta Wasilewska & Klukowski, 2015).

The adjustment of gut microbiota, primarily through probiotics, is suggested as a possible treatment for gastrointestinal and behavioural issues in autism spectrum disorder (ASD). This approach may improve communication and repetitive behaviours by influencing the gut-brain connection, though the exact mechanism is still unclear. Recent studies have shown that probiotics, especially those containing Lactobacillus and Bifidobacterium, can help reduce gastrointestinal problems, restore gut health, balance gut microbiota, and boost the immune system in both animal models and individuals with autism. Another promising method is microbiota transfer therapy (MTT), which involves a modified faecal microbiota transplant using standardized doses of healthy human gut microbiota. This technique was explored by Kang and colleagues in a recent clinical trial with 18 children with ASD, resulting in increased bacterial diversity and an 80% decrease in gastrointestinal symptoms, such as constipation, diarrhoea, indigestion, and abdominal pain, after 10 weeks of treatment (Lefter et al., 2019)

GI disorders are associated with an altered composition of the gut microbiota. Gut microbiome is able to communicate with brain activities through microbiota-derived signalling molecules, immune mediators, gut hormones as well as vagal and spinal afferent neurons.

**CHAPTER 3**

**METHODOLOGY**

**3.1 SELECTION OF AREA**

**3.2 SELECTION OF SUBJECT**

**3.3 FORMULATION OF ASSESSMENT TOOL**

**3.4 COLLECTION OF DATA**

**3.5 INTERVENTION TOOL**

**3.6 STATISTICAL TOOL**

**3.7 INTERVENTION TOOL**

**3.1 SELECTION OF AREA**

The study was conducted in Kerala . Autism spectrum disorder (ASD) is a developmental condition that impacts how individuals perceive and engage with others, resulting in difficulties with social communication. Children with ASD may face challenges in their communication skills, behaviour, and nutritional health, which can make them more susceptible to nutritional deficiencies. Recent studies have pointed out that children with ASD often experience shortages of essential vitamins and minerals due to their selective eating habits. By analysing a small group of children within this population, we can better understand their overall nutritional health and eating patterns. This understanding can help identify specific needs and inform strategies to support their dietary requirements.

**3.2 SELECTION OF SUBJECT**

A group of children aged between 5 to 19 years was chosen for the study. Based on the proportion of nutritional status - underweight (64.1%) among autism children observed from an existing literature and with 20% relative precision and 95% confidence, the minimum sample size comes to 52 children.

Formula

n = $\frac{Z^{2}\_{1-\frac{α}{2}} \left(1-p\right)p }{(d\*p)^{2}} $

where,

p- proportion =0.641

d- relative precision=0.20

$Z^{2}\_{1-\frac{α}{2}}$ - standard normal deviate = 1.96

**3.3 FORMULATION OF ASSESSMENT TOOL**

A questionnaire is a type of research tool made up of a list of inquiries intended to elicit information from participants. It is frequently used to collect data about people's opinions, preferences, actions, or experiences in surveys, scholarly research, market studies, and assessments. In quantitative research, questionnaires are a vital instrument that assist researchers collect standardized data from sizable populations.

A self-designed questionnaire was created to gather primary data and secondary data . It included both open-ended and closed-ended questions to examine the nutritional status of children with autism spectrum disorder and their gastrointestinal issues.

**3.4 COLLECTION OF DATA**

Data was gathered using a self-designed questionnaire. It included details like name, age, height, weight, and questions about children's eating habits, food preferences, overall nutrition, and issues related to gastrointestinal health.

 **3.4.1NUTRITIONAL ASSESSMENT**

Nutritional assessment involves analysing dietary habits, lab results, body measurements, and clinical findings. It helps to understand the nutritional health of individuals or groups based on their nutrient consumption and absorption. Evaluating nutritional status is essential to identify if someone has a nutritional imbalance caused by a health issue or to determine the risk of developing health problems due to poor nutrition.

To study food preferences and eating habits in children with autism spectrum disorder, a questionnaire was used. By examining this information, we can also assess a person's nutritional health and any gastrointestinal issues they may have.

 **3.4.1.1ANTHROPOMETRIC MEASUREMENTS**

Anthropometric measurements are safe and quantitative ways to assess the body. They offer important insights into the nutritional health of both children and adults. By analysing body measurements, we can evaluate health, dietary habits, and the risk of future diseases in adults. These measurements also help in understanding body composition, which is essential for identifying nutritional issues and diagnosing obesity. Key parameters include height and weight. The following sections will discuss the parameters used in anthropometric assessments: -

 **3.4.1.1.2HEIGHT**

Body height is an important factor in evaluating how children grow. This measurement is often compared to a reference group and monitored over time to ensure that children are developing properly. The World Health Organization (WHO) and the Centres for Disease Control and Prevention (CDC) have created standardized methods for measuring height, which helps ensure that the results are accurate and consistent. Measuring height is a straightforward and non-invasive process that can help identify children who might be at risk for issues like malnutrition or obesity. It serves as a reliable indicator of overall growth and is usually recorded in either centimetres or inches.

**3.4.1.1.3WEIGHT**

Body weight is the simplest and most widely used method to evaluate a person's nutritional health. In scientific language, weight is defined as the force of gravity acting on an object, and this force can change based on the mass of other objects around it. To ensure accurate measurements, a digital scale was utilized to record the weights of the participants. This approach helps provide reliable data for assessing their nutritional status.

**3.4.1.1.2 BMI**

Body mass index (BMI) is one way to estimate a person's body fat that takes into consideration the person's height. BMI is calculated using a person's weight and height. In children and teens,











**3.5 INTERVENTION TOOL**

Intervention in research methodology means actively engaging in a study to influence its outcomes. Researchers can use different intervention tools to make changes or improvements. These tools can be applied at three main levels: individual, community, and policy. At the individual level, interventions might include personalised treatments or educational programs. At the community level, researchers could implement initiatives that target groups of people, such as health campaigns or support services. At the policy level, interventions may involve advocating for changes in laws or regulations to improve public health or social conditions. Each level of intervention aims to create a positive impact on the study's results and the broader context in which the research is conducted.

The methodical and scientific process of planning, creating, and refining a product's composition to satisfy particular performance, safety, and customer needs is known as product formulation. In sectors like pharmaceuticals, cosmetics, food and drink, agrochemicals, and home goods, it is a crucial stage where the product's stability, effectiveness, and appeal are all determined by the proper ingredient combination. Choosing appropriate raw materials, figuring out their ideal ratios, and testing different formulas to get the best results are the next steps in the process, which starts with establishing the required qualities of the finished product.

One micronutrient enriched product was developed after careful sensory evaluation. Another micronutrient enriched recipe was familiarized. The two recipes popularized were :

* sprouted ragi balls ( micro nutrient enriched recipe developed )
* mulberry smoothies ( micro nutrient enriched recipe familiarized )

These tools are specifically created to address particular nutritional requirements and sensory preferences. The sprouted ragi balls provide essential nutrients and are easy to digest, while the mulberry smoothies offer a delicious way to incorporate vitamins and minerals into the diet. Together, they aim to enhance overall health and meet the unique needs of individuals. Many kids with ASD face issues like picky eating, sensitivity to textures, and lack of essential nutrients, which can affect their health and development. This tool seeks to tackle these issues by providing a variety of balanced, simple-to-make, and sensory-friendly recipes that encourage healthy eating while considering personal tastes and dietary needs.

**3.6 STATISTICAL TOOL**

The nutritional status of the children with autism spectrum disorder, and factors influencing nutritional status such as feeding behaviours, food preferences and gastrointestinal symptoms will be represented in frequency and percentage. To test the statistical significance of the association of gastrointestinal symptoms with nutritional status, the Pearson Chi-Square test/Fisher exact test will be applied.

The information recorded on the data collection forms were uploaded in an excel sheet and data was analysed using IBM SPSS version 20.0 version (Chicago, USA). To obtain the characteristic of categorical variables, frequency and percentage were applied. Chi square test was employed to find association or comparison between categorical variables. The data were tabulated, analysed and compared with studies which are described in detail in the results and discussion section. A P-value ≤0.05 was considered to denote statistical significance.

**3.7 SENSORY EVALUATION**

The scientific method of measuring and evaluating the qualities of goods, such food and figuring out how customers feel about them is called sensory assessment. Its goals are to comprehend and enhance product quality, create new items and guarantee customer happiness. Serial dilution was done by selecting 20 students out of that 10 students was selected for the sensory evaluation





**CHAPTER 4**

**RESULT AND DISCUSSION**

The research included a total of 52 autistic children’s from Kerala. The study focused on various aspects of their eating habits, gastro intestinal complications, age categories and their vitamin deficiencies. To determine the importance of our findings, we used the P-value to assess statistical significance. The results of the study entitled “Nutritional **status of children affecting from autism spectrum disorder and their gastro intestinal complications”** was systematically complied and presented under the following headings;

**4.1 Demographic detail**

 4.1.1 Classification of subject based on age

 4.1.2 Classification of subject based on gender

**4.2 Vitamin deficiency in ASD**

**4.3 GI complications in ASD**

 4.3.1 Frequency of GI complications

 4.3.2 Frequency of GI discomfort

 4.3.3 Frequency of hospital visit due to GI trouble

 4.3.4 Child’s appetite loss due to GI symptoms

4.3.5 Dietary impact on child’s GI symptoms

 4.3.6 Avoidance of food due to GI symptoms

 4.3.7 Implementation of specialised diet

 4.3.8 Frequency of behavioural changes due to GI discomfort

**4.4 Corelation on dietary habits and GI complications**

 4.4.1 GI complications and child’s eating habits

 4.4.2 GI complications and food preference pattern

 4.4.3 Frequency of GI complications and food preference pattern

 4.4.4 Frequency of GI complications and management strategies for selective eating

 4.4.5 Appetite loss and management strategies for selective eating

 4.4.6 Appetite loss and child’s food preference pattern

 4.4.7 Avoidance of food and child’s food preference pattern

 4.4.8 Avoidance of food and strategies for ensuring balanced diet

 4.4.9 Implementation of specific diet and food preference pattern

**4.1 DEMOGRAPHIC DETAILS**

General information forms an important part of the study. The basic details and information collected from the subjects has been arranged and tabularised as given below .

**4.1.1 Classification of subject based on age**

The data collected included the age categories of children from 6- 19 years of age. The data collected are classified into school going and adolescent’s students.

|  |  |  |
| --- | --- | --- |
| **Age category** | **Frequency (n=52)** | **Percentage** |
| School going | 13 | 25.0 |
| Adolescents | 39 | 75.0 |

 **Table 1: Age distribution of students**

 **Figure 1: Age category of students**

The table presents the age distribution of the students comprising 52 autistic children. The majority were adolescents 75 %(n=39) followed by a smaller proportion of school going students 25%(n=13). This indicates that the study primarily comprised for nutritional and gastro intestinal patterns in adolescents with relatively fewer observations from school going students.

The predominance of adolescents suggests the nutritional status and their GI complications is frequently assessed than school going children.

**4.1.2 Classification of subject based on gender**

The data collected includes the gender of the subjects. The information collected has been arranged and tabularised below.

|  |  |  |
| --- | --- | --- |
| **Gender of the student** | Frequency(n= 52) | Percent |
| Male | 33 | 63.5 |
| Female | 19 | 36.5 |
|  |  |  |

 **Table 2 : Gender classification**

 **Figure 2: gender classification**

The table comprises that the gender distribution is uneven with a significant skew towards male 63.5% and fewer females 36.5%. This may reflect gender disparities in the studied population.

**4.2 VITAMIN DEFICIENCY IN ASD**

Nutritional deficiencies particularly of essential vitamins are well documented concern in the children with autism spectrum disorder. The age of the child also influence the nutritional pattern and their dietary habits. The majority was adolescents and fewer was school going therefore they may exhibit distinct vitamin intake profile. The information collected has been arranged and tabularised as given below:

**4.2.1 Age classification and vitamin deficiency identified**

The study explores the interplay between age specific classifications and vitamin deficiency patterns which aims to identify the high risk groups of subjects vitamin identified. By analyzing age as a determinant this bridges the gap in nutritional strategies .

|  |  |
| --- | --- |
| Age distribution |  Vitamins deficiency  |
| Nil  | Vit D | Biotin & thiamin | Vit C | Iron  | Vit B | Vit A | Vit D&C | Vit D &iron  | Vit C &B | Vit B & A |
| School going n=13 (25) | 8(34.8) | 2(22.2) | 0(0.0) | 0(0.0) | 2(25) | 0(0.0) | 0(0.0) | 1(100) | 0(0.0) | 0(0.0) | 0(0.0) |
| Adolescents n=39(75) | 15(65.2) | 7(77.8) | 1(100.0) | 2(100) | 6(75.5) | 1(100) | 1(100) | 0(0.0) | 2(100) | 3(100) | 1(100) |

**Table 3: Age classification and vitamin deficiency**

* **Fat soluble vitamin ( vitamin D)**

|  |  |  |
| --- | --- | --- |
| Age distribution  | Frequency ( n=52) | Vitamin D  |
| School going  |  25% (n =13) | 22.2% |
| Adolescents  | 75%(n = 39)  | 77.8% |

 **Table 4: fat soluble vitamin D**

Vitamin D is a fat soluble vitamin which is essential for the crucial calcium absorption , bone health and immune function. Vitamin D deficiency occur due to the limited exposure to sun and inadequate dietary intake or certain medical conditions. The symptoms of vitamin D deficiency include fatigue , weakness and bone pain. Food such as fatty fish ,eggs , milk cereals etc contain vitamin D. In the above table vitamin D deficiency was higher among adolescents 77.8% that may be due to limited exposure to sunlight and inadequate intake of dietary food that involves vitamin D. Meanwhile school going children also exhibited vitamin D but was in fewer percentage 22.2% as compared to adolescents. The adequate dietary intake and supplementations can elevate the concentration of vitamin D content in the body.

* Iron

|  |  |  |  |
| --- | --- | --- | --- |
| Age distribution  | Frequency ( n=52) | Iron  |  |
| School going  |  25% (n =13) | 25% |
| Adolescents  | 75%(n = 39)  | 75.5% |

 **Table 5 : iron**

Iron is essential for producing hemoglobin which is a protein in red blood cells that carries oxygen throughout the body. It is a vital mineral that play a crucial role in oxygen transport. The lack of iron in the body leads to the deficiency of iron that leads to a condition knowns as anemia, where the body lacks enough oxygen to carry red blood cells in the body. Symptoms of iron deficiency includes pale skin, fatigue , shortness of breath and other symptoms. Iron deficiency is caused due to inadequate absorption , poor dietary intake or due to excessive blood loss. Iron are found in animal products like meat ,liver and seafood and found in red meat , dark green vegetables ,cereals etc. In the above table iron deficiency is higher in adolescents indicating that they are higly deficient which is due to inadequate dietary intake due to GI discomforts and inadequate absorption of nutrient due any underlying medical conditions. In the case of girls menstruation also become a factor that reduces the iron content in the body. In the case of school going 25% were deficient becoming major concerns.

 **Figure 3 : vitamin deficiency identified**

The table compares the vitamin deficiencies between adolescents and school going children. The data revealed that Vitamin D was the most common deficiency in both the age groups affecting 77.8 of adolescents and 22.2 in School going children. Iron deficiency was notably high in adolescents 75.5 but was lower in school going children 25.0. Adolescent’s children also showed multiple vitamin deficiency such as biotin and thiamine, Vitamin D and iron and vitamin B and C. unique vitamin deficiency appeared commonly in adolescents

Comparatively fewer in school going children. The higher prevalence of vitamin deficiency in adolescent children suggests the nutritional challenges in ASD .That may intensify with age due to restrictive eating patterns. Vitamin D was aligned in both groups due to Limited exposure to sunlight. The occurrence of combined deficiency in adolescents underscores the Complexity of their nutritional status.

**4.3 GASTROINTESTINAL COMPLICATIONS**

**4.3.1 Frequency of GI complications**

The prevalence and types of gastro intestinal complications was an important part of the study. The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
|  **GI complications**  | Frequency (n=52) | Percentage |
| Constipation | 18 | 34.6 |
| Diarrhea | 4 | 7.7 |
| Bloating | 6 | 11.5 |
| Other | 24 | 46.2 |
|  |  |  |

 **Table 6: Frequency of GI complications**

 **Figure 4: GI complications**

According to the study the gastrointestinal problems in children, the most often reported specific problem was constipation, which affected 34.6% (n=18) out of 52 participants. Bloating was 11.5% (n=6) of children, moreover diarrhea was less common, occurring in just only 7.7% (n=4) of instances. Notably, the Other"group accounted for the biggest percentage of GI complications 46.2%, (n=24), indicating the existence of other GI-related issues not specifically included in the survey. These findings generally show how frequent constipation is in autistic children.

**4.3.2 Frequency of GI discomfort**

The study investigates the frequency and patterns of gastro intestinal discomfort across school going and adolescents with ASD. By analyzing the data it seeks to contribute the occurrence of discomforts in the children which can contribute to dietary modifications and improved clinical management in the children. The details and the information collected has been arranged and tabularized as given below.

|  |  |  |
| --- | --- | --- |
| GI discomfort | Frequency (n=52) | Percentage |
| Daily | 5 | 9.6 |
| Weekly | 4 | 7.7 |
| Occasionally | 24 | 46.2 |
| Rarely | 19 | 36.5 |

 **Table 7: frequency of GI discomfort**

 **Figure 5 : GI discomfort**

Participant’s rates of gastrointestinal discomfort in children differed greatly. A significant percentage of the children, 36.5% (n=19) reported discomfort infrequently, but nearly half of the children, 46.2% (n=24) reported symptoms occasionally. A lower proportion experienced gastrointestinal problems either daily 9.6 %( n=5) or weekly (7.7%, n=4). These results show that although the majority of children experienced gastrointestinal distress rarely and a significant minority experienced recurrent symptoms, indicating variation in the intensity and duration of symptoms.

**4.3.3 Frequency of hospital visit due to GI trouble**

The data investigates the epidemiological patterns and the determinants of hospital visit due to ASD gastrointestinal discomfort. This aim to identify the risk and implement specific dietary management to reduce avoidable hospitalizations . The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Frequency of hospital visit due to GI trouble  | Frequency (n=52) | Percentage |
| Yes, regularly | 3 | 5.8 |
| Occasionally | 18 | 34.6 |
| Rarely | 21 | 40.4 |
| No | 10 | 19.2 |

 **Table 8: Frequency of hospital visit due to GI trouble**

 **Figure 6: hospital visit due to GI trouble**

The survey regarding whether they had consulted doctor about GI complications symptoms the majority stated that they rarely consult 40.4(n=21). Meanwhile 34.6%(n=18) consulted the doctor occasionally regarding the GI symptoms of the child. Only a fewer portion seeked medical advice for GI symptoms that is 5.8%(n=3) and 19.2%(n= 10) did not seek the medical advice.

**4.3.4 Child’s appetite loss due to GI symptoms**

Children with ASD frequently experiences GI symptoms such as constipation , diarrhea , abdominal pain. These issues often contribute to appetite loss which can lead to nutritional deficiencies. It examines the appetite loss in ASD children as a consequence of GI symptoms . The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Child’s appetite loss due to GI symptoms | Frequency (n=52) | Percentage |
| Severely reduces appetite | 5 | 9.6 |
| Reduces appetite slightly | 27 | 51.9 |
| No impact on appetite | 18 | 34.6 |
| Increases appetite | 2 | 3.8 |

 **Table 9: Appetite loss due to due to GI symptoms**

 Figure 7: appetite loss due to GI symptoms

The study examined the impact of gastrointestinal symptoms on children’ s appetite. A majority of parents reported that child’s appetite are reduced slightly 51.9(n=27) but a smaller significant proportion 9.6%(n=5) observed reduction in the appetite. Meanwhile 34.6%(n=18) of children did not experienced any impact on appetite and minimal percentage 3.8%(n=2) exhibited a increase in the appetite .

These findings suggest that GI complications often lead to mild to moderate appetite suppression that could potentially effect the child’s nutritional intake and growth. The small subset with increased appetite may reflect the compensatory eating behavior or specific GI disorders such as acid reflux mimicking hunger .

**4.3.5 Dietary impact on child’s GI symptoms**

It investigates the role of dietary factors in modulating GI symptoms. The data examines to guide personalized dietary intervention that alleviate GI discomfort to improve nutrient intake and the overall well being of the child . The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
|  **Dietary impact on child’s GI symptoms**  | Frequency (n=52) | Percentage |
| Yes, significantly | 7 | 13.5 |
| Somewhat improved | 26 | 50.0 |
| No improvement | 3 | 5.8 |
| Not tried dietary changes | 16 | 30.8 |

 **Table10: dietary impact on child’s GI symptoms**

 **Figure 8: dietary impact on child’s GI symptoms**

The study evaluated the effectiveness of dietary modifications in managing the GI symptoms for autistic children’s. The findings revealed that 50.0 %( n=26) of parents reported somewhat improvement in the GI symptoms after dietary changes, while 13.5 %( n=7) observed significant relief in the symptoms. A notable proportion of 30.8 %( n=16) had not tried any dietary changes due to lack of awareness or any other alternative treatments. A small proportion 5.8 %( n=3) reported no improvement in the symptoms.

This results highlights that dietary changes can be moderately to highly effective for most children with GI discomforts. The high percentage of not trying any dietary changes underscores potential gaps in parental education or clinical guidance regarding the dietary management.

**4.3.6 Avoidance of food due to GI symptoms**

Autistic children frequently exhibit food avoidance due to specific GI symptoms. This avoidance may be due to sensory sensitivities. The data examines the food avoidance behaviours as a direct consequence of GI symptoms . The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
|  **Avoidance of food due to GI symptoms**  | Frequency (n=52) | Percentage |
| Always | 6 | 11.5 |
| Frequently | 11 | 21.2 |
| Sometimes | 21 | 40.4 |
| Rarely | 14 | 26.9 |

 **Table 11:** Food avoidance due to GI symptoms

 **Figure 9 : avoidance of food**

The study examined food avoidance behaviours in autistic children who experienced GI discomforts. It revealed that 40.4%(n=21) children sometimes avoid the triggered foods , while 21.2%(n=11) frequently avoided and 11.5%(n=6) always avoided trigger foods . a significant proportion 26.9%(n=14) rarely avoided such foods.

The complex relationship between autism spectrum disorder and GI complications highlights in the results. The selective food avoidance sometimes reflect both physiological responses and ASD related sensory aversions, which exacerbates the risk of nutritional deficiencies or restrictive eating patterns .

**4.3.7 Implementation of specialised diet**

The data examines the specialised diet for GI symptom management in autistic children. By evaluating implementation it bridges gaps between clinical recommendations and dietary interventions. The details and the information collected has been arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| **Implementation of specialised diet**  | Frequency (n=52) | Percentage |
| gluten free diet  | 1 | 1.9 |
|  casein free diet | 5 | 9.6 |
| No , but I am considering it | 22 | 42.3 |
| No , I haven’t tried any specific diet | 24 | 46.2 |

**Table 12: implementation of specialized diet**

 **Figure 10: Implementation of specialized diet**

The study explored the adoption of specialized diet among autistic children’s. the findings revealed that 46.2%(n=24) has not tried any specific diets and 42.3%(n=22) were considering dietary interventions indicating lack of guidance. Only a fewer proportions of caregivers had implemented elimination diets 9.6%(n=5) with casein free diet and 1.9%(n=1) with a gluten free diet.

The low adoption rates of not trying any specific diets suggests the unmet need for professional dietary counselling and its raises the concerns about unmanaged GI symptoms and potential nutritional risks.

**4.3.8 Frequency of behavioural changes during GI discomfort**

The data quantitatively examines the frequency and nature of behavioural changes coinciding with GI symptoms. It aim for the early identification of GI disorders. The details and the information collected has been arranged and tabularized as given below.

|  |  |  |
| --- | --- | --- |
|  Frequency of behavioural changes during GI discomfort | Frequency (n=52) | Percentage |
| Yes , frequently | 7 | 13.5 |
| Occasionally | 20 | 38.5 |
| Rarely | 18 | 34.6 |
| No behavioural changes | 7 | 13.5 |

 **Table 13: Frequency of  behavioural changes during GI discomfort**

 **Figure 11: behavioural changes during GI discomfort**

The study investigated behavioural changes in children during the episodes of gastro intestinal discomfort. The findings revealed that 38.5%(n=20) exhibits behavioural changes occasionally and 34.6%(n= 18) demonstrated rarely. The fewer proportions of 13.5%(n=7)showed no behavioural changes and 13.5%(n=7) frequent changes. The results suggests a variable connecion between behavioural manifestations and GI discomforts in children with ASD.

**4.4 Correlation on dietary habits and GI complications**

**4.4.1 GI complications and child’s eating habits**

Dietary habits and GI complications among autistic children play a significant role in the study. The information collected are arranged and tabularised as given below:

|  |  |  |
| --- | --- | --- |
| GI complications  |  child’s eating habits | P value |
| Picky eater | Eats a variety of food | Prefers specific textures/flavours | Other |
| Constipation  | 3 (16.7%) | 7 (38.9%) | 5 (27.8%) | 3 (16.7%) | 0.831 |
| Diarrhea  | 1 (25.0%) | 2 (50.0%) | 1 (25.0%) | 0 (0.0%) |
| Bloating  | 1 (16.7%) | 2 (33.3%) | 3 (50.0%) | 0 (0.0%) |
| Other | 4 (16.7%) | 13 (54.2%) | 6 (25.0%) | 1 (4.2%) |

**Table 14 : GI complications and child’s eating habits**

 **Figure 12 :GI complications and eating habits**

The study examined the relation between dietary habits and GI complications in autistic children. The data revealed that constipation was the most common GI discomfort in 16.7% in picky eaters, 38.9% who eats a variety of food, 27.8% children who prefers specific flavours and textures and 16.7%with others. Diarrhea was less frequent but it was present among children with different eating habits that is 25% among both picky eater and who prefer specific textures. Bloating was more prevalent among the children with specific children. While other GI complications was reported high among the children who ate variety of food.

A chi square test was conducted to asses the relation between dietary habits and GI complications yielding a P-value 0.831which indicates no statistically significant between the both variables.

The results highlights that constipation is more prevalent among ASD children regardless of their eating habits. The lack of statistical significant suggest that other factors may play role in GI discomforts. This suggests that eating habits alone not directly predict GI symptoms.

**4.4.2 GI complications and food preference pattern**

The data investigates the reciprocal bridge between GI complications and food preference patterns in autistic children. It aims in personalized nutrition framework that address gastro intestinal health and dietary diversity. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
|  GI complications  | Child’s food preference pattern  | P value |
| Sweet | Salty | Bland | No specific preference | Spice |
| Constipation  | 12(66.7) | 0(0.0) | 0(0.0) | 4(22.2) | 2(11.1) | <0.001 |
| Diarrhea | 0(0.0) | 3(75.0) | 0(0.0) | 0(0.0) | 1(25.0) |
| Bloating  | 1(16.7) | 1(16.7) | 1(16.7) | 3(50.0) | 0(0.0) |
| Other | 6(25.0) | 0(0.0) | 3(12.5) | 12(50.0) | 3(12.5) |

 **Table 15: GI complications and child’s food preference pattern**

 **Figure 13: GI complications and food preference pattern**

The study examined the relation between dietary habits and GI complications in autistic children. The data revealed that constipation was more prevalent among who preferred sweet food 66.7% while none of the children preferred salty and bland foods. Diarrhea was associated among salty eaters 75.0% and while none of the diarrhetic children preferred sweet and bland food. Bloating was reported among who preferred no specific preference. Moreover other GI complication was mostly reported with no specific preference 50% and 25% who preferred sweet food.

A chi square test was conducted yielding a P-value <0.001 which is statistically significant between specific food preference and GI symptoms.

The findings suggest that food preferences play a major role in GI disturbances among children with ASD. The p-value confirm statistical significant relationship which suggests that dietary preferences influence GI health.

**4.4.3 Frequency of GI complications and food preference pattern**

The table investigates the frequency of GI complications food preference pattern. The gastro intestinal frequency alters the feeding behavior and nutritional status. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Frequency of GI complications  |  Child’s food preference pattern | P value |
| Picky eater | Eats a variety of food | Prefers specific textures/flavours | Other |
| Daily  | 2(40.0) | 1(20.0) | 0(0.0) | 2(40.0) | 0.032 |
| Weekly  | 2(50.0) | 5(50.0) | 0(0.0) | 0(0.0) |
| Occasionally  | 3(12.5) | 13(54.2) | 8(33.3) | 0(0.0) |
| Rarely  | 2(10.5) | 8(42.1) | 7(36.8) | 2(10.5) |

**Table 16 : Frequency of GI complications and child’s food preference pattern**

 **Figure 14: frequency of GI complications and child’s food preference pattern**

The study examined the relation between dietary habits and GI complications in autistic children. The data revealed that daily GI discomforts was among the children with picky eater 40% and who prefer other specific food 40% while who eats a variety of food reports least20%. Weekly distributed GI discomforts was equally distributed 50% among picky eater and who prefer to eats a variety of food. Occasional discomfort was highest in children who ate variety of food followed by 33.3% who prefers specific flavours. Rare discomfort was frequent in varied eaters 42.1% and with those who preferred specific flavours 36.8%.

A chi square test was conducted and the analysis revealed a statistical significant relationship of p- value 0.032 indicating that eating habits influence the children with ASD experience GI discomforts.

The findings indicates that the picky eater are more prone to frequent GI discomforts due to nutrient deficiencies. Moreover children who ate a variety of food reports occasional and rare discomfort. The higher frequency was reported among who prefers other unspecified eating habits that suggest unmeasured factors .The statistical significance underscores the need for tailored dietary interventions.

**4.4.4 Frequency of GI complications and management strategies for selective eating**

The data examines the frequency and pattern of GI complications and evidence based management strategies for associated selective eating. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Frequency of GI complications  | Management strategies for selective eating | P value |
| Yes | No |
| Daily  | 5(100.0) | 0(0.0) | 0.640 |
| Weekly  | 3(75.0) | 1(25.0) |
| Occasionally  | 22(91.7) | 2(8.3) |
| Rarely  | 17(89.5) | 2(10.5) |

**Table 17 : Frequency of GI complications and management strategies for selective eating.**

 **Figure 15: frequency of GI complications and management strategies for selective eating.**

The study examined the relationship between selective eating behavior and the frequency of GI discomfort among autistic children. Children experiencing daily discomfort was highly 100% managed by the parents followed by those with 91.7% occasionally and 89.5% rarely. Weekly discomfort showed lower management rates 75.0%.

Chi square test was conducted which yielded a non-significant p value 0.640 indicating no association between management of selective eating behavior and GI discomforts.

The findings reveals that most parents selectively managed the eating behaviors in child. The high management indicates the strong awareness of parents related to the feeding challenges of children with ASD. But low statistical significant implies that there is no direct influence if GI symptoms with selective eating behavior.

**4.4.5 Appetite loss and management strategies for selective eating**

It investigates how the GI symptoms affect the intake of appetite and the management strategies for selective eating. The selective eating and the appetite impact influence the nutrient intake leading to deficiency. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Appetite loss due to GI symptoms  | Management strategies for selective eating | P value |
| Yes | No |
| Severely reduces appetite  | 5(100.0) | 0(0.0) | 0.015 |
| Reduces appetite slightly  | 27(100.0) | 0(0.0) |
| No impact on appetite | 13(72.2) | 5(27.8) |
| Increases appetite | 2(100.0) | 0(0.0) |

**Table 18: Appetite loss and management strategies for selective eating**

 **Figure 16: appetite loss and management strategies for selective eating**

The analysis examined the relationship between GI symptoms on child’s appetite and the management of selective eating behaviors in child. 100% of children with selective eating behaviors severely and slightly reduces the appetite due to GI symptoms. 100% of children with increased appetite also received the management. Meanwhile 72.2 % of children had no impact on appetite also received the management. 27.8% does not received the management.

A chi square test which yielded statistical significant of p value 0.015 indicates that the parents are more likely to intervene with selective eating when GI symptoms affect their child’s appetite.

The statistical significant association between impact on appetite and selective eating behavior suggests that parents use appetite changes as a major indicator for nutritional intervention. It also raises parental concerns about nutritional status.

**4.4.6 Appetite loss and child’s food preference pattern**

The data examines the impact of appetite loss and food preference pattern of the autistic child. It also affect the intake of specific nutrient leading to nutrient deficiency. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Appetite loss due to GI symptoms  | Child’s food preference pattern  | P value |
| Sweet | Salty | Bland | No specific preference | Spice |
| Severely reduces appetite  | 1(20.0) | 1(20.0) | 0(0.0) | 2(40.0) | 1(20.0) | 0.007 |
| Reduces appetite slightly  | 10(37.0) | 2(7.4) | 1(3.7) | 11(40.7) | 3(11.1) |
| No impact on appetite  | 8(44.4) | 1(5.6) | 1(5.6) | 6(33.3) | 2(11.1) |
| Increases appetite | 0(0.0) | 0(0.0) | 2(100.0) | 0(0.0) | 0(0.0) |

**Table 19: Appetite loss and child’s food preference pattern**

 **Figure 17: appetite loss and child’s food preference pattern**

The study examined how GI symptoms affect appetite and specific food preferences in children with ASD. Severely reduced appetite was distributed across multiple preferences such as sweet, salty and spice 20% and no specific preference was higher 40%. Slightly reduced appetite showed highest preference for sweet food 37% followed by no specific preference 40.7%. No impact on appetite preferred sweet food 44.4% and equally distributed 5.6% salt and bland foods followed by no specific preference 33.3%. Increased appetite showed exclusively bland food.

A chi square test was conducted and analyzed that test was statistically significant with p value 0.007 indicating that food preferences significantly vary based on how GI symptoms affect the appetite.

**4.4.7 Avoidance of food and child’s food preference pattern**

The table examines the avoidance of certain food due to GI discomforts and child’s food preference pattern. Due to GI discomfort ASD children often prefers specific food patterns such as picky eater, prefer certain flavors and textures and sometimes eats variety of food . The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Avoidance of food causing GI discomfort  |  Child’s food preference pattern | P value |
| Picky eater | Eats a variety of food | Prefers specific textures/flavours | Other |
| Always  | 1(16.7) | 3(50.0) | 2(33.3) | 0(0.0) | 0.974 |
| Frequently  | 1(9.1) | 5(45.5) | 4(36.4) | 1(9.1) |
| Sometimes  | 3(14.3) | 10(47.6) | 6(28.6) | 2(9.5) |
| Rarely  | 4(28.6) | 6(42.9) | 3(21.4) | 1(7.1) |

**Table 20: Avoidance of food and child’s food preference pattern**

**Figure 18 : avoidance of food and child’s food preference pattern**

The table represents the relation between the child eating habits and their tendency to avoid the food that causes GI discomforts. The data shows that among the children who always avoid the food that causes discomfort, 50% were reported to eats a variety of food followed by 33.3% preferred specific flavors and 16.7% was picky eater. For those who frequently avoids the food 45.5% ate a variety of food, 36.4% preferred specific flavors and preferences and 9.1% equally distributed among picky eater and other foods. For those who sometimes avoided the food, the highest was among who preferred variety of food 47.6%, 28.6%had specific flavors and 14.3% was picky eater. In the case of rarely avoiding such foods 42.9% was among picky eaters, 28.6% were preferred specific flavors.

A chi square test was done with p value 0.974 indicating no statistical significance between the eating habits and the avoidance of food that causes GI discomforts among ASD children.

The lack of statistical significance indicates that there is no strong correlation between specific eating habits and the avoidance of GI triggering foods.

**4.4.8 Avoidance of food and strategies for ensuring balanced diet**

The data investigates the avoidance of food and the parental strategies for ensuring balanced diet. Due to GI discomfort child avoid certain food that causes GI discomfort, due to that parents include variety of food and supplements for ensuring balanced diet. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Avoidance of food causing GI discomfort | Strategies for ensuring balanced diet  | P value |
| Includes a variety of food | Use supplements | Consult with a nutritionist | Struggle to maintain balance |
| Always  | 4(66.7) | 0(0.0) | 1(16.7) | 1(16.7) | 0.644 |
| Frequently  | 7(63.6 | 2(18.2) | 0(0.0) | 2(18.2) |
| Sometimes  | 17(81.0 | 2(9.5) | 1(4.8) | 1(4.8) |
| Rarely  | 11(78.6 | 1(7.1) | 0(0.0) | 2(14.3) |

**Table 21:** **Avoidance of food and strategies for ensuring balanced diet**

 **Figure 19: avoidance of food and strategies for ensuring balanced diet**

The table examines the relationship about the strategies for ensuring a balanced diet and the avoidance of food that causes GI discomfort. The study examined parental strategies for ensuring a balanced diet for ASD children who avoid food due to gastro intestinal discomfort. Of 52 respondents, parents 81.0% whose children sometimes avoided GI-triggering foods reported diverse inclusion of foods in their child’s diet, meanwhile only 66.7% of parents whose children always avoided GI-triggering foods did the same. Supplement usage was highest 18.2% in children with GI discomfort at least occasionally. Consulting a nutritionist was most common 16.7% among parents with children who avoided agonistic foods always. Parents of children who always or frequently avoid certain foods reported higher struggles in maintaining dietary balance 16.7% and 18.2%, compared to those whose children sometimes 4.8% or rarely 14.3% avoid such foods.

A chi square test was conducted with P value 0.644 indicating no statistical significant relationship between frequency of food avoidance and dietary management.

**4.4.9. Implementation of specific diet and food preference pattern**

The given table examines the implementation of specific diets and food preference pattern of autistic child. The information collected are arranged and tabularised as given below.

|  |  |  |
| --- | --- | --- |
| Implementation of specific diets  | Child’s food preference pattern | P value |
| Sweet | Salty | Bland | No specific preference | Spice |
| Yes, a gluten free  | 1(100.0) | 0(0.0) | 0(0.0) | 0(0.0) | 0(0.0) | 0.763 |
| Yes a casein free diet  | 4(80.0) | 0(0.0) | 0(0.0) | 0(0.0) | 1(20.0) |
| No, but I am considering it  | 7(31.8) | 2(9.1) | 2(9.1) | 9(40.9) | 2(9.1) |
| No, I haven’t tried any specific diet | 7(29.2) | 2(8.3) | 2(8.3) | 10(41.7) | 3(12.5) |

**Table 22: Implementation of specific diet and food preference pattern**

**Figure 20: implementation of specific diet and food preference pattern**

The table represents the relationship between specific dietary interventions and food preferences among children with autism spectrum disorder. In the data gluten free diet was provided only by one parent who preferred sweet foods. In the case of casein free diet 80.0% was preferred in sweet food followed by 20.0% in spicy food. Meanwhile majority was reported in no specific preference 40.9% about considering a specific diet and in no tried any specific diet 41.7%.

 **CHAPTER 5**

**SUMMARY AND CONCLUSION**

Autism spectrum disorder is a developmental condition that affects behaviour , social interaction and the behaviour. They often face nutritional deficiencies due to the selective eating pattern which leads to the risk of obesity. The diagnosis follows the DSM-V criteria that includes at least six behaviour including repetitive behaviour and social behaviour. The individuals with ASD are at greater risk of mental health challenges which includes anxiety , depression and aggression. Moreover gastro intestinal issues are common including constipation, diarrhoea , bloating and abdominal pain that may share neurological or genetic links with ASD and mental health conditions. Certain research on autism and feeding issues focused mainly on feeding behaviour , food preferences but it often neglected the food quality and diet quality. A deeper understanding of these can provide better in sights in nutritional challenges in autistic children. The relationship between feeding behaviour and autism severity varies based on the assessment methods. Children with autism spectrum often experiences gut dysbiosis which reduces the microbial diversity and harmful bacterial overgrowth that may contribute to ASD symptoms by disrupting the brain development , neurotransmitter balance and disrupting the metabolite production. The gut microbiota plays a major role in brain function, immunity and digestion. The brain affects the gut bacteria via stress response and neuro transmitters that influences the brain through the immune signals , vagus nerve and gut barrier integrity. The enteric nervous system usually manages the digestion independently which communicates directly with the brain via gut brain axis that involves neurotransmitters that influence digestive and cognitive functions. Nutritional status is shaped by food quantity , quality and the overall health of the child with social and cultural factors. As per the surveys conducted the following summary is drawn based on the results obtained.

**Objective 1**: The first objective was to asses the nutritional status of children with ASD including common nutrient deficiencies.

Total 52 autistic children were selected for the study. A self designed questionnaire was designed to collect the primary and secondary data. They were 33 males and 19 females which was classified as school going and adolescents categories. According to the objective vitamin D was the most common deficiency in the both age groups affecting 77.8% of adolescents and 22.2% in school going children. Iron deficiency was also notably high in adolescents 75.5% but relatively fewer in school going children 25%. Multiple vitamin deficiency was found such as vitamin D and iron , vitamin B and C in adolescents students.

**Objective 2** : The second objective was to analyse the prevalence and types of gastro intestinal complications in children with ASD.

Out of 52 autistic children ,constipation was the common gastrointestinal complication 34.6% and 46.2% other GI complication that was not specific. Most of them reported the frequency of GI discomfort occasionally 46.2% and rarely 36.5%. due to the issue of GI discomfort the frequency of visiting the hospital was rarely among the children with 40.2% and 34.6% consulted occasionally. Most of the students appetite was greatly reduced slightly 51.9% due to GI discomforts. Regarding the dietary impact there was somewhat improvement 50% in the GI discomforts showed by them and then avoidance of the food that causes GI trouble was eliminated sometimes 40.4% by the subject. To reduce the occurrence of GI symptoms implementations of any specific diet was not provided 46.2% ,meanwhile 42.3% was considering about the diet. The behavioural changes was occasionally shown 38.5% by the subjects.

**Objective 3** : The third objective was to evaluate the impact of dietary and GI complications in ASD.

Out of 52 samples constipation was the most common GI complications discomfort 16.7% in those who preferred to eat variety of food 38.9%. while in the case of preferring certain food diarrhoea was common who preferred salty food 75%. Regarding GI frequency it was equally distributed 50% among picky eater and who preferred to attain a variety of food. The occurrence of GI complications was occasionally managed 91.7% by the parents. The management for selective eating was provided , who reduced the appetite during GI discomforts. The assurance of balanced diet was higher 18.2% who reported GI discomfort frequently. Gluten free diet was provided only by one parent and 41.7% had not tried any specific diet , meanwhile others were considering.

**Objective 4**: The fourth objective was to formulate a intervention tool.

The project included the formulation of a intervention tool and a recipe was formulated as a intervention tool. Sprouted ragi balls was developed as a new product. A sensory evaluation was conducted among 10 subjects. The product was analysed for its texture , taste, appearance and overall acceptability. The product was sensorily acceptable to all the subjects.

**Conclusion**

The present study analysed the nutritional status and gastro intestinal complications in autistic children in Kerala. The study focused on their GI problems , food preferences and vitamin deficiency. Data revealed that the most were vitamin D and iron deficient and possessed constipation as the GI discomfort who preferred to eat variety of foods. This is due to limited access of certain food due to GI complications and avoidance of certain foods. Moreover the data shows most them preferred different foods and choices are also different. Majority of parents are ensuring a balanced diet and trying to provide implementation of specific diet for the children with ASD. Adequate dietary modifications are required to change their overall eating habits to ensure well maintained diet.0.

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**APPENDIX I**

**QUESTIONNAIRE TO ELICIT THE INFORMATION REGARDING NUTRITIONAL STATUS AND GASTRO INTESTINAL COMPLICATIONS OF AUTISTIC CHILDREN**

Below are few statements to assess the nutritional status and the gastro intestinal complications of the children with autism spectrum disorder. Please read them carefully and kindly attend all the questions. The data collected are highly confidential and is used for academic purpose only.

1. **GENERAL INFORMATION**

Name of the student :

Gender of the student

* Male
* Female
* Other

Age of the student :

Height of the student :

Weight of the student:

Mobile no ( what’s app)

Place :

Email id :

1. How would you describe your child’s eating habits ?
* Picky eater
* Eats a variety of food
* Prefers a specific textures /flavours
* Other
1. Do you manage selective eating behaviours in your child ?
* Yes
* No
1. Describe strategies or interventions you have tried and their outcomes.
2. Does your child prefer specific types of food (e.g., sweet, salty)?
* Sweet
* Salty
* Spice
* Bland
* No specific prefernces
1. Does your child have any specific food aversions or preferences?
2. Provide examples of foods your child avoids or prefers ?
3. How do you ensure your child gets a balanced diet?
	* + - Include a variety of foods
			- Use supplements
			- Consult with a nutritionist
			- Struggle to maintain balance
4. Does your child show aversion to certain food textures (e.g., crunchy, soft)?
* Yes , very often
* Sometimes
* Rarely
* Not at all
1. How often does your child eat fruits and vegetables?
* Daily
* A few times a week
* Rarely
* Never
1. Does your child prefer specific mealtime routines?
* Yes , strictly follows routine
* Sometimes prefers routines
* Rarely follow routines
* No preference
1. Are you concerned about your child's overall nutritional intake?
* Yes, very concerned
* Somewhat concerned
* Slightly concerned
* Not concerned
1. Do you use nutritional supplements for your child?

* Yes, regularly
* Occasionally
* Rarely
* No
1. What type of GI complications does your child commonly face?

* Constipation
* Diarrheoa
* Bloating
* Other ( then specify :
1. How often does your child experience gastrointestinal discomfort (e.g., constipation, diarrhoea)?
* Daily
* Weekly
* Occasionally
* Rarely
1. Have you consulted a doctor about your child’s GI symptoms?
* Yes, regularly
* Occasionally
* Rarely
* No
1. How do GI symptoms affect your child’s appetite?

* Severely reduces appetite
* Reduces appetite slightly
* No impact on appetite
* Increases appetite
1. Have dietary changes improved your child’s GI symptoms?
* Yes , significantly
* Somewhat improved
* No improvement
* Not tried dietary changes
1. Does your child avoid foods that cause GI discomfort?

* Always
* Frequently
* Sometimes
* Rarely
1. Have you tried specific diets for your child?
* Yes, a gluten free diet
* Yes a casein free diet
* No, but I am considering it
* No I haven’t tried any specific diet
1. Have you been informed by a healthcare provider that your child may have a vitamin deficiency?

* Yes
* No
1. If yes, which vitamins were identified as deficient?
2. What advice or interventions were recommended?
3. Have you identified any foods that trigger or worsen your child’s gastrointestinal issues?
* Yes
* No
1. List specific foods or dietary patterns that seem to contribute to GI discomfort ?
2. Does your child exhibit behavioral changes during GI discomfort?

* Yes, frequently
* Occasionally
* Rarely
* No behavioural changes
1. Do you think improving GI health can enhance your child’s overall well-being?
* Strongly agree
* Agree
* Neutral
* Disagree

**APPENDIX II**

**INTERVENTION TOOL**

After the evaluation of nutritional status and gastro intestinal complication one micronutrient enriched product was developed after careful sensory evaluation. Another micronutrient enriched recipe was familiarized. The recipes formulated was :

* sprouted ragi balls ( micro nutrient enriched recipe developed )
1. **SPROUTED RAGI BALLS**

Sprouted ragi enhances the nutritional value by improving the digestion and absorb essential nutrients like iron, calcium and fiber. Sprouted ragi is a good source of antioxidant that can help to boost the immune system in the body**.**

**INGREDIENTS :**

1. Sprouted ragi : 100g
2. Jaggery : 1 piece
3. Coconut : 50g
4. Ghee : 2 table spoon

Method of preparation :

* Roast the sprouted ragi and grind into powder .
* Take a pan and add little bit of water into pan, and add jaggery until its melt and become a thick consistency.
* In to the melted jaggery and after that add coconut into it and mix it.
* Leave until it is cool and crush it again in grinder for seconds.
* Then add it into the sprouted powder and mix thoroughly.
* Add ghee and make it into small balls .

