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Review Article

THE ROLE OF DIET IN THE MANAGEMENT OF AUTISM SPECTRUM DISORDER - A REVIEW EMPHASIZING LOCAL DIETARY PRACTICES

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ABSTRACT

Autism spectrum disorder"(ASD) refers to a group of repetitive sensory-motor behaviors and early-onset social communication impairments. Reduced social interactions, lack of eye contact, repeated stereotypical sensory and motor behaviors, etc, are characteristics of children diagnosed with autism. According to the Child Development Centre's (CDC) Autism and Developmental Disabilities Monitoring (ADDM) Network, about one in every 36 children has been diagnosed with autism spectrum disorder. Epidemiological studies show that the prevalence of ASD has increased globally over the past few decades. Patients with Autism Spectrum Disorders report having a high prevalence of gastrointestinal (GI) symptoms, including bowel motility issues, adverse reactions to specific foods, and reduced nutritional absorption. Individuals with GI disorders tend to exhibit more behavioral impairments. (e.g., irritability, hyperactivity) and they may be linked to gut dysbiosis, which is an indication of the "gut-brain axis disruption." Numerous studies indicate that nutrition may have a special role in the development of ASD as well as its management by reducing symptoms. In children with ASD, it is essential to evaluate dietary necessities to prevent further nutritional deficiencies through appropriate dietary interventions. Thus, in addition to medicine and other therapies, diet has an important role in the management of autism.

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impaired communication, socialization, and restrictive behavior patterns. Derived from the Greek word "autos," meaning "self," the word "autism" came into existence.[1] It encompasses conditions like Asperger syndrome, Autism, Pervasive Developmental Disorder-Not Otherwise Specified, Childhood Disintegrative Disorder, and genetic disorders like Rett syndrome.[2] Approximately one in every 36 children is diagnosed with ASD,[3] with a 3:1 frequency in males and females.[4] World Autism Awareness Day is celebrated on April 2 as ASD is the third most prevalent developmental disorder. Longitudinal analysis shows an increase in ASD prevalence over time.[5]

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Etiology of Autism

Although the exact etiology of ASD is unknown, several genetic and non-genetic risk factors have been identified that are either alone or in combination thought to contribute to the development of ASD. The significant genetic component of ASD is shown by epidemiological twin research. For identical twins, the concordance rate is 70–90%; for fraternal twins, it is 0–10%.[6] Familial clustering is also present. ASD risk may be mediated by non-genetic variables such as parental age, the nutritional and metabolic health of the mother, prenatal stress, infection during pregnancy, and exposure to specific chemicals, heavy metals, or medicines. Numerous studies have been conducted in an attempt to determine the cause of ASD, and they have included toxic environments, toxic foods, nutritional deficiencies, immune system issues, oxidative stress, gastrointestinal issues, allergies, and emotional stress. In the context of ASD, a toxic environment or toxic food is defined as air pollution, soil containing lead, food production manipulation through chemical spraying, etc. [7]

Clinical Features

It is a complex neurological disorder that affects how the brain functions, which affects different abilities. It usually starts before the age of three. Patterns of onset include early developmental delay and loss of social or language skills, which may be gradual or rapid. The first symptom of ASD frequently involves delayed language development, followed by a lack of social interest /unusual social interest. Usually, parents get concerned due to delayed language development by the age of 18 months. Also, odd play patterns and unusual communication patterns are noticed.

Diagnosis

Diagnosis of ASD mainly involves clinical history from a reliable person who has very close interaction with the child. Standardized criteria for diagnosing ASD are provided by the Diagnostic and Statistical Manual, Fifth Edition (DSM-5) published by the American Psychiatric Association. Other tools include the M-CHAT (Modified Checklist for Autism in Toddlers) Childhood Autism Rating Scale (CARS), and the Autism Treatment Evaluation Checklist (ATEC). Genetic testing is done to identify the risks associated with ASD.

Co-Morbidities

Sometimes ASD co-occurs with other disorders such as attention deficit hyperactivity disorder (ADHD), which is considered the most common comorbidity in people with ASD (~ 28%). Other co-morbidities include anxiety and phobias, dissociative disorders, depression, bipolar disorder, mood disorders, sleep problems, sinusitis, headaches, seizures, etc. In addition, 46–84% of children with ASD have comorbidities such as gastrointestinal issues (reflux, persistent constipation, and diarrhea). [8]

Gut-*Brain* Axis

A greater spotlight has been given in recent years to the influence of the gut microbiota via this axis on neurodevelopment. Research has revealed the involvement of the microbiota–gut–brain axis in neurodevelopmental conditions such as Rett syndrome, attention deficit hyperactivity disorder, and autism spectrum disorder. The gut barrier may change as a result of dysbiosis of the gut microbiota, creating a "leaky gut", facilitating pathogen translocation into the portal and systemic circulation, which causes neuroinflammation in CNS conditions such as ASD. Through the components of its cell walls and the systemic circulation, the gut microbiota regulates neurodevelopment. They also influence social behavior, anxiety, and stress reactions, all of which are linked to autism spectrum condition, via modifying neurodevelopmental processes. Neurotransmitters and neuromodulators, which can both affect neurodevelopment, are released by the gut microbiota along with a variety of other metabolites.

Ayurvedic Perspective

Symptoms of autism are similar to *Unmada*. Ayurveda classics have elaborated on the etiology and pathogenesis of *Unmada* along with symptoms and management of each type of *Unmada*. By analyzing these symptoms, it can be seen that they closely resemble autism spectrum disorders, especially autism and Asperger syndrome (table 1,2,3).

Table 1: *Vatika* Unmada & ASD

Symptoms of *Vatika Unmada* [9,10,11]	**Feature of ASD**
Parisaraṇamajasram (constant wandering)	Hyperactive
Akasmat akshi bhru oshṭa amsa hanu agrahasta pada anga vikshepana (repeated movements of eyes, eyebrows, lips, shoulder, jaws, hands, feet)	Highly repetitive and stereotyped hand and eye movements.
Satatam aniyatanam ca giram utsargah (frequent utterance of uncontrolled sound and voice)	Monotonous speech, odd speech
Phenaagamanam Aasyat (frothing from mouth)	Drooling of saliva
Abhikshna smita Hasita nrutya gita vaditra samprayogasca asthane	Frequent smiling, laughing, dancing, singing, and playing musical instruments in improper places and situations.
Vina vansa sankhasamyatala sabdanukaraṇam (loudly mimicking the sound of the lute, flute, conch, *Samya*, and *Tala*)	Echolalia
Yanam ayanaih (riding non-vehicle toys/ objects)	Riding non-vehicle toys/ objects
Alankaraṇam analankarikair dravyair (adoration by non-ornamental objects)	Adoration by non-ornamental objects
Abhyavahareṣu avalabdheshu lobham	Eating disorder

Labdheshu cha avamanam (The desire for rare edible food materials that are not available and not wanting what is available)	Selective eating

Table 2: *Paithika Unmada* & ASD

Symptoms of *Paithika Unmada* [12,13,14]	**Features of ASD**
Amarsha (Intolerance/impatience)	Intolerance/impatience, don't wait for his turn
Krodha (anger)	Temper tantrums
Asthane samrambha (aggression in improper situations)	Aggression in improper situations
Sastra loshtra kusha kaashta mushtibhir abhihananam swesham paresham va (injures himself of others using weapons, bricks, fists, etc)	Harming himself and others
Santapam cha atirekam (excess anguish)	Excessive distress
Bahubhuk	Voracious appetite
Anidra	Insomnia
Prachaya seta udaka anna Abhilasha	Desire for shade, cold food & water

Table 3: *Kaphaja Unmada* & ASD

Symptoms of *Kaphaja Unmada*[15,16,17]	**Symptoms of ASD**
Ekadese sthanam (stay in one place or spot)	Solitary play
Tuṣṇimbhavah (silence, less talkative)	Reduced speech
*Alpasah camkramaṇam (*less mobility)	Reduced mobility
Lala singhaṇaka sravaṇam (excessive salivation and nasal secretion)	Drooling of saliva
Swapna nityata (excess drowsy)	Less active
Anannabhilasa (aversion towards food)	Eating disorder
Rahah kamata (liking for loneliness)	Reduced attention to surroundings and people.
Soucha dwesha (dislike for bathing and cleanliness)	Dislike for bathing and cleanliness.

Ayurveda aims to maintain health in a healthy individual and to cure disease. To achieve this goal various rules and regulations are told in various *Ayurvedic* classics. *Dinacharya (*daily regimens*), Ritucharya (*seasonal regimens*), and Sadvrutta (*ethical and moral guidelines*)* are said in Ayurveda classics for the same purpose. Rules related to *Ahara (*food*)* are one of the most important rules among these. Each food has its specific properties which play a significant role in the causation and curing of disease. *Pathyahara* (wholesome diet) plays a significant part in treating many diseases along with medication. This concept varies for each individual. A wholesome diet to one person may be unwholesome to another. Wholesome food can be taken regularly while others should be avoided. It varies according to disease also. The principles of Ayurveda are mainly based on the concept of *Tridoshas (*3 humors*)*. For a person to be healthy these humors should be in equilibrium. Imbalance in these humors produces diseases of both body and mind. In the concept of *Trayopastamba* (3 pillars of life- *Ahara*, *Nidra*, *Brahmacharya*), food is regarded as the main one.[18] *Acharya Charaka* has mentioned that the intake of unwholesome, polluted, and unclean ingredients with mutually contradicting properties is one of the causative factors of *Unmada*.[19] These factors may cause alterations in the gut-brain axis by disturbing digestion and metabolism. Due to these improper food habits, *Agni* (digestive fire) is affected resulting in indigested or semi-digested food leading to *Amavastha (*stage of indigestion*)*. This may lead to inflammation in the gut causing increased gut permeability and finally leaky gut. Also, *Ama* along with *Agnimandya (*reduced digestive fire*)* affects *Dhatu Parinama (*digestion at micro level*)*. The purity of food is needed for purity of mind. This explains the role food plays in *Unmada*. To tackle the gastrointestinal issues in autistic children, wholesome diet should be taken according to rules and regulations.

Management

Management for ASD includes non-biological as well as biological therapies. Non-biological therapies include applied behavioral analysis, discrete trial training, early intensive behavioral intervention, verbal behavioral intervention, pivotal response training, etc. Nowadays new therapies such as

horseback riding therapy, dolphin-assisted therapy music therapy also prevail. Biological therapies include symptomatic treatments, chelation, intravenous immunoglobulins, gastrointestinal therapy, etc. [20] Not every person with ASD responds well to a single therapy. Ayurvedic treatments have shown great effectiveness in the management of autism, and treatment includes both external and internal therapies. Internal therapies include the intake of medicated ghee, which may be a difficult task for parents due to palatability and sensory issues. In such situations, a diet that can be as useful as internal medication is beneficial to parents. *Acharya Kasyapa* considers food as *Mahaoshada*.[21] while *Acharya Charaka* uses the term *Pathya* as a synonym for *Chikitsa (*treatment) itself.[22] Individualized medical nutrition therapy should be used in conjunction with counseling, occupational therapy, speech therapy, and behavior management. The nutritional need of children with a disability varies from a normal child. Nutritional risk factors include obesity, underweight, growth deficiency, gastrointestinal disorders, metabolic disorders, feeding problems, dental cavities, allergies, and drug-nutrient interactions. Children with autism often experience extremes in their digestive systems. Digestion, absorption, and excretion- the three main parts of the system- are never in the right order. The child is a fuzzy eater as a result. Unusual eating habits are also a result of sensory integration problems. They might stop consuming many everyday items and start craving inedible like toothpaste, soap, paint, plastic, lotions, etc. They could like diets high in sugar and processed carbohydrates. People frequently observe that the items they crave make their behavior worse and uncontrollable. Bowels also have an erratic pattern. Complementary Alternative Medicine (CAM) treatments usually include dietary interventions, vitamin supplements, and herbal remedies. Nutrition therapy can be either an additive or an elimination diet. Elimination diets, particularly those free of gluten and/or casein, are among the most widely used complementary and alternative medicine (CAM) for autism.[23] According to studies, one out of every seven kids are placed on this diet. Dietary counseling regarding better carbohydrate food choices is often necessary in these cases. Although there has been relatively limited research, intolerance to gluten and casein has been related to intestinal inflammation and the development of brain opioids. As a result, parents of children with ASD are increasingly adopting gluten-free and casein-free diets, which are regarded as complementary and alternative therapies. Some studies have reported improvements in IQ and social quotients in children with ASD treated with magnesium and vitamin B6, as well as high-dose supplementation of vitamin C for enhancing clinical symptoms.[24] Including a variety of fruits, vegetables, grains, etc according to the condition of the child may be beneficial to the child. Our traditional food, like avial, sambar, etc, including multiple vegetables, is very useful here (Table 4). Some of the main ingredients and their nutritive values are explained in Table 5.

Table 4: Properties of some local food

	Rasa	***Guna***	***Virya***	***Vipaka***	***Karma***
Dosha[25]	*Madura Lavana Kasaya*	*Guru Snigda*	*Ushna*	*Madura*	*Vata samana, Kapha vardana*
Idli[26] (a type of rice cake)	*Madura,Lavana Eeshat amla*	*Guru Snigda*	*Ushna*	*Madura*	*Vata samana, Kapha vardana*
Ariputtu[27]	*Madura, Lavana*	*Guru Ruksha*	*Seta*	*Madura*	*Kapha vardana*
Ragi puttu[28]	*Kasaya Madura Lavana*	*Guru Ruksha*	*Seta*	*Madura*	*Kapha haram, eeshat vata vardanam*
Ari upma[29]	*Katu, Madura Lavana*	*Guru Snigda*	*Seta*	*Madura*	*Kapha vardanam*
Rava upma[30]	*Katu, Madura Lavana*	*Guru Snigda*	*Seta*	*Madura*	*Kapha Pitta vardanam*
Coconut chutney[31]	*Katu, Madura Lavana*	*Laghu Snigda*	*Seta*	*Madura*	*Eeshat Kapha vardanam*
Kadala curry[32]	*Katu, Madura Lavana*	*Guru Ruksha*	*Ushna*	*Katu*	*Vata vardanam*
Cherupayar curry[33]	*Katu, Madura Lavana Kasaya*	*Eeshat Guru, Ruksha*	*Seta*	*Katu*	*Alpam vata vardanam*

Vegetable stew[34]	*Madura Lavana*	*Guru Snigda*	*Seta*	*Madura*	*Kapha vardanam*
Sambar[35]	*Katu, Amla Lavana*	*Ushna Tikshna*	*Ushna*	*Katu*	*Vata pitta vardanam*
Avial[36]	*Sarva rasa amla rasa pradana*	*Guru Snigda*	*Anushna seta*	*Amla*	Doesn't aggravate any *Dosha*
Kanji[37] (Rice gruel)	*Madura rasa Kasaya anurasa*	*Laghu Snigda*	*Seeta*	*Madura*	*Agni dipti*

Table 5: Properties of commonly used fruits and vegetables

Carrot [38,39]	• *Vata Pitta Samaka* (mitigates *vata* and *pitta*) • High in α- and β-carotene and is a rich source of provitamin A. Good source of dietary fiber, magnesium, and manganese, and the trace mineral molybdenum • It acts as an antioxidant and immune enhancer.
Drumstick [40,41,42]	• *Kapha Samana* • Rich in lipids, non – non-structural carbohydrates, fiber, protein, and fatty acids like oleic acid, palmitic acid, and linolenic acid, and a great source of vitamin C. • Helps to improve digestive health and boosts immunity.
Green gram[43]	• It has antioxidants vitexin and iso-vitexin, rich in potassium, magnesium, calcium, fiber, and vitamins A, B, D, and K.
Beans[44,45]	• *Kapha Pitta Samana* • Helps in fetal development & proper digestion. • Rich in calcium, magnesium, phosphorus, protein, iron, folic acid and vitamin C.
Ash gourd[46]	• *Vata Pitta Samana, Medya, Vak Vishudhikara* • It improves memory and is beneficial for intelligence • Rich in thiamine, niacin, calcium, potassium, vitamin C, and fiber. • Aids in digestive function • It is indicated in *Apasmara* (epilepsy)and *Unmada*.
Brahmi[47]	• Improves cognitive function and memory • It also has anti-stress activity • It is *Medya, Matiprada, Vatakapha Samana, Mohahara*
Gooseberry[48]	• It is rich in antioxidants, vitamins A & C, calcium, phosphorus, and fibers and is low in fat and calories.
Brown rice[49]	• Rich in Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), Magnesium, Phosphorus, Selenium, and Manganese. A half-cup serving of brown rice contains: - Calories (108), Protein (3gm), Fat (1 gm), Carbohydrates (22 gm), Fiber (2 gm), and Sugar (0 gm).

The diet should be taken by recommended dietary allowances (RDA). RDA varies according to patient and condition. Care should be taken not to cause excess intake.

DISCUSSION

Nutritional intervention and complementary and alternative medicine approaches are highly prevalent (about 74%) among children affected with ASD. In recent years, many types of diets, such as the ketogenic diet and gluten-free, casein-free diets, have grown in popularity. Many studies have been conducted to evaluate the effect of diet and probiotics in ASD children. Most studies have shown improvement in both systemic symptoms and behaviors. Kerala's diet, which includes rice, avial, sambar, etc., shows an abundance of both macro and micronutrients. They should be able to compensate for nutrient deficiencies and tackle gastrointestinal issues since nutrient supplementation has proved to be effective in these conditions in ASD children. Additionally, in the causes of Unmada, improper food habits (including unclean, unwholesome, incompatible, and untimely eating habits, as well as neglecting dietary rules) have been identified as contributing factors to the disease. This improper food may lead to *Agnimandya* and the formation of ama/toxins in the gut, leading to gut inflammation and increased gut permeability. By correcting diet, the digestive fire will

increase, and there will also be a reduction in ama formation. This will also improve gut permeability and prevent leakage of toxins to the brain via the blood-brain barrier. Many of the food items included in the Kerala diet aid in digestion and are also rich in both macro and micronutrients.

CONCLUSION

Autism is a neurological condition that impairs behavior and social skills. Along with problems in communication and behavior, gastrointestinal symptoms including constipation, diarrhea, etc.

A nutritious diet can help reduce symptoms related to metabolism, digestion, and mental health. Many GI symptoms including constipation showed improvement by dietary interventions. To reduce the symptoms of ASD, various dietary approaches have been explored, particularly the prevalent digestive issues that those with ASD experience. Many dietary interventions have been developed with the relationship between gut health, brain processes, and microbiota in mind. Some of these interventions have been shown to have positive effects on the mental health of autistic children. Most of our local foods are rich in macro and micronutrients like calcium, magnesium, potassium, phosphorus, and many vitamins. They are also rich in fiber. These foods may help in improving digestion and removing *Amavastha,* thereby restoring gut permeability. Vitamin and mineral supplementation have shown positive changes in children with ASD. But long-term intake of medicines, even if they are vitamins and minerals, may not be good for the long-term health of these children, as there is the risk of hypervitaminosis, etc. Following a proper diet in proper quantity according to the condition of the child may be very effective in improving behavioral as well as gastrointestinal symptoms in these kids.

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