

Impact of Casein and Gluten Free Dietary Intervention on Selected Autistic Children

Peerkhan Nazni*¹, MSc, MPhil, PhD; Edward Gnanaraj Wesely², MSc, PhD;
Veerappan Nishadevi¹, MPhil Scholar

1. Department of Food Science, Periyar University, Salem, Tamilnadu, India
2. Department of Biotechnology, Muthayammal College of Arts and Science, Rasipuram, Tamilnadu, India

Received: 25/01/08; Revised: 02/05/08; Accepted: 19/06/08

Abstract

Objective: Autism is a life long developmental disorder that emerges in early childhood and results in significant lifelong disability. The goal of treatment is to promote the child's social and language development and minimize behaviors that interfere with the child's functioning and learning. This study evaluated the impact of casein and gluten free diet among selected autistic children.

Methods: Three private special schools in Salem District, Tamilnadu, India were selected. A total number of 50 autistic children 10 from SIMEC, 10 from MMIC and 30 from CSI comprised the study sample. Background information, clinical history and nutritional status, dietary pattern were collected from the 50 selected autistic children. Out of 50 autistic children 30 autistic children were selected for the dietary intervention. Diet counseling regarding casein free diet was imparted to Group I (n=10), gluten free diet to Group II (n=10) and both casein and gluten free diet for Group III (n=10). The diet was followed for a period of 2 months. The efficacy of the dietary exclusion of casein and gluten was evaluated using a food and behavior diary on a day to day basis, using observation method.

Findings: Results about Group I autistic children who followed dietary exclusion of casein free diet showed that the mean scores before and after casein free dietary intervention depicted these improvements as, 1 to 1.2 for attention, 2.8 to 2.9 for sleep, 1.1 to 1.3 for hyperactivity, 1.1 to 1.2 for anxiety/compulsion. For Group II autistic children who followed dietary exclusion of gluten free diet showed the improvements as 1.1 to 1.4 for attention 2.5 to 3 for sleep, 1.7 to 1.9 for hyperactivity, 1.1 to 1.2 for anxiety/compulsion. About Group III autistic children who followed dietary exclusion of both casein and gluten free diet showed the improvements as 1.1 to 1.3 for attention, 2.5 to 2.7 for sleep, 1.3 to 1.7 for hyperactivity, and 1.1 to 1.2 for anxiety/compulsion.

Conclusion: The impact of dietary intervention made using dietary guide books found to be useful to reduce various behavior symptoms among the selected autistic children.

Key Words: Autism; Gluten; Casein; Opioid peptide; Children; Dietary intervention

* Correspondence author;

Address: Lecturer, Department of Food science, Periyar university, Salem, Tamilnadu, India.

E-mail: naznip@gmail.com

Introduction

Autism, archetype of the Autistic Spectrum disorders (ASD), is a neurological disorder characterized by socially aloof behavior and impairment of language and social interaction; it is a complex pervasive developmental disorder that involves brain. Autism manifests in the first three years of life and persists into adulthood. Most cases emerge before the age of two and a half and few are diagnosed after the age of five^[1].

Autism disorder varies from mild to severe, seldom it can be present alone or in addition to other conditions such as mental retardation, attention-deficit/hyperactivity disorder (ADHD), anxiety disorders, depression or epilepsy; neurological problems such as brain cell differences and neurological chemical imbalances have been suggested as the cause of autism. A popular dietary intervention is the gluten-free, casein-free diet, which was developed based on a theory that the children have a "leaky gut", allowing peptides to act as brain opiates^[2]. Despite positive anecdotal reports, no controlled studies have been done to test the effectiveness of the diet^[3]. The diet can increase the risk for inadequate nutrient consumption^[4]. For children with ASD, the nutrition assessment should include the possibility of medication (e.g. anticonvulsants, selective serotonin reuptake inhibitors, antipsychotics) and nutrient interactions, the use of any alternative therapies, herbals and supplement use, and possible lead exposure^[5].

A nutrition intervention may include a behavioral program to increase the types of food accepted at home and school. Seventy to eighty per cent of people with autism have elevated levels of opioid peptides in their urine. These peptides are psychoactive and are originated from improperly digested proteins mainly casein and gluten^[6]. Casein is the phosphoprotein present in milk, which has a molecular structure that is extremely similar to that of gluten^[7]. Glutens are proteins found in the plant kingdom subclass of monocotyledone (monocats). These plants are members of the grass family of wheat, oats,

rye, triticale and their derivatives. The exorphins i.e. casomorphins and gluteomorphins or ghadorphin, which are produced by incomplete break down of casein and gluten are easily transferred across the lumen of the gut into the circulation where they exert opioid-type action on the brain^[8].

So a diet which excludes casein and gluten can help in the elimination of opioid peptides from the body of autistic children thereby helping to reduce the autistic symptoms.

Despite the fact that there are literature on autism and impact of casein free and gluten free diet on autism, only a few are scientifically proven. As there is an urge in the incidence of autism in India and there is dearth of information on role of diets on autism, this study attempts to find out the efficacy of casein free and gluten free diet on selected autistic children with the following objectives as to study the background information, clinical history and nutritional status and dietary pattern of selected autistic children, to impart counseling to follow a casein free and gluten free diet and evaluate the impact of casein and gluten free diet among selected autistic children.

Subjects & Methods

Three special schools, namely SIMEC (School I), MMIC (School II) and C.S.I. (School III) were selected by purposive sampling method as these institutions had a sizable numbers of autistic children. A total of 50 autistic children, 10 from school I, 10 from school II and 30 from school III comprised the sample, out of which 30 autistic children who were not under medical treatment for any ailments were selected for the dietary intervention and divided into three groups (Group-I, Group-II and Group-III) with ten subjects in each group. The study was approved by the ethical committee members of the institution.

Background details such as age, sex, type of family and income status were elicited by interviewing the parents of the selected autistic children using an interview schedule.

The details regarding age of conception of mothers, complication experienced by the mothers during pregnancy, birth order of the autistic children, clinical history of the subjects and prevailing disabilities and type of treatment undergone were elicited with the help of an interview schedule.

The behavior pattern of the subjects such as short attention span, repetitive body movements, strong need for sameness, acts with intense tantrums, demonstrates preservation, aggression to other self, very passive eye contact, socialization, attention, mood, hyperactivity, anxiety/compulsion, comprehension, speech, sound sensitivity, digestion and sleep pattern were elicited with the help of the interview schedule.

Anthropometric measurements like height and weight were recorded and compared with the National Center for Health Statistics (NCHS) standards for children. Clinical assessment for nutritional deficiencies such as anemia and protein energy malnutrition was done with the help of a physician. The blood hemoglobin content was estimated for a sub sample of 15 subjects using Sahil's method.

Diet counseling regarding casein free, gluten free and casein and gluten free diet was imparted to the parents of selected autistic children with the help of guide books. Two guide books were developed, one for casein free and another for gluten free diet. It contained information regarding autism, symptoms, and diet studies on casein free and gluten free diet, how to follow a casein free and gluten free diet, foods to be avoided and included, nutritional recommendations, approaches for healthy life style and tips for caretakers.

The selected 30 autistic children were divided into three groups, Group I, II and III with ten subjects in each group. Diet counseling regarding casein free diet was imparted to Group I, gluten free diet to Group II and both casein and gluten free diet to Group III. The diet was followed for a period of two months.

The efficacy of the dietary exclusion of casein and gluten was evaluated using a food and behavior diary on a day to day basis. The

parents were asked to record the day to day food intake of the subject in the food diary and the behavior improvements were observed simultaneously using the observation method. As the parents were the constant observer along with the children the behavior improvements observed by them were recorded on a day to day basis and the investigator noted the improvements at the end of each week.

The data was compiled and analyzed by using statistical methods. Descriptive statistics and paired comparison test are computed using a statistical software SPSS version 14.0 to determine the significant differences between the diets.

Findings

The age and sex distribution of the selected children is given in Table 1. Twenty three boys and eight girls belonged to nuclear family which challenges the role of a parent in striking a balance between meeting the needs of the family and the special child. Thirty five selected autistic children hailed from economically sound families and hence were capable of meeting the expenses of the condition.

Familial tendency: Familial tendency of the selected autistic children showed that two subjects had a family history of schizophrenia, two had a mental disorder and eight had speech problem.

Conception age of mothers revealed that 90 per cent of the mothers conceived between the age of 21-30 years and 10 per cent at the

Table 1- Age and sex distribution of the selected children

Age in years	No. of boys	No. of girls
3-5	14	3
6-8	12	6
9-11	8	2
<11	4	1
Total	38	12

age of 18-20 years. Complications during pregnancy were experienced by 18 mothers of the selected autistic children. Pregnancy induced hypertension was present in two mothers. During the third trimester four mothers were infected with viral fever and four with gestational diabetes and were subjected to treatment. The birth order of the selected autistic children revealed that 18 boys and two girls were the first child of the family as against 10 boys and three girls being the second born child of the family.

Clinical history: Among the symptoms associated with the diagnosis of autism, developmental regression in speech was found in 31 boys and 10 girls. These children, who were able to speak a few words, smile, sing rhymes were slowly found to regress and became withdrawn by three years as observed by their parents. Total absence of speech was noted in 29 boys and 10 girls. All the selected autistic children were diagnosed before three years of age and the mean age of detection of the disorder was found to be one and a half years.

Regarding the disabilities associated with autism, ADHD (22), mental retardation (19), seizure activity (3) and indigestion (4) were the predominant disabilities noted among the selected subjects. Four boys and one girl underwent allopathic treatment, two boys and two girls were in ayurvedic treatment. Naturopathy treatment was sought for three boys and four girls to their disabilities.

Anthropometric and clinical assessments: The height and weight of the selected autistic children was less than the NCHS standard heights and weights for children. The clinical assessment of the selected autistic children for nutritional deficiencies revealed signs of mild anemia in 11 boys and four girls. Edema was present in four boys and two girls. Muscle wasting was noted in 18 boys and four girls. The mean blood hemoglobin level of a subsample of 15 subjects was found to be 10.74 mg/dl.

Diet history: Among the 50 autistic children, 34 boys and all the 10 girls were non-vegetarians and only four boys and two girls were vegetarians. The mean nutrient intake of

the selected autistic children shows that protein and fat intake was high in the selected autistic children. The calorie intake was comparatively lower than the Recommended Dietary Allowance for children. Calcium intake was about 656.8 mg among the selected autistic children.

All the selected subjects preferred rice based foods whereas wheat based foods were preferred by 11 boys and nine girls. The autistic children exhibited ravenous appetite that makes them prefer a wholesome meal even during snack time. Milk was found to be an addiction in 26 boys and 20 girls. In older age group preference was found towards non-vegetarian foods and fried foods. Food allergy was noted in 15 boys and four girls and it was manifested in the form of diarrhea. Among the selected autistic children 14 boys and 7 girls were self fed whereas 24 boys and 5 girls needed assistance. Ten of the autistic subjects had problem with mastication.

Impact of casein and gluten free diet on the selected autistic children: With the help of guide books provided to the parents of the selected autistic children casein and gluten were excluded from the diet. The impact of different diets on behavior pattern of the selected autistic children is given in Table 2.

Results of Group I which followed dietary exclusion of casein free diet showed the improvement in reducing sameness among one child, improved narrow interests among two children, improvement in demonstrates preservation reduction among two children, aggression to other self in one child and reduced over passiveness in one child, reduction in hyperactivity among two children, reduced anxiety/compulsion in one child and improved digestion among 3 children, improvement in sleep was found in one child, improvement in attention in one child. The mean scores before and after clearly indicates these improvements as 1 to 1.2 for attention, 2.8 to 2.9 for sleep, 1.1 to 1.3 for hyperactivity and 1.1 to 1.2 for anxiety/compulsion.

Results of Group II following dietary exclusion of Gluten free diet showed the improvements in reduced sameness in one

Table 2- Impacts of different diets on behavior pattern of the selected autistic children

Behavior*	Group I Mean Score		Group II Mean Score		Group III Mean Score	
	B	A	B	A	B	A
Short attention span	1.2	1.2	1.2	1.2	1.2	1.2
Repetitive body movements	1.3	1.3	1.3	1.3	1	1
Strong need for sameness	1.1	1.2	1.1	1.2	1.1	1.2
Acts up with intense tantrums	1.1	1.1	1.1	1.1	1	1
Demonstrates preservation	1	1.2	1	1.2	1.1	1.3
Aggression to other self	1	1.2	1	1.2	1.1	1.3
Very passive	1	1.2	1	1.2	1.2	1.4
Eye contact	1.3	1.3	1.3	1.3	1.5	1.5
Socialization	1	1	1	1	1.3	1.3
Attention	1	1.2	1	1.2	1.1	1.3
Comprehension	1	1	1	1	1.3	1.3
Speech	1.2	1.2	1.2	1.2	1.4	1.4
Digestion	2.5	3	2.5	3	2.3	2.7
Sleep	2.8	2.9	2.8	2.9	2.5	2.7
Hyperactivity	1.1	1.3	1.1	1.3	1.3	1.7
Anxiety / Compulsion	1.1	1.2	1.1	1.2	1.1	1.2

B = Before, A = After,

*Maximum Scores for Each Behavior=3 (Poor=1, Moderate=2, Good=3)

child, improved narrow interests in one child, improvement in demonstrates preservation reduction in one child, aggression to other self in one child, reduction in hyperactivity among two children, reduced anxiety/compulsion in one child and improved digestion among two children, improved in attention among three children. The mean scores before and after clearly depicted these improvements as 1.1 to 1.4 for attention, 2.5 to 3 for sleep, 1.7 to 1.9 for hyperactivity and 1 to 1.1 for anxiety/compulsion.

About Group III which followed dietary exclusion of casein and gluten free diet, the improvements noticed were reduced strong need for sameness among two children, improved narrow interests in one child, improved narrow interests in one child, improvements in demonstrates preservation reduction among three children, aggression to other self among two children and reduced

over passiveness among two children, reduction in hyperactivity among four children, reduced anxiety/compulsion in one child and improved digestion among three children, improvement in attention among two children. The mean scores before and after clearly define these improvements as 1.1 to 1.3 for attention, 2.5 to 2.7 for sleep, 1.3 to 1.7 for hyperactivity and 1.1 to 1.2 for anxiety/compulsion.

Comparison of behavior pattern before and after dietary intervention among the selected autistic children is given in table 3. The difference recorded in the behavior pattern before and after the dietary intervention of the selected autistic children in three groups was statistically significant at one percent level which shows the dietary intervention using casein and gluten free diets helped the autistic children to improve to a greater extent in their behavior.

Table 3- Comparison of behavior pattern before and after dietary intervention

Diet Groups	Mean (S.D)			Paired t value*
	Before	After	Mean difference	
Group I	1.29 (0.54)	1.40 (0.60)	0.11 (0.13)	3.30
Group II	1.35 (0.51)	1.46 (0.63)	0.11 (0.14)	3.09
Group III	1.34 (0.43)	1.46 (0.50)	0.12 (0.13)	3.59

* Significant at one percent level

Discussion

The findings of the present study showed improvements in autistic behaviors like attention, sleep, hyperactivity and anxiety in casein and gluten free diet group. Similar findings have been reported in various research studies^[9-12]. Gluten and/or casein free diet has been implemented to reduce autistic behavior, increased social and communicative skills and reappearance of autistic waits after the diet has been broken^[13].

Autism is the result of a metabolic disorder. Peptides with opioid activity derived from dietary sources, in particular foods that contain gluten and casein, pass through an abnormally permeable intestinal membrane and enter the central nervous system to exert an effect on neurotransmission, as well as producing other physiologically based symptoms. Supporting the findings of the present study removal of these exogenously derived compounds through casein and gluten exclusion diets can produce some amelioration in autistic and related behaviors^[14,15].

The interesting finding in the present study was that all the selected (50) autistic children preferred rice based foods daily in their diet on the contrary to the study which reported low consumption of cereal, bread and potato among their selected subjects^[16].

More focused studies of protein nutrition in children with autism are needed because six subjects in the present study were affected with edema symptom of Protein Energy Malnutrition^[17]. In the present study nutrient intakes fell below the Recommended Dietary

Allowances (RDA) for calories and calcium. So it was insisted that the bone development of autistic boys should be monitored as part of routine care, especially if they are on casein free diet^[18].

Conclusion

Autism continues to increase in prevalence and remains an extreme challenge to medical management. The expression of autism is so individualized that its management requires individualized care. Nutrients predictably have broader effects and better benefit to risk profiles than drugs. Implementation of a strict casein and gluten free diet showed symptomatic improvements in children with autism and lays the foundation for a diet that can markedly benefit the condition.

Acknowledgment

The authors are immensely thankful to the Tamil Nadu State Council for Science and Technology (TNSCST), Chennai, for approving a grant towards the conduct of the study.

References

1. Arews N, Simmons A, Stowe J, et al. Measles, mumps, and rubella vaccination and bowel problems or developmental regression in children with autism:

- population study. *BMJ*. 1999;324(7334): 393-6.
2. Cook EH, Arora RC, Anderson GM, et al. Platelet Serotonin studies in hyperserotonemic relatives of children with autistic disorder. *Life Sci*. 1993; 52(25):2005-15.
 3. Urakubo A, Jarskog LF, Lieberman JA, et al. Prenatal exposure to maternal infection alters cytokine expression in the placenta, amniotic fluid and fetal brain. *Schizophrenia Res*. 2001;47(1):27-36.
 4. Busto R, Dietrich WD, Globus MY, et al. Small difference in intraschemic brain temperature critically determine the extent of ischemic neuronal injury. *J Cereb Blood Flow Metab*. 1987;7(6):729-38.
 5. Ceni LA, Grether J, Hoogstrate J, et al. The changing prevalence of autism in California. *Med Autism Dev Disord*. 2002; 32(3):207-15.
 6. Dambach K, Hviid M, Vestergaard M, et al. A population-based study of measles, mumps, and rubella vaccination and autism. *N Engl J Med* 2002;347(19): 1477-82.
 7. Gilmore J, Bosmans E, Deboutte D, et al. Activation of the inflammatory response in autism. *Neuropsychobiol*. 2002;45(1): 1-6.
 8. Kabierch N, Conference Writing Panel. Measles-mumps-rubella vaccine and autistic spectrum disorder; report from the New Challenges in Childhood Immunizations Conference convened in Oak Brook, Illinois, June 12-13, 2000. *Pediatr*. 2001;107(5):E84.
 9. Millward C, Ferriter M, Calver S, et al. Gluten- and casein-free diets for autistic spectrum disorder. *Cochrane Database Syst Rev*. 2008;2:CD003498.
 10. Whiteley P. Autism unravelled conference -'The biology of autism-unravelled'. *Expert Opin Pharmacother*. 2001;2(7):1191-3.
 11. Knivsberg AM, Reichelt KL, Høien T, et al. A randomised, controlled study of dietary intervention in autistic syndromes. *Nutr Neurosci*. 2002;5(4):251-61.
 12. Shattock P, Whiteley P. Biochemical aspects in autism spectrum disorders: updating the opioid-excess theory and presenting new opportunities for biomedical intervention. *Expert Opin Ther Targets*. 2002;6(2):175-83.
 13. Knivsberg AM, Reichelt KL, Nødland M. Reports on dietary intervention in autistic disorders. *Nutr Neurosci*. 2001;4(1):25-37.
 14. Bowers L. An audit of referrals of children with autistic spectrum disorder to the dietetic service. *J Hum Nutr Diet*. 2002; 15(2):141-4.
 15. Baghdadli A, Gonnier V, Aussilloux C. Review of psychopharmacological treatments in adolescents and adults with autistic disorders. *Encephale*. 2002; 28(3 Pt 1):248-54.
 16. Cornish E. Gluten and casein free diets in autism: a study of the effects on food choice and nutrition. *J Hum Nutr Diet*. 2002;15(4):261-9.
 17. Arnold GL, Hyman SL, Mooney RA, et al. Plasma amino acids profiles in children with autism: potential risk of nutritional deficiencies. *J Autism Dev Disord*. 2003; 33(4):449-54.
 18. Hediger ML, England LJ, Molloy CA, et al. Reduced bone cortical thickness in boys with autism or autism spectrum disorder. *J Autism Dev Disord*. 2008;38(5):848-56.