

**THE ROLE OF FOOD INTOLERANCE IN
GASTROINTESTINAL SYMPTOMS IN CHILDREN**

A RETROSPECTIVE SURVEY

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DECLARATION

1. I, Ugur Murat, hereby declare that none of the work presented in this essay has been submitted to any other University or Institution for a higher degree and that to the best of my knowledge contains no material written or published by another person, except where due reference is made in the text.
2. The studies described in this essay were approved by the Central Sydney Area Health Service Medical Ethics Committee (RPAH Zone), and all subjects gave informed consent before participating.

Signature..... Monday 8th June, 1998

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ABSTRACT

Introduction: From 1995 to 1998, 750 children aged 3-12 years were seen at the Royal Prince Alfred Hospital (RPAH) Allergy Unit, for the investigation of suspected food allergy and/or intolerance. Of these, 223 children presented with gastrointestinal symptoms. The aims of this project were (1) to document the occurrence of food intolerances in this subgroup, (2) to determine the long-term outcome of dietary modification, and (3) to determine the nutritional adequacy of the diet after appropriate modification.

Methods: Clinical data on these 223 children was collected from the medical and dietetic notes at the RPAH Allergy Unit. Parents were sent a Follow Up Questionnaire and a Conners' Rating Scale for Parents on behalf of their child, to obtain information regarding the long term outcome of the Simplified Elimination Diet (SED), dietary modification and any changes in their child's symptoms. Ten volunteers were sent a Food Frequency Questionnaire to assess nutritional adequacy of dietary management of such children. All data was entered into a computerized database for analysis.

Results: At presentation and on challenge the most common gastrointestinal symptoms were diarrhoea and abdominal pain, and the most common associated symptoms were hyperactivity, eczema and headaches. Eighty-three percent of respondents found that their gastrointestinal symptoms improved significantly when their diets were modified. Of these, 56% achieved this by dietary modification based on formal challenge testing, and 27% by a self modified diet based on information and advice received at the clinic. Dietary modification significantly improved behaviour and physical symptoms. Salicylates, amines, milk, wheat and additives were the common triggers and therefore the most restricted. Children on modified diets maintained their growth velocity but can have inadequate intake of vitamin A without supplementation. Dietary calcium intakes did not meet Recommended Daily Intake in those with milk exclusion without supplementation.

Conclusions: Gastrointestinal symptoms were found to be associated with intolerance to salicylates, milk, wheat and amines. The SED protocol was a useful tool for the investigation of food intolerance in children, however many parents preferred to modify their child's diet empirically, based on the information received at the clinic, rather than

going through the formal elimination and challenge protocol. Dietary modification requires monitoring by a dietitian to ensure adequate nutrition.

INTRODUCTION

Food intolerances are common causes of gastrointestinal symptoms in childhood. A number of double blind studies ^{12, 21, 29} have shown that individual foods can reproduce symptoms in children with gastrointestinal symptoms, but the mechanisms are not fully understood.

From 1995 to 1998, 750 children aged 12 or under were seen at the RPAH Allergy Unit for investigation of suspected food allergy and/or food intolerance. In many cases, the outcome of the simplified elimination diet was not recorded in the dietetic or medical notes, since parents of children who improved did not always feel the need to return for follow-up. The purpose of this study was to follow-up a subgroup of 223 children aged between 3-12 years presenting with gastrointestinal symptoms, in order to document (1) the results of the dietary elimination and challenge protocol, (2) the long-term effectiveness of dietary modification, and (3) nutritional adequacy in these children.

FOOD INTOLERANCE

Classical food allergies are mediated by IgE antibodies, and present with well recognised clinical features such as atopic eczema and anaphylaxis. By contrast, food intolerances are non-immunological reactions to food, and may present with a variety of non-specific symptoms. It is currently believed that these reactions are pharmacologically mediated responses to common food chemicals. These chemicals may be naturally occurring substances (e.g. salicylates, amines, and glutamate) or additives (preservatives, flavourings and colourings) found in a wide range of foods. Reactions are dose-related, cumulative and delayed reactions are common, often

Comment [PJH1]:

Comment [PJH2]:

making diagnosis difficult. These characteristics of food intolerance often confuse patients as to what foods are causing symptoms any in many cases leads to unnecessary avoidance of foods ⁷. Studies have shown a discrepancy between foods perceived to cause food intolerance and the results of double blind placebo controlled food challenges ³⁴.

Clinical manifestations

In children, the most common gastrointestinal symptoms are abdominal pain, nausea, feeling "sick", colic, flatulence and loose stools. Associated symptoms can include hives, headaches, mouth ulcers, nasal congestion, leg aches and pain, learning difficulties and behavioural disturbances ⁷. Allergy and intolerance can coexist in the same individual ⁷.

Toddler's diarrhoea is seen in the first few years of life, and is characterized by irregular bowel movement, watery or mushy faeces, which often contain mucus or undigested food. Growth patterns are normal ². Recurrent abdominal pain affects 10-15% of school age children who generally have a history of colic in the first three months of life, loose faeces, pain relieved by evacuation and food intolerance. The pain can interfere with normal activity and may be associated with other symptoms such as headaches, limb pains, enuresis and behaviour disturbances ^{2, 3, 5}.

Diagnosis

There are no reliable blood or skin tests for the diagnosis of food intolerance. Currently, the most effective means of diagnosis is by an elimination diet and challenge protocol. Those patients whose symptoms either improve significantly or resolve completely within 2-6 weeks on an appropriate elimination diet are systematically challenged with food substances. This can be done either as open food challenges, or double blind challenges where purified food chemicals and placebos are administered in capsule form ³⁰.

Management

The long-term effectiveness of dietary modification has not been established. Strict adherence to a modified diet requires self-discipline, motivation, and a major alteration in eating habits. Jones et al.²¹ found that only a small number of adult patients were able to successfully complete an elimination diet and challenge protocol, but they considered the effort of doing the elimination diet worthwhile since 50-65% of patients became symptom free. In other studies, of those patients who responded positively to an elimination diet, long-term compliance was about 80%^{17, 26}.

Some authors^{18,20} have suggested that dietary modification is inappropriate for children with recurrent abdominal pain. They consider this to be primarily a psychosomatic disorder, since many patients have associated symptoms consistent with the diagnostic criteria for hysteria. However, other studies^{3, 19} have shown that dietary elimination can simultaneously relieve both gastrointestinal symptoms and associated neuropsychiatric symptoms in sensitive individuals.

NUTRITIONAL ADEQUACY

Criticisms have been made about the degree of dietary restriction required when following an elimination diet or modified diet, due to the reduced variety of foods and hence nutrient intake. The potential for malnutrition and growth failure is the greatest concern, and particular emphasis has been placed on children who avoid staple foods such as milk and wheat^{8, 23}.

A study by Devlin et al⁹ reported on 46 children with food intolerance. Twenty children avoided milk, received no milk substitute, and 15 had a calcium intake below the RDI for children. However in the 26 children who avoided cows milk but were

provided with a soya or casein hydrolysate formula only three had a calcium deficiency⁹.

A study by Chiu ⁶ assessed the nutritional adequacy of 20 patients (5 adults and 15 children) seen at the RPAH allergy unit and placed on the "Simplified Elimination Diet" (SED). Nutritional adequacy was assessed before and after the SED. The children were divided into three groups: (i) children on the SED (n=5), (ii) children on the milk free SED (n=5) and (iii) children on the milk free, wheat free SED (n=5). The study showed that all groups had a significant reduction of vitamin A intake to below the RDI, and also a significant increase in protein and vitamin C intake to levels well above the RDI. The milk-free and wheat-free group had a significant reduction in calcium intake, to a level below the RDI. But these levels were still better than the inadequate intake on their regular diet ⁶.

AIMS

The purpose of this study was to document the role of food intolerance in children with gastrointestinal symptoms.

The specific aims were:

1. To document the occurrence of food intolerance in a cohort of children aged 3 to 12 years presenting to the RPAH Allergy Clinic with gastrointestinal symptoms, by analysis of medical and dietetic records.
2. To determine the long-term outcome of dietary modification by a follow-up questionnaire.
3. To determine the nutritional adequacy of a sub-set of these patients by administration of a Food Frequency questionnaire.

METHODS

ETHICAL APPROVAL

Ethical approval was obtained from the Ethics Review Committee of the Central Sydney Area Health Service (RPAH Zone).

RECRUITMENT

Subjects

A cohort of 223 children of both sexes, 3-12 years of age, who had presented at the RPAH Allergy Unit, with gastrointestinal symptoms were included in the study. The subjects were selected from a larger cohort of 750 patients with a variety of symptoms seen at the clinic between 1995 and 1998. The parents of all 223 children were sent a follow-up questionnaire and were offered the opportunity to participate in a study of nutritional adequacy. The first ten who volunteered were sent a food frequency questionnaire and were given an appointment for dietetic and medical review. The methodology is summarised in a flow diagram (Figure 1).

Dr. Velencia Soutter, Paediatrician at the Allergy Unit, recorded the diagnosis of gastrointestinal symptoms. The children recruited had recurrent or chronic gastrointestinal symptoms in the absence of organic disease. Where relevant, food allergens were identified by skin prick tests. All the children in the study sample underwent dietary investigation for suspected food intolerance. Dietary investigation was with the use of the SED (appendix A).

PROCEDURE

The Questionnaires:

All parents of children with gastrointestinal symptoms were sent the following package, containing:

1. An information letter outlining the aims and procedures of the study. A follow-up consultation and nutrient analysis of the child's diet, was offered to the first 10 parents to return the questionnaires (Appendix B).
2. Conners' Behaviour Rating Scale Questionnaire for children >3years. The Conners' provides a percentile score for six aspects of child behaviour (Appendix C).
3. A Follow-up Food Allergy and Intolerance Questionnaire was developed by Dr Velencia Soutter and Dr Robert Loblay of the Allergy consulting Rooms. The questionnaire was designed to obtain information on symptoms, diet, food/chemical challenges and reactions, and medication (Appendix D).
4. A reply paid envelope.

A CSIRO Food Frequency Questionnaire to assess nutrient intake (Appendix E), was sent to for the first 10 volunteers.

Four weeks after the initial mailing, a reminder letter was sent to parents who did not respond to the initial request (Appendix F).

Data Collection

Preliminary information was gathered from the medical and dietetic files of children seen by Dr. Soutter between 1995-1998. This information was entered into a computerized database that was password protected and used for analysis. The children were divided into four main symptom groups:

1. Gastrointestinal symptoms only.
2. Gastrointestinal symptoms and eczema.
3. Gastrointestinal symptoms and behaviour.
4. Gastrointestinal symptoms, eczema and behaviour.

Data from the Follow-Up and Conners' Behaviour Rating Scale for Parents questionnaires were entered into an access database.

Data from the CSIRO food frequency questionnaires were used to analyze the macronutrients and micronutrient intake using the SOFFA (System for On-Line Food Frequency Analysis) nutrition software. The program utilizes the NUTTAB food list. Food items not listed in NUTTAB were added by creating an 'Own Foods Database'. Dietary supplements were not included in the analysis, in order to assess if they were still required.

Nutritional adequacy of each child's diet was assessed by comparison of selected nutrients with the Recommended Dietary intake (RDI) for Australians by age and sex³¹. Nutritional inadequacy was considered to be less than two-thirds the RDI for sex, age and weight. For those RDI values with a range of nutrient intakes, the upper limit was taken to ensure adequacy.

FOLLOW UP CONSULTATION

The first 10 volunteers for nutritional assessment were offered a free follow-up consultation with Dr. Velencia Soutter (Paediatrician) and specialist dietitians Dr. Anne Swain and Dorothy Callender. Travel reimbursement was made available if necessary.

At the follow-up consultation parents were given a summary of their child's dietary nutrient analysis (appendix G), and the opportunity to discuss the results and any other problem regarding their child's adverse reactions to food.

STATISTICAL ANALYSIS

All descriptive statistics (mean, range, and standard deviations) were calculated using Minitab Statistical Package. A Pearson Chi-square test using Minitab was used to determine:

- (a) gender differences in the total survey sample and respondents,
- (b) difference between symptoms before diet, and now,
- (c) difference between levels of dietary restriction of food/chemical and symptoms,
- (d) difference in change in symptoms and severity and dietary restriction between self-modified diets and challenge-modified diets.

A Students t-test (unpaired samples) was used to compare the age of participants of total survey sample and respondents. A t-test (paired samples) was used to test for differences between initial and final behaviour scores. A t-test (unpaired samples) was

used to identify any differences in nutrient intake for those on the elimination diet and those on milk free and wheat free elimination diet.

P values less than 5% were reported as evidence of statistic significance.

Figure 1: *Diagram of Study Methodology*

RECRUITMENT OF SUBJECTS

Children who presented at RPAH allergy unit with gastrointestinal symptoms and suspected food intolerance between 1995 and 1998 through records of RPAH allergy unit

PACKAGES SENT

- Containing:
- Information letter
 - Follow up questionnaire
 - Conners' Parent Behaviour Rating Scale(for children> 3 years)
 - Food frequency questionnaire (only for the recruited 10 patients)
 - Reminder letter (sent after 4 weeks of initial package to non-responders).

DATA COLLECTION

Preliminary information from medical and dietetic files
Questionnaires returned via mail by respondents

FOLLOW-UP CONSULTATION

Follow-up session with Dr Soutter/Dietitian, patients given summary of nutrient analysis.

DATA ANALYSIS

RESULTS

Gender

In the total survey sample of 223 children with gastrointestinal symptoms there were significantly more males 59% than females 41%, ($p < 0.05$, $p = 0.01$, $DF = 1$).

Age of Presentation to the Allergy Clinic of Total Survey Sample

The total survey sample consisted of children from the age of 3-12 years. The mean age was 6.61 years (SD 2.53) and the range was 3.00- 12.79 years. Table 1 shows the number of boys and girls in each age division.

Table 1: *Age of presentation to the clinic for children with gastrointestinal symptoms*

Age in years	Female (N=92)	Male (N=131)	Total (N=223)
< 4	16	20	36
4-7	45	72	117
8-11	31	36	67
≥ 12	0	3	3

Gender and Age of Respondents Compared to the Total Survey Sample

The results from the questionnaires represent a small percentage of the total survey sample, due to the low response rate of 29 %. There is a high correlation in age ($DF=221$, $p=0.23$, $P>0.05$) and sex ($DF=1$, $p=0.86$, $p>0.05$) distribution between the

survey respondents and non-respondents. A summary of the results is presented in Table 2.

Table 2: Gender and Age of Total Survey Sample and Respondents

Sex and Age	Total Survey Sample (N=223)	Survey Respondents (N=65)
Gender *		
Male (%)	59	60
Female (%)	41	40
Mean age (years)	6.61	6.09
SD for Age (years)	2.53	2.50
Age range (years)	3.00-12.79	3.09-12.79

*Significantly more males than females, P value = 0.01.

Presenting Symptom Groups:

The total survey sample (n=223) was divided into four main symptom groups: 1.

1. 21% gastrointestinal symptoms only.
2. 16% gastrointestinal symptoms and eczema.
3. 54% gastrointestinal symptoms and behaviour.
4. 9% gastrointestinal symptoms, eczema, and behaviour.

The results indicate that over half the survey sample had associated behaviour problems.

Gastrointestinal and Associated Symptoms

All the children in the total survey sample (n=223) had their symptoms recorded in the medical notes on presentation at the clinic. All the children had gastrointestinal symptoms. The main gastrointestinal symptoms were diarrhoea (47%) and abdominal

pain and cramps (46%). The most common symptoms associated with gastrointestinal were found to be hyperactivity (42%), eczema (29%), and headaches (22%). A summary of gastrointestinal and associated symptoms is presented in table 3.

Table 3: *Symptoms in the Total Survey Sample (N=223).*

Symptoms	Children (N=223)	% of Total Survey Sample
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Gastrointestinal		
Diarrhoea/Loose stools	105	47
Pain/Cramp/Colic	103	46
Mouth Ulcers	23	10
Vomiting	14	6
Constipation	12	5
Reflux	7	3
Wind/Gas/Bloating	5	2
Central Nervous System		
Hyperactivity/Restless	94	42
Headaches	48	22
Irritable	18	8
Anxious	14	6
Concentration	13	6
ADD(diagnosed)	9	4
Learning Difficulties	8	4
Muscle/Joint pain	8	4
Aggression	5	2
Respiratory		
Wheeze/Asthma	43	19
Sinus Irritation	37	17
Runny Nose	27	12
Skin		
Eczema	65	29
Urticaria	15	7
Angioedema	6	3
Other		
Anaphylaxis	2	1

Family History of Allergy/Intolerance

In the total survey sample (n=223) 66 % of mothers and 52 % of fathers had one or more symptom associated with intolerance. The most common symptoms experienced

by the parents of children with gastrointestinal symptoms were diarrhoea/loose stools, and rhinitis. Symptoms are summarized in Table 4.

Table 4: *Parents Food Allergy/Intolerance Symptoms*

	% of Survey Sample Mothers (N=147)	% of Survey Sample Fathers (N=115)
Gastrointestinal		
Diarrhoea/Loose Stools	51	26
Pain/Cramp/Colic	34	13
Mouth Ulcers	16	10
Constipation	2	2
Wind/Gas/Bloating	1	2
Central Nervous System		
Headache	13	2
Muscle/Joint Pain	7	1
Hyperactive/Restless	5	15
Irritable	3	1
Anxious	1	2
Concentration	1	2
Learning difficulties	2	2
Respiratory		
Rhinitis	29	19
Asthma/Wheeze	14	11
Runny Nose	7	13
Skin		
Eczema	7	3
Urticaria	3	2
Angioedema	1	1
Other		
Anaphylaxis	1	0

Progress Status

Progress status was documented in the dietetic notes of the total survey sample and in the returned questionnaires from the respondents. Patients were classified according to the following categories:

- **Abandoned SED** if follow-up information was not recorded in the dietetic notes or questionnaires were not returned.
- **Completed SED (challenge-modified diet)** if they completed all the foods/chemicals challenges and as a consequence modified their diet.
- **Incomplete SED (abandoned)** if they started SED but did not complete all challenges and then abandoned.
- **Self-modified diet** if they did not start SED or if they started SED but did not complete all challenges and instead self modified their diet based on information given at the clinic.

The results show that the two-third abandoned the SED and one-third modified their diet based on either challenge results or information received at the clinic. The majority of patients whose responses were recorded showed an improvement in symptoms. Table 5, 6 and figure 2 show a summary of the progress status and response to dietary modification of the total survey sample. Figure 3 shows the progress status and response of only the respondents.

Table 5: *Progress Status of Total Survey Sample*

Progress	% of Total Survey Sample (N=223)
Abandoned SED	52
Completed SED(challenge modified diet)	20
Incomplete SED(abandoned)	15
Self-modified diet	10
Incomplete SED (self-modified diet)	3

Table 6: *Response of Total Survey Sample to Modified Diets*

Response to Dietary Modification	% of Total Survey Sample (N=223)
Responders(improved)	29
Non-Responders(did not improved)	5
Unknown	66

Figure 2: *Tree Diagram-Progress Status and Response of Total Survey Sample*

From dietetic notes and returned questionnaires

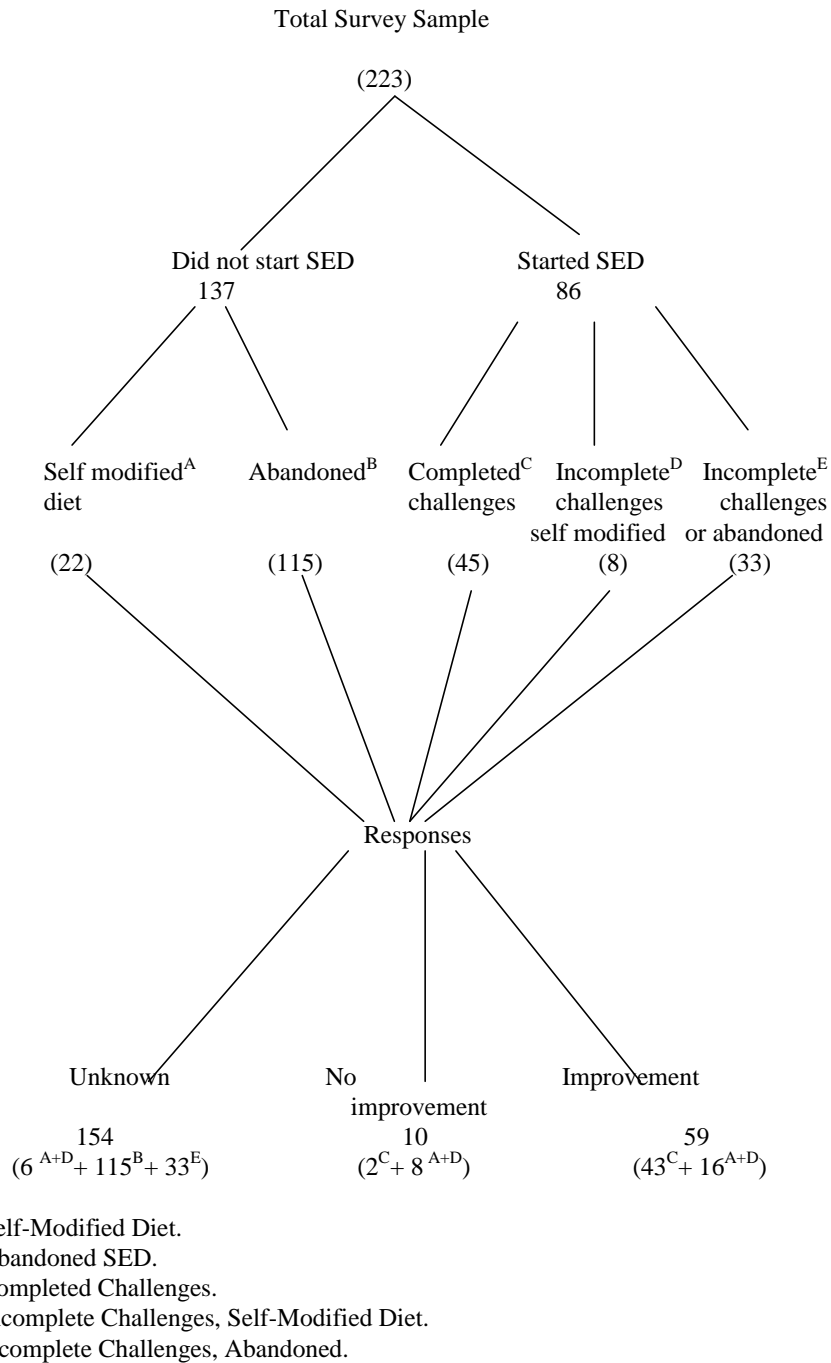
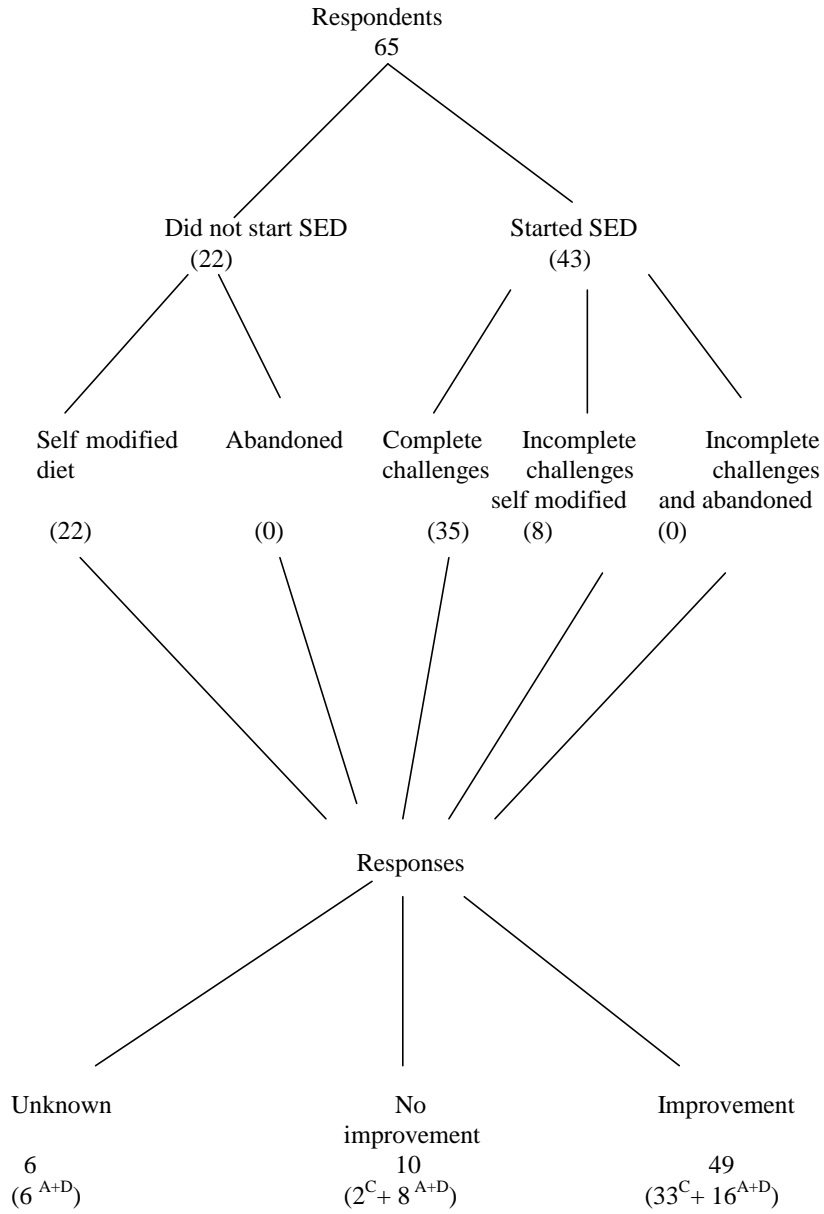


Figure 3: Tree Diagram-Progress Status and Response of Respondents

From returned questionnaires



- A= Self-Modified Diet.
- B= Abandoned SED.
- C= Completed Challenges.
- D= Incomplete Challenges, Self-Modified Diet.
- E= Incomplete Challenges, Abandoned.

QUESTIONNAIRES RESULTS

Conners' Behaviour Rating Scale for Parents

All children presenting to the allergy clinic were assessed for behaviour using the Conners' Rating Scale for Parents Questionnaire (appendix C). In the 223 children with gastrointestinal symptoms 63% had one or more associated behaviour problems. Significant change was assessed by comparing returned questionnaires to questionnaires completed at initial presentation at the Allergy Clinic. Only 37 questionnaires could be matched for behaviour before and after dietary modification, due to incomplete data concerning the patient. Some improvement was seen with all behaviour problems assessed, however this only reached statistical significance with: conduct (p=0.02, DF=32), impulsive-hyperactivity (p=0.0015, DF=35), somatic (p=0.0007, DF=34), and hyperactive index (p=0.022, DF=36). No significant improvement was seen with learning difficulties (p=0.06, DF=34) or anxiety (p=0.34, DF=34). In no instance did the elimination diet cause deterioration in behaviours measured by the Conners' Rating Scale for Parents. The results are summarized in table 7.

Table 7: Conners' Parent Behaviour Rating Scale Mean T-Scores

Behaviour	Mean T-Score at Presentation N=37(SD)	Mean T-Score at Follow up N=37(SD)	Mean Difference In T-Score (SD)
Conduct*	67 (±17.90)	62 (±20.38)	5 (± 13.60)
Hyperactive***	66 (±13.41)	60 (±14.31)	6 (± 11.41)
Learning difficulties	68 (±17.29)	63 (±18.94)	5 (± 18.46)
Somatic***	81 (±18.65)	68 (±20.67)	13 (± 20.66)
Anxiety	58 (±13.09)	56 (±14.76)	2 (± 15.83)
Hyperactive Index*	66 (±16.32)	62 (±15.80)	4 (± 13.13)

Significant improvement in behaviour

*** P<0.001

** P<0.01

*P<0.05

Food Allergy and Intolerance Follow up Questionnaire

The Simplified Elimination Diet

The first question of the questionnaire (Appendix D) asked parents if their child started the SED. Sixty-five parents responded to this question. Sixty-six percent (n=43) started the SED. The 34% (n=22) who did not start the SED were then asked (Q13) to explain the reasons for not starting the elimination diet. In the 22 children who did not start SED the reasons for not starting were: child refused 36%, too sick 23%, and too difficult 41%.

Parents were asked when they started their child on the elimination diet (Q2). Sixteen parents responded to the question. The majority (67%) of children started within 3-6 months, and the range was 1-36 months.

Parents were asked (Q3) if they noticed any improvement in their child’s symptoms with the SED. Forty-three parents responded to this question. Forty-one children (95%) noticed an improvement. Half began to notice an improvement within one to seven days (range 1-56 days). The results are summarized in Table 8. Two (5%) children did not show an improvement in symptoms and their parents were then asked (Q12) how long they persisted with the elimination diet. Both persisted up to 6-7 weeks before deciding that the SED was not helping. Both then went back to their normal diet.

Table 8: Time Taken to Notice Improvement on SED

Days	% of Respondents (N=41)
------	----------------------------

1-7	51
8-14	17
15-21	15
22-28	2
29-35	5
36-42	8
43-49	0
50-56	2

Thirty-seven parents responded to question five and six about the occurrence of withdrawal symptoms on the SED. Fifty-one percent of children had withdrawal symptoms. Sixteen parents responded to part two and three of question five about when and how long withdrawal symptoms occurred. The majority (76%) of withdrawal symptoms occurred within one to seven days (range 1-35 weeks) of starting the SED. Withdrawal symptoms for over half the children lasted one to seven days (range 1-27 days). The results are summarized in table 9.

Table 9: *Withdrawal Symptoms on the SED*

Days	When Withdrawal Occurred. % of Respondents (N=16)	How Long Withdrawal Lasted. % of Respondents (N=16)
1-7	76	56
8-14	6	19
15-21	6	19
22-28	6	6
29-35	6	0

Thirty-seven parents recorded how long it took for their children's symptoms to settle before they could start the SED (Q6). Forty-one percent settled within the first two

weeks, and 47% settled within 2-6 weeks. The range was 1-84 days. The results are summarized in table 10.

Table 10: Time Taken for Symptoms to Settle before SED was started

Days	% of Respondents (N=37)
1-7	22
8-14	11
15-21	8
16-28	19
29-35	14
36-42	14
43-49	0
50-56	5
57-63	2
63+	5

Food/Chemical Challenge Results

Forty-three parents who started the SED answered the questions (7 and 8) regarding the taking of challenges on the SED. Eighty-one percent (n=35) did do the challenges, and 19 % (n=8) did not start. Of the 35 children who did the challenges 63 % (n=22) did the food challenges, 8 % (n=5) did the capsule challenges and 12 % (n=8) did both.

For question 9, parents were asked how long it took to do the challenges. Thirty parents responded, the majority taking 9-12 weeks (range 3-52 weeks) to do the challenges. The results are summarized in table 11.

Table 11: *Time Taken To Do Challenges in the SED*

Weeks	% of Respondents (N=30)
1-4	10
5-8	3
9-12	30
13-16	7
17-20	7
21-24	27
25+	17

Thirty-five parents responded to question 11 about their results from doing food/chemical challenges in the SED. Parents were also asked to list their child's main symptoms and severity to each challenge. The results of the challenges show that salicylates (89%), amines (66%), milk (64%), and wheat (52%) were the main chemicals/foods to provoke symptoms, notably gastrointestinal symptoms and central nervous system symptoms. The main gastrointestinal symptoms were diarrhoea and abdominal pain. Central nervous system symptoms of hyperactivity and irritability provoked by the four main chemicals/foods as well as by colourings. Of the 35 patients the results of the food challenges are summarised in table 12 and figure 4. Individual symptoms in each symptom group are shown in figure 5-8 (Appendix H).

Most parents rated their children's symptoms as severe or moderate. The results are summarized Figure 9.

Table 12: Challenge Results % of Positive Reactions in Respondents (N=35)

Chemicals /Foods	Total Symptoms	G.I Symptoms ¹	CNS Symptoms ²	Respiratory Symptoms ³	Skin Symptoms ⁴	Unknown Symptoms
Salicylate	89	34	40	3	9	3
Amines	66	20	31	6	3	6
Milk	64	34	15	6	3	6
Wheat	52	23	20	3	3	3
Colourings (102-155)	26	0	20	3	0	3
Preservatives*	21	6	15	0	0	0
Nitrate (249-252)	17	6	11	0	0	0
MSG (621)	15	0	15	0	0	0
Propionate (280-283)	12	3	6	0	0	3
Antioxidants	3	0	3	0	0	0

*benzoates (210-213), sorbates (200-203), sulphites (220-228).

1. Diarrhoea, abdominal pain, vomiting, nausea.
2. Anxious, hyperactivity, concentration, irritable, headaches, growing pains.
3. Runny nose, sinus irritation.
4. Eczema, rash, urticaria.

Figure 4: Challenge Results

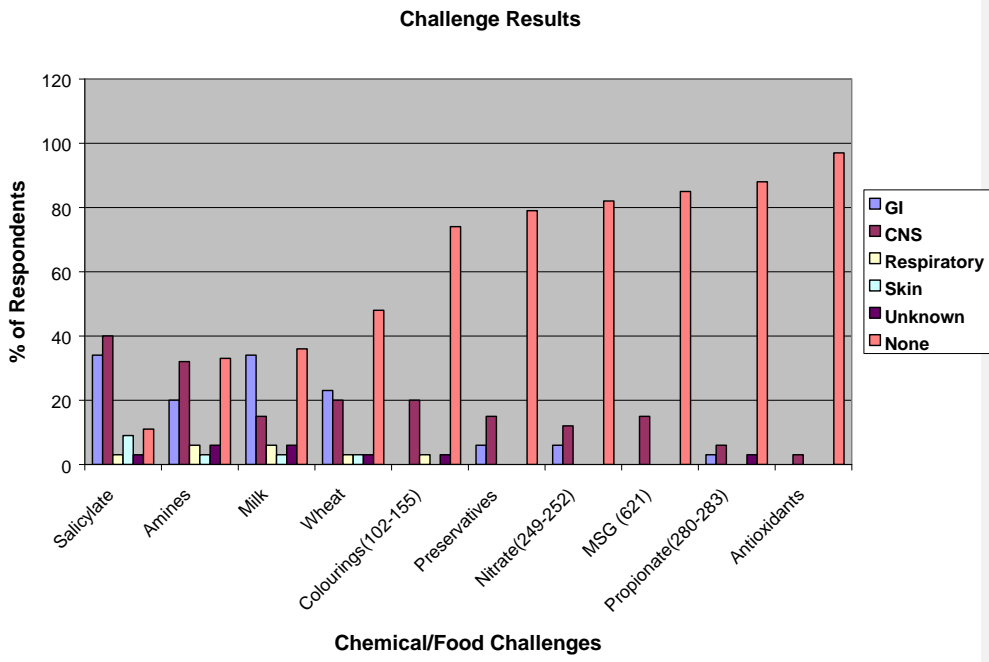
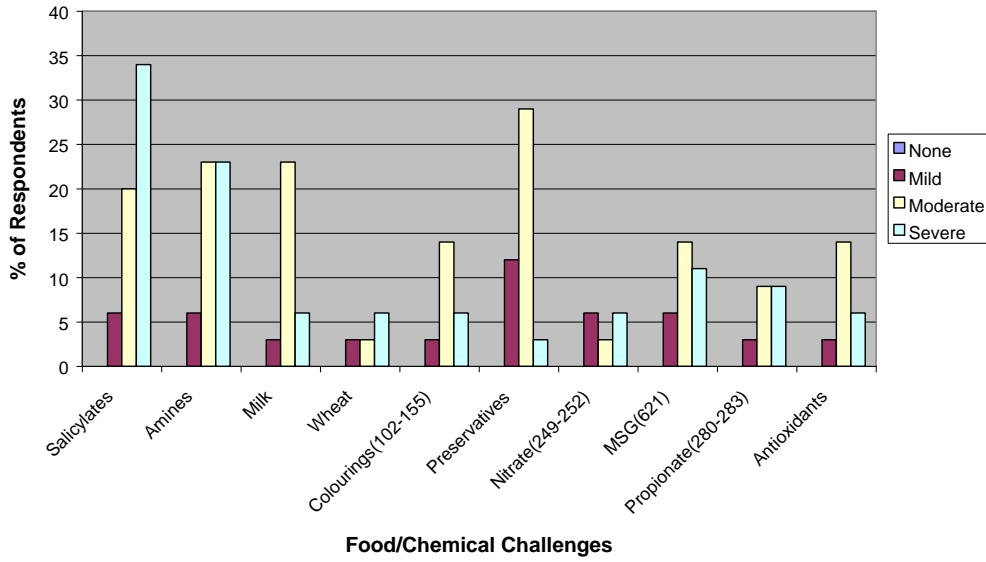


Figure 9: *Severity of Symptoms*

**Challenge Results
Severity of Symptoms**



Self-Modified Diets

Parents who did not place their child on the SED were asked to answer whether they modified their child's diet based on information received at the clinic (self-modified). Thirty parents responded affirmatively to this question (consisted of 22 parents who did not start the SED and 6 who started the SED but did not complete it). Modification of the diet involved avoiding or reducing suspected food/chemical intolerants in the diet.

Improvement of Symptoms and Severity on Dietary Modification

All parents were asked (Q14) to rate their child's symptoms as mild, moderate or severe before starting the diet, and now (follow up). Forty-seven parents responded to this question. Of the 47 children on modified diets 22 were on self-modified diets, and 25 were on challenge-modified diets. The children on self-modified diets were compared with those on challenge-modified diets with no significant difference in symptoms or severity. The results are summarised in table 13. Therefore the following results on symptoms and severity are looked at as a group.

Both those children on self-modified and challenge-modified diets had a significant improvement in most of their symptoms from presentation to follow-up. Learning difficulties and a runny nose's did not improve with dietary change. Table 13 and figure 10 shows a summary of the results.

At presentation most parents rated their children's symptoms moderate or severe. On follow-up most children had mild or no symptoms. Severity of symptoms was presented in figure 11 and 12 (Appendix I: Severity of symptoms on self-modified and challenge-modified diets, figures 11.1-11.4).

Table 13: *Improvement in Symptoms (N=47)*

Symptoms	Significance Level Symptoms Before SED to Follow-up P value(DF=1)	Significance Level Between self and challenge modified Diets P value(DF=1)
Gastrointestinal		
Diarrhoea	<0.001	0.1(NS)
Cramps/colic	<0.001	0.3(NS)
Reflux	=0.01	0.8(NS)
Mouth Ulcer	<0.05	0.4(NS)
Central Nervous System		
Behaviour	<0.001	0.1(NS)
Headaches	<0.001	0.3(NS)
Growing Pain	<0.001	0.1(NS)
Learning Difficulties	0.10 (NS)	0.1(NS)
Upper Airway		
Ear Infection	<0.001	0.3(NS)
Blocked Nose	<0.05	0.2(NS)
Runny Nose	0.21(NS)	0.2(NS)
Skin		
Eczema	<0.001	0.3(NS)

Figure 10: Change in Symptoms over the Three-Time Period

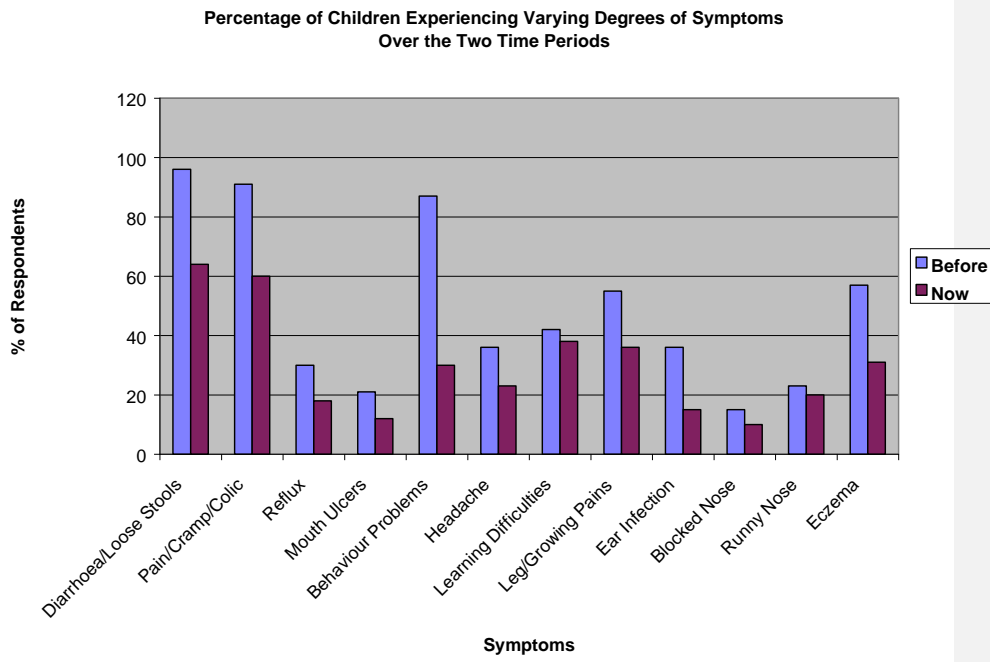


Figure 11: *Severity of Symptoms before Dietary Modification*

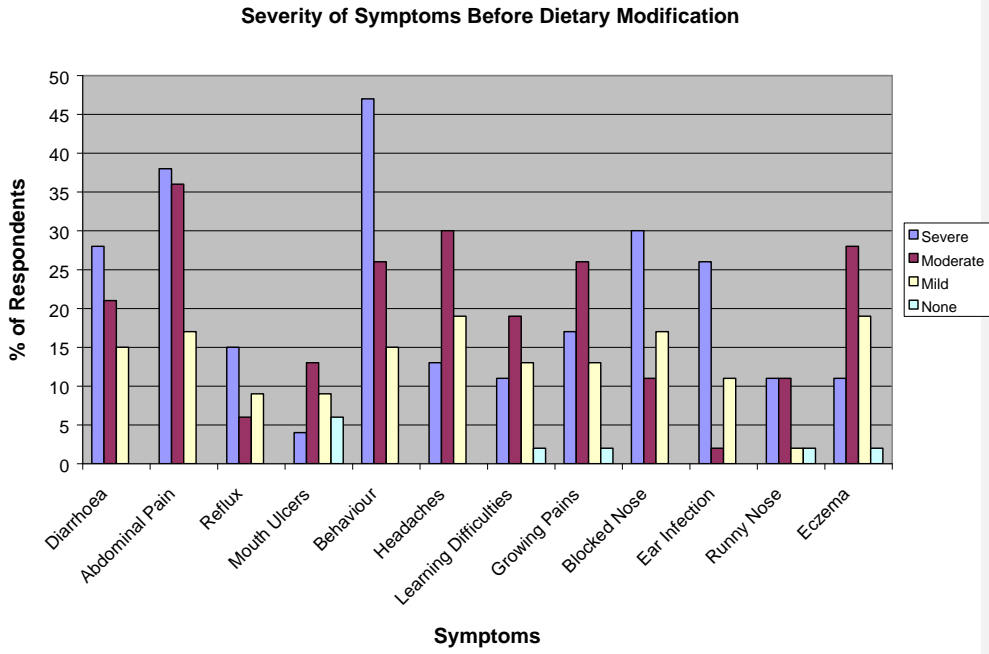
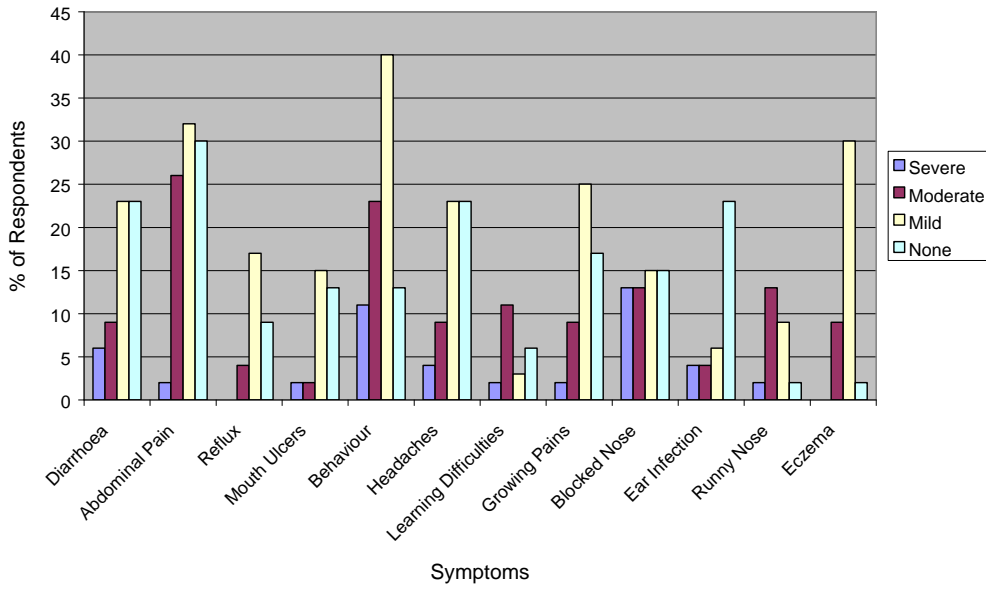


Figure 12: Severity of Symptoms at Follow-Up
Severity of Symptoms Now



Level of Dietary Restriction

Parents were asked if they currently had their child on a modified diet (Q15). Fifty-five parents responded to this question, and 82 % (n=45) of parents still had their child on a modified diet. They were also asked to state the level of restriction of chemicals and foods in their child's diet. Fifty-one parents responded to this question. Of the 51 who responded, 24 were on self-modified diets and 27 on challenge-modified diets. There was no significance difference between both groups and their levels of restriction. Both groups highly restricted salicylates, milk, additives, and wheat (Appendix J tables 15.1-15.2). There was a significant difference between individuals on each level of dietary restriction (DF=3, p=0). The results are summarised in table 14.

Table 14: Degree of Ongoing Dietary Restriction (% of Respondents n=51).

Food/Chemicals	Highly Restricted	Quite Restricted	Somewhat Restricted	Not Restricted	Significance Difference Between Self and Challenge Modified Diets P Values (DF=1)
Salicylates	61	19	10	10	0.87(NS)
Amines	27	27	34	12	0.46(NS)
Additives	38	29	30	3	0.34(NS)
MSG	13	8	24	55	0.57(NS)
Milk/Dairy	43	22	29	6	0.39(NS)
Wheat	40	15	9	36	0.44(NS)

How Often Children Experience Food Intolerance Reactions

Fifty-one parents responded to the question about how often their child experienced food intolerance reactions while on their modified diet (Q16). The results indicate these reactions tended to be due to accidental exposure rather than knowingly consuming the food or chemical. The results are summarized in table 15.

Table 15: *Frequency of Food Reactions (% of Respondents, N=51)*

Exposure	Never	Occasionally	Fairly Often	Frequently
Accidental Exposure	14	37	31	18
Knowing Exposure	29	27	31	13

Overall Improvement in Symptoms

All parents were asked if they noticed an improvement in their child’s symptoms since coming to the clinic, and to rate their overall improvement (Q17). The 59 responses to this question are presented in table 16, which indicates that 83% (n=49) of respondents experienced an improvement (of these respondents 56% were on challenge modified diets and 27% on self-modified diets). The majority (78%) being much better or a little better once appropriate food/chemicals were avoided.

Table 16: *Symptom Improvement on Modified Diet*

Improvement On Modified Diets	% of Respondents (N=59)
Completely well	5
Much Better	47
A little Better	31
Same	17
Worse	0

The Need for Medication

Of the 57 parents who responded to question 18, 54% (n=31) reported that their children continued to require medications to control their symptoms. The main medications used were those for atopic problems: asthma, eczema and rhinitis. The results are summarized in table 17.

Table 17: *The Continuing Need for Medication*

Medication	% of Respondents (N=57)
Asthma Drugs	72
Steroid Cream	56
Antihistamine	49
Nasal Sprays	47
Antibiotics	26
Ritalin/Dexamphetamine	14

Food Allergy

Fifty-two parents responded to the question about if their child tested positive to food allergens at the clinic (Q19). Twenty nine percent (n=15) of children tested positive for food proteins (egg and peanut), 48% (n=25) tested negative, and 23% (n=12) were not tested.

In the questionnaire (Q21) parents were asked if their child had suffered from any serious reactions to foods since being at the clinic. For children who had positive SPT (n=15) to one or more food allergens at presentation, 33%(n=5) were reported to have had a serious allergic reactions to foods to their food allergy.

Further Treatment

Of the total survey sample (n=223), 22% of parents sought further treatment elsewhere for their children's symptoms (Q22). The majority sought further assistance from a psychologist. The results are summarized in table 18.

Table 18: *Further Treatment*

Further Treatment	% of Respondents (N=14)
Psychologist	65
Naturopath	21
Dermatologist	7
Paediatrician	7

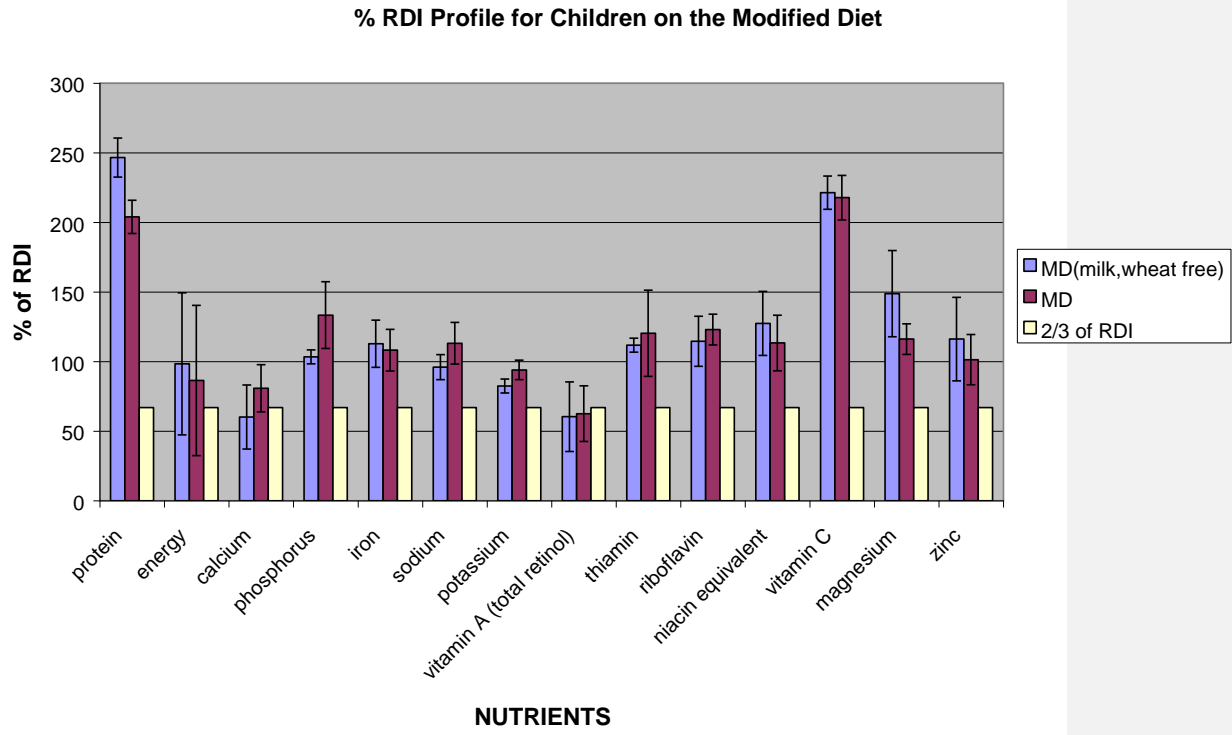
Nutritional Adequacy of Modified Diets

The average nutrient intake (without supplements) of the children placed on modified diet's (MD) was estimated using a CSIRO food frequency questionnaire and comparing with RDI values calculated for sex and age. The nutrition study sample consisted of five children on a wheat free and milk free modified diet, and five children on a modified diet which included wheat and milk. There was no significance difference between both groups. Both groups had an average vitamin A intake below the RDI meeting 60% and 63% of the RDI respectively from their diet alone. The milk and wheat free group had an average calcium intake below the RDI meeting 60 % of the RDI. Protein (207% and 204 % of the RDI) and vitamin C (221% and 215% of the RDI) average intake was high in both the groups. The five children who had no milk and wheat in their modified diet were taking calcium supplements and 3 were also taking multivitamins. Of the modified diet group who included milk and wheat, two were taking calcium and multivitamin supplements. Table 19 and figure 13 shows a summary of the results.

Table 19: Mean Percentage of RDI met on Modified Diets.

Nutrients	Modified Diet n=5 (SD)	Modified Diet No milk & wheat N=5 (SD)	Significance Difference between groups	Total group Modified Diet n=10 (SD)
Energy	86 (±24.4)	98 (±28.9)	0.5 (NS)	92 (±27.0)
Protein	204 (±107.6)	247 (±103.9)	0.4 (NS)	225 (±90.0)
Calcium	81 (±33.2)	60 (±46.1)	0.3 (NS)	71 (±32.2)
Iron	108 (±48.7)	113 (±10.5)	0.8 (NS)	11 (±34.4)
Zinc	101 (±30.8)	116 (±34.9)	0.4 (NS)	109 (±27.3)
Sodium	113 (±29.8)	96 (±17.6)	0.3 (NS)	105 (±24.8)
Potassium	94 (±13.3)	82 (±9.8)	0.2 (NS)	88 (±34.2)
Magnesium	116 (±40.3)	149 (±50.8)	0.3 (NS)	133 (±42.2)
Phosphorus	133 (±61.1)	103 (±10.8)	0.3 (NS)	118 (±40.3)
Vitamin A (retinol Eq)	63 (±22.8)	60 (±35.3)	0.9 (NS)	62 (±15.9)
Thiamin	120 (±41.0)	112 (±45.5)	0.7 (NS)	116 (±28.2)
Riboflavin	123 (±35.1)	115 (±23.4)	0.7 (NS)	119 (±39.3)
Niacin Eq	113 (±21.4)	127 (±61.5)	0.5 (NS)	120 (±36.1)
Vitamin C	215 (±36.3)	221 (±60.1)	0.9 (NS)	220 (±54.9)

Figure 13: Percent RDI Profile for Children on the Modified Diet



DISCUSSION

This study reports on a group of children, aged 3-12 years who presented to the Allergy Clinic for investigation of the role of food intolerance in their gastrointestinal symptoms.

This was a retrospective observational study, based on:

- 1) Clinical data recorded by pediatrician/ dietitian.
- 2) Dietary challenge test results
- 3) Self-reported questionnaire information

There was a low response rate (29%). Possible reasons were:

- 1) 30% moved or changed address.
- 2) Young families-too busy to reply (know that phone call-"yes I was meaning to reply"). However accept with alacrity the opportunity to come for a review.
- 3) They thought they did not fit the criteria for the study.
- 4) Responsive bias parents might be less likely to respond if:
 - The diet did not lead to a clinical improvement,
 - They were unhappy about the quality of the service provided,
 - They were disinterested in dietary modification as a means of controlling symptoms.

Had there been more time available for the study, it would have been possible to increase the response rate by follow-up phone calls.

The first three reasons above are unlikely to influence the generalizability of the results. Comparing those who replied with those who did not reply to the questionnaire, there were no significant differences in age or sex distribution. The

fourth reason would influence generalizability of results; therefore generalization can not be made. However the results provide valuable information for generating hypothesis for future, prospective studies.

Gender and Age

In this study there was significantly more males to females. This reflects the proportion of males to females in other studies on children with food intolerance ^{2,16}. In adult studies about food intolerance there is significantly more females to males^{22, 29}.

The majority of children presented at the clinic aged between 4-7 years (school age years) A study by Hymans ¹⁸ shows that the 60% of children with gastrointestinal symptoms present during the school age years suggesting a link with school associated anxiety.

Associated Symptoms

Sixty-three percent of the children presenting with gastrointestinal symptoms also had associated behaviour problems. The incidence of eczema (26%), asthma (20%), and rhinitis (17%) was no different than the general population. These results do not support the literature that reports food intolerance occurs more often in patients with established allergic diseases such as asthma, rhinitis and eczema ⁵.

Family History

In the survey sample with 66 percent of mothers and 52 percent of fathers had one or more food intolerance related symptoms. The most common symptoms for mothers were diarrhoea/loose stools, abdominal pain and rhinitis. For fathers it was

diarrhoea/loose stools, rhinitis and hyperactivity. These results are consistent with other studies^{16,32} which suggest that a family history of gastrointestinal symptoms is a strong predictor for the development of gastrointestinal symptoms in childhood.

Graziol et al¹⁶ found in his study that 50 percent of the children with food intolerance had an atopic family history. It was also noted that 70% of these families had gastrointestinal symptoms after food ingestion.

Behaviour

Sixty-three percent of the total survey respondents had gastrointestinal and behavioural symptoms. Only six percent of these children scored highly for anxiety, indicating that anxiety did not play a big role in these children's gastrointestinal symptoms. However these children scored high for somatic symptoms. Dietary manipulation significantly improved somatic symptoms and also conduct, and impulsive-hyperactivity. The chemicals that triggered behaviour problems were predominantly food salicylates, amines, wheat, and colourings. Salicylates, wheat and amines were also predominately the cause of gastrointestinal symptoms. Once these chemicals were removed from the diet there was a significant improvement in both behaviour and gastrointestinal symptoms.

These results support studies that have shown dietary elimination to relieve gastrointestinal and neurotic symptoms at the same time¹⁹. Similar outcomes were found in a study by Boris³ who shows that 73% of children with ADHD significantly improved when food additives were removed from the diet. A study by Feingold¹³ suggested also that natural salicylates frequently provoke hyperactivity.

Simplified Elimination Diet

Fifty-four percent of children completed the simplified elimination diet with 95 percent of patients recording improvement on their modified diet. Withdrawal symptoms occurred with 50% of children on the SED. Symptoms occurred within one to seven days (range 1-35 days), and lasted one to seven days (range 1-27 days). Results as such have not previously documented.

Many found the SED too difficult to start. Even among those who did complete the SED, it took the majority 3-6 months to start (range 1-36 months). However long-term compliance was high with 95% of respondents continuing to modify their diet. Most reactions to foods were due to accidental exposure rather than knowingly eating the food. This type of response is well documented in a number of studies ^{7, 21}. Only a small number of patients are able to successfully complete an elimination diet. However 50-65% of those who do finish improve or are symptom free ²¹ and long term compliance is about 80% ^{17, 26}.

Food/Chemical Intolerance and Gastrointestinal Symptoms

Salicylates, milk, wheat, and amines were the four main foods and chemicals responsible for provoking the main gastrointestinal symptoms of diarrhoea and abdominal pain. As a result salicylates, milk, wheat are the most highly restricted foods and chemicals on follow up.

Stefanini et al ²⁹ reported the same observations that food intolerance is more commonly associated with diarrhoea and abdominal pain than other gastrointestinal

symptoms. Other studies also found that wheat, milk, salicylates and amines are common triggers of diarrhoea and abdominal pain ^{15, 29}.

Modified Diets Symptoms and Severity

Eighty-three percent of children who modified their diet had a significant improvement in symptoms. Forty seven percent of parents reported that their child was much better once the identified food/chemicals were avoided.

In the paediatric population with gastrointestinal symptoms it is estimated that 39-62% have symptoms related to intolerance ²⁹. Grazioli et al ¹⁶ also found a significant improvement in children with food-related gastrointestinal symptoms after avoidance of foods identified as precipitating symptoms.

Self-Modified versus Challenge-Modified diets

At follow-up when children on self-modified diets were compared with children on challenge-modified, there were no significant differences in improvement of symptoms and degree, or type of dietary restriction. These results indicate that significant improvement and identification of foods responsible for adverse food reactions can be achieved by the information provided to patients at the clinic.

These findings contrast with the study by Young et al ³⁴ who found that foods patients perceive to cause reactions at presentation are different to results of the double-blind placebo controlled food challenges.

Medication

The results of this study reflected the need for additional medication to control asthma, rhinitis and eczema. The main medications used were asthma medications (72%), steroid cream (56%), and antihistamines (49%).

Asthma, rhinitis, and eczema can be provoked by aeroallergen such as dust, and dust mite⁷. Dietary modification alone is not always sufficient for these conditions⁷.

Further Treatment

The majority of respondents who reported a need for further treatment saw a psychologist (65%). This finding supports the study by Kellow et al²² on adults where patients needed dietary and/ or psychological treatment for gastrointestinal symptoms. Some patients benefited more by treatment with both therapies.

Food Allergy

Of the 65 children who returned the questionnaires and were tested for food allergy, 38% tested positive. However food intolerance was more often the cause of gastrointestinal symptoms than food allergy. The most common food allergens were egg, and peanut.

These findings were consistent with those reported by Zwetchkenbaum³⁶ who reviewed a number of studies on food allergy/intolerance and gastrointestinal symptoms, and found insufficient evidence that food allergy was the cause of gastrointestinal symptoms. What he found was that food intolerance is more likely to cause gastrointestinal symptoms. Among patients with food allergy and

gastrointestinal symptoms it is well documented that egg, peanut and milk are the most common food allergens³⁶.

Nutritional Adequacy of Modified Diets

The average vitamin A intake was below the RDI for both groups of children assessed, and calcium intake was below the RDI for the milk and wheat free group. All children on the milk-free and wheat-free modified diet were taking calcium supplements prescribed by the dietitians at the Allergy Unit. Fifty percent of all the study children were also taking multivitamin supplements. These results reflected the need for supervision by a dietitian to ensure nutritional adequacy of the diet.

Devlin et al ⁹ found similar results in children on an elimination diet who avoided milk and received no milk substitute had a calcium intake below the RDI. A study by Chiu ⁶ found the same result among children who were on the milk and wheat free elimination diet. In addition Chiu also found vitamin A intake to be below the RDI, and protein and vitamin C intake to be excessive.

CONCLUSION

This study has shown that food intolerance plays a key role in children who presented at the allergy clinic with gastrointestinal symptoms. Identifying food intolerance with the use of the simplified elimination diet and challenges, and modifying the diet as a consequence, has proven in this study to be extremely beneficial in the management of gastrointestinal and associated symptoms. However for the majority of children this protocol was too difficult. Completion of the elimination diet required motivation and self-discipline, and often was seen to be a 'cure worse than the disease'. Many parents, instead, self-modified their child's diet based on information given at the clinic, and apparently benefited as much as those who completed the SED. Long-term monitoring by a dietitian is important to ensure the child receives adequate nutrition in particular vitamin A and calcium, and dietary supplements may be necessary.

This study has highlighted a number of factors, which are commonly seen in children with gastrointestinal symptoms and food intolerance. These are:

- Reaction to food in the maternal diet.
- A family history of food intolerance and gastrointestinal symptoms.
- Diarrhoea and pain/cramps as the main gastrointestinal symptoms.
- A range of associated symptoms of central nervous system, skin, and respiratory.
- Behaviour problems often linked to abdominal pain and salicylate intake.
- Wheat, milk, salicylates and or amines are common intolerances.
- Chemicals/foods most commonly restricted in the diet correspond with the chemical/food intolerances identified by challenge testing.

RECOMMENDATIONS (For Future Research)

Design a questionnaire or a method to obtain information from patients regardless of progress status. The information obtained by this questionnaire does not represent those who abandoned the SED. This is important, as there is incomplete knowledge of long-term success of dietary modification among children with gastrointestinal symptoms.

The long-term management of food intolerance should be supervised by a dietitian in order to ensure adequate nutrition throughout the various stages of the growth cycle. Regular follow up is important to help liberalise the diet as tolerance to foods/chemicals improves.

The SED is a diagnostic tool, not a life-long cure for food intolerance. Further investigation is required into the natural history of food intolerance among children.

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APPENDIX A

SIMPLIFIED ELIMINATION DIET

APPENDIX B

INFORMATION LETTER

APPENDIX C

CONNERS' BEHAVIOUR RATING SCALE FOR PARENTS

APPENDIX D

ALLERGY AND INTOLERANCE FOLLOW UP QUESTIONNAIRE

APPENDIX E

FOOD FREQUENCY QUESTIONNAIRE

APPENDIX F

REMINDER LETTER

APPENDIX G

A PATIENT'S NUTRIENT SUMMARY

APPENDIX H

FIGURE 5-8: CHALLENGE RESULTS (Q11)

APPENDIX I

**FIGURES 11.1-11.4: SEVERITY OF SYMPTOMS ON MODIFIED DIETS
(Q14)**

APPENDIX J

TABLES 15.1-15.2: LEVELS OF DIETARY RESTRICTION ON MODIFIED DIETS (Q15)

Figure 4: *Challenge Results-Gastrointestinal Symptoms*

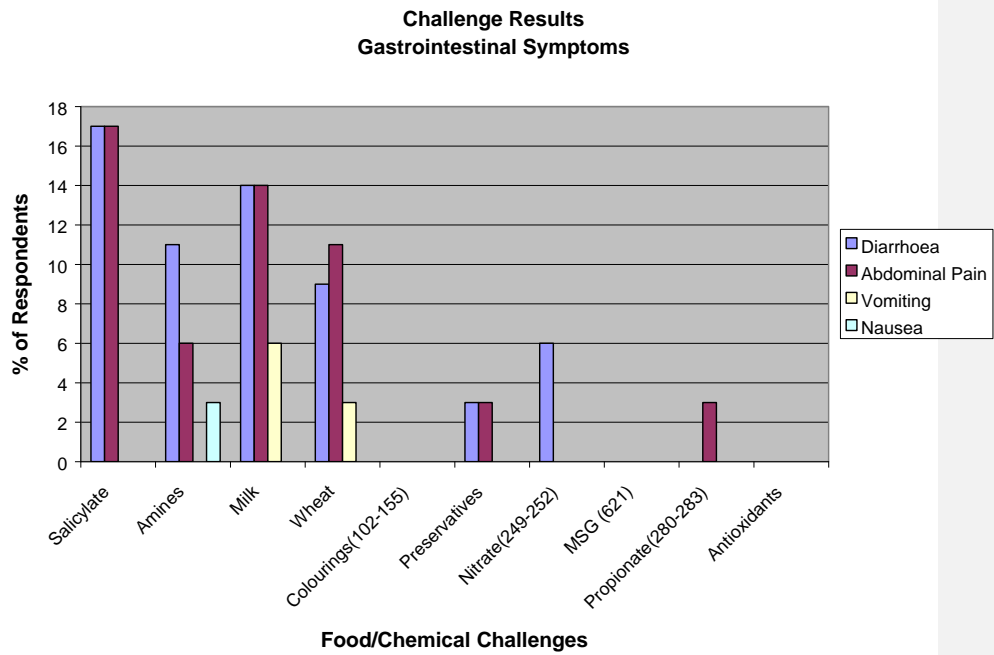


Figure 5: Challenge Results-Central Nervous Symptoms

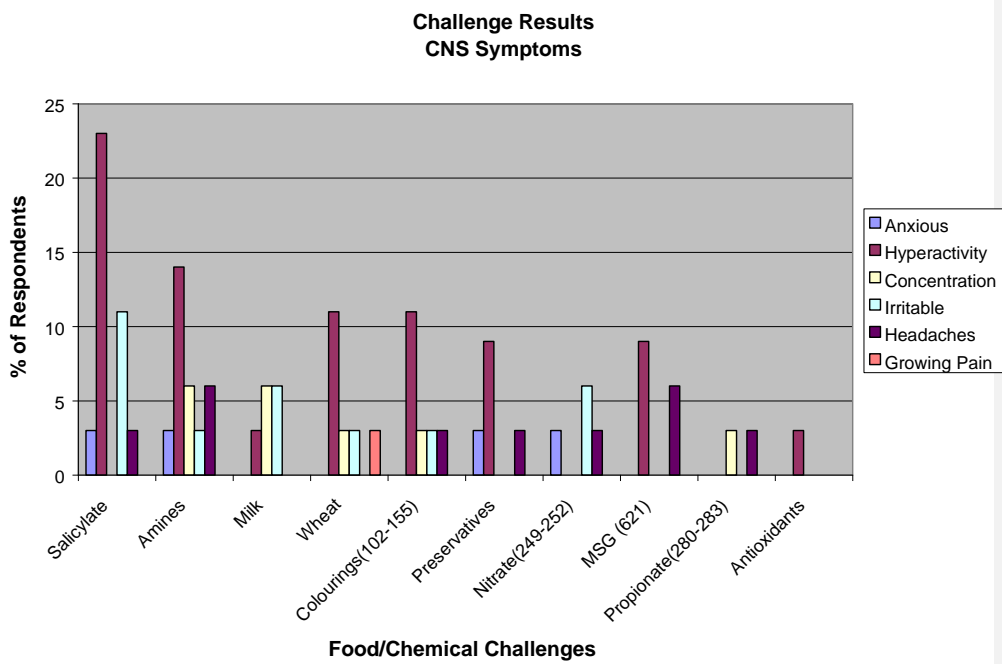


Figure 6: Challenge Results-Skin Symptoms

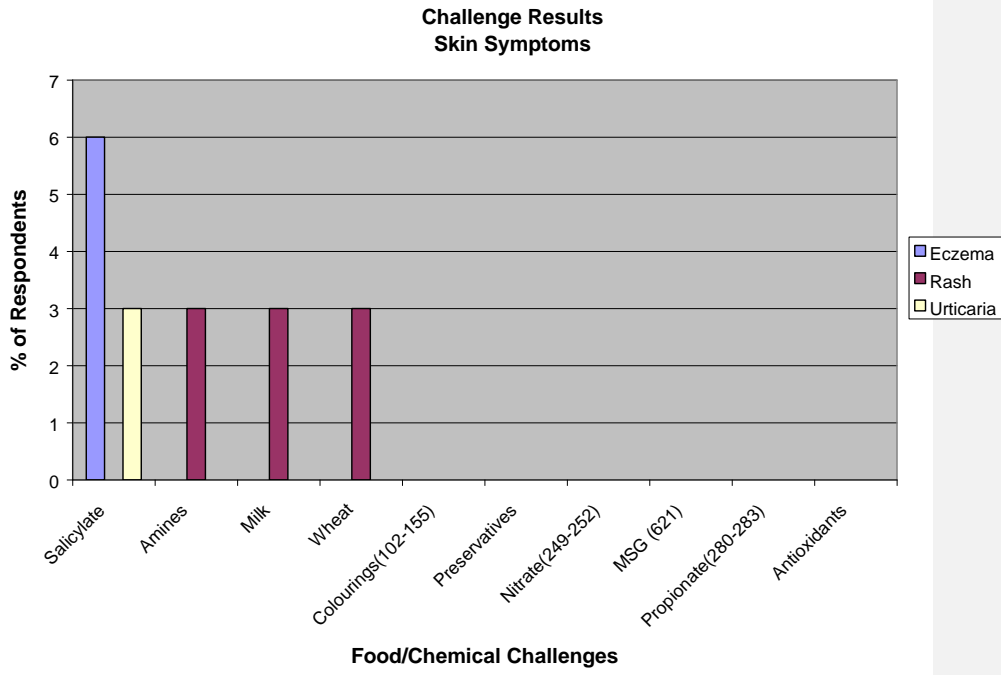
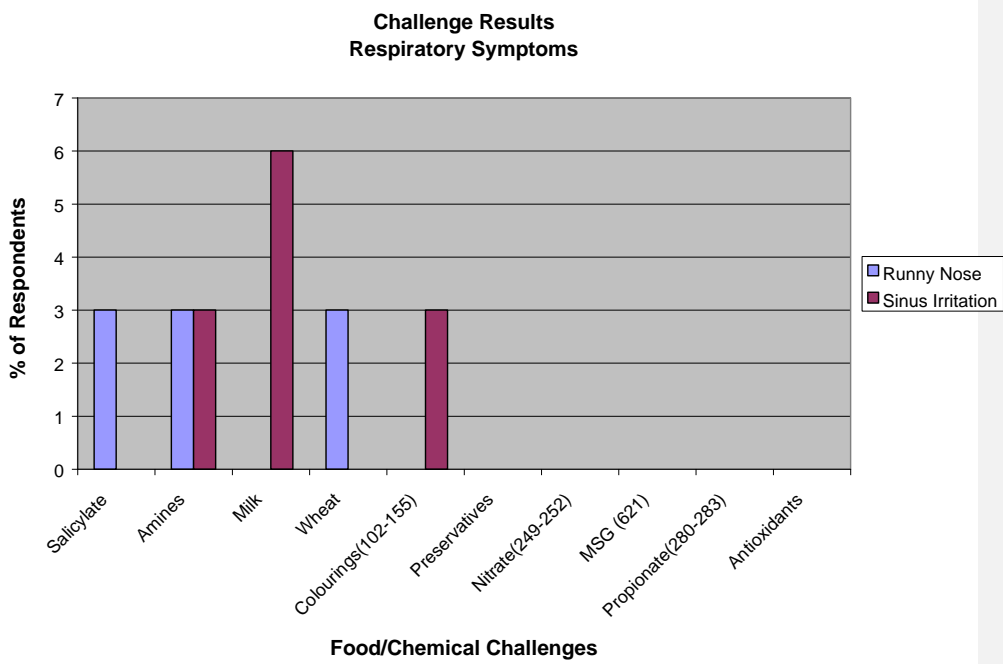


Figure 7: Challenge Results-Respiratory Symptoms



Level of Dietary Restriction

Table 15.1 Degree of Ongoing Dietary Restriction(% of Challenge-Modified Respondents n=27)

Food/Chemical	Highly Restricted	Quite Restricted	Somewhat Restricted	Not Restricted
Salicylates	56	20	11	13
Amines	30	26	37	7
Additives	33	30	33	4
MSG	19	7	26	48
Milk/Dairy	41	22	30	7
Wheat	37	15	7	41

Table 15.2 Degree of Ongoing Dietary Restriction(% of Self-Modified Respondents n=24)

Food/Chemical	Highly Restricted	Quite Restricted	Somewhat Restricted	Not Restricted
Salicylates	67	17	13	4
Amines	25	25	38	13
Additives	37	29	29	4
MSG	22	6	25	46
Milk/Dairy	42	21	25	13
Wheat	38	8	19	35

Challenge Modified Diets

Figure 11.1: Severity of Symptoms Before Dietary Modification

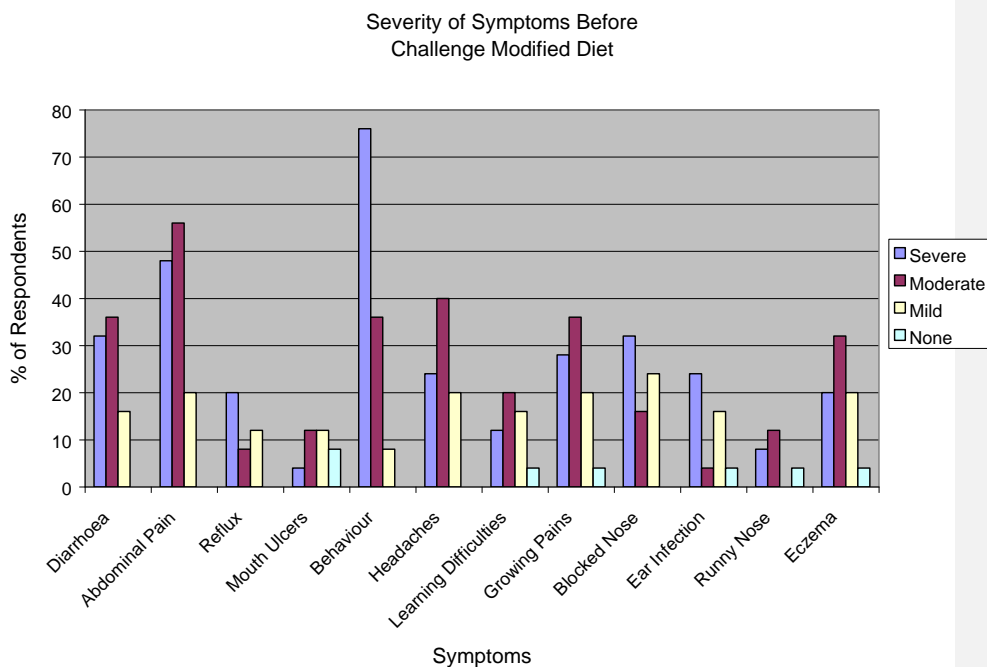
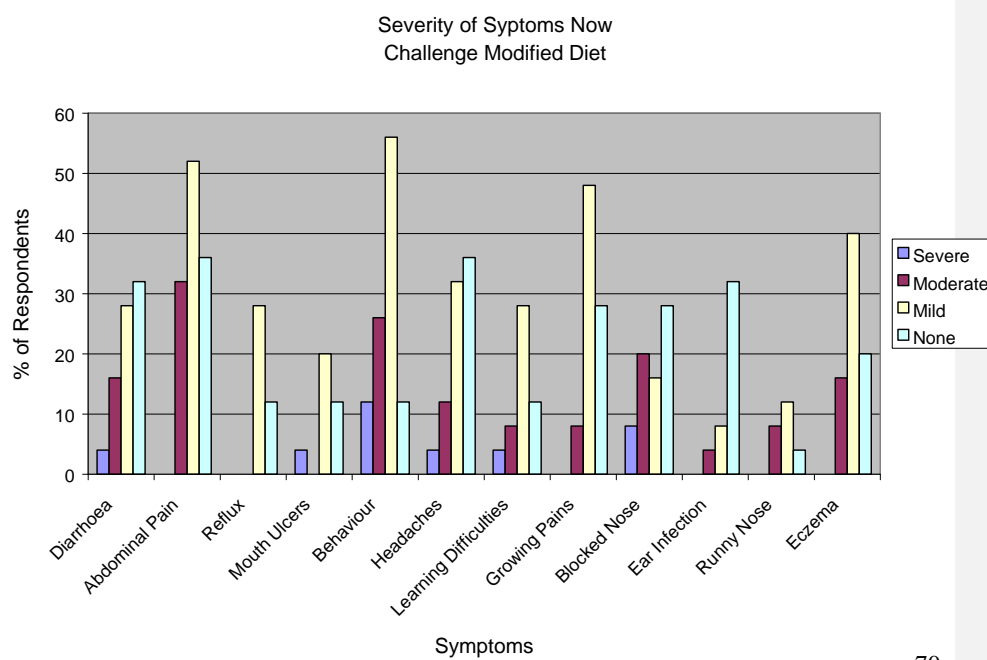


Figure 11.2: Severity of Symptoms at Follow-Up



Self-Modified Diets

Figure 11.3: *Severity of Symptoms before Dietary Modification*

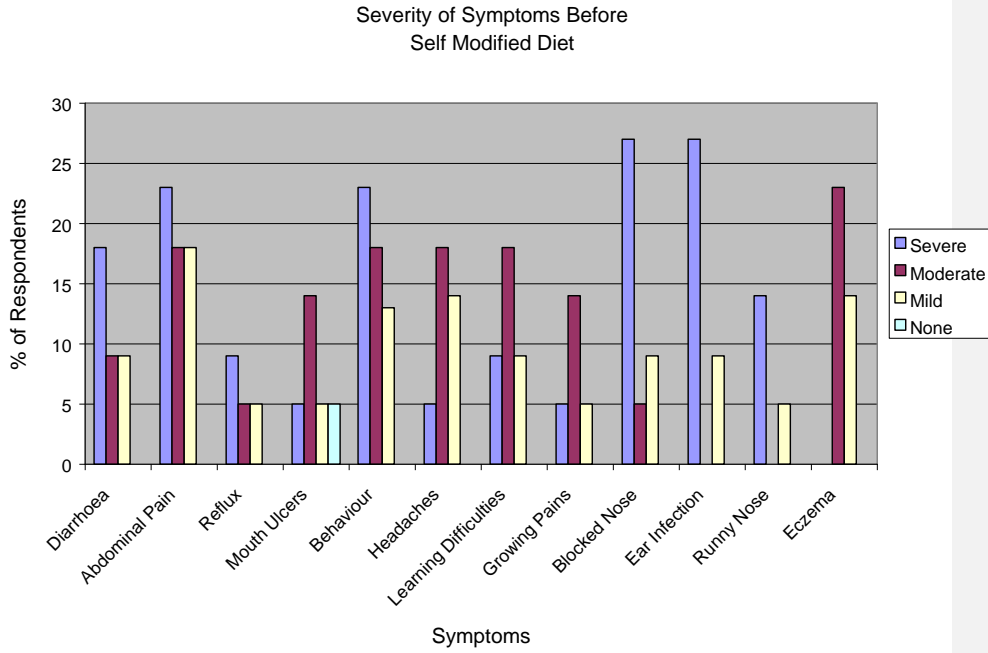


Figure 11.4: *Severity of Symptoms at Follow-Up*

