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Food Elimination Diets are Effective for Long-term Treatment of Adults with Eosinophilic Oesophagitis

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Summary

Background—Limited data describe the long-term efficacy of dietary elimination in eosinophilic oesophagitis (EoE).

Aim—We assessed the long-term outcomes of food elimination diets (FED) for treatment of adults with EoE.

Methods—We conducted a retrospective cohort study at our center analyzing all EoE patients receiving a FED without concomitant steroids. Baseline data were abstracted using standardized collection forms. Follow-up data from a mean 24.9-month period were collected for patients with a histologic response to a FED during and after food reintroduction. The main outcomes were symptomatic, endoscopic, and histologic responses.

Results—Of 52 patients, 18 received 6FED, 32 received targeted diet, and 2 received 6FED with targeted elimination. There were 21 (40%) patients with an initial histologic response. Responders reported less dysphagia after treatment (95% baseline vs. 11%; $p = 0.001$) and at the end of follow-up (95% baseline vs. 33%; $p = 0.008$). Significant and durable endoscopic improvements were recorded at the same time points: Endoscopic reference score: 3.2 vs. 0.7; $p = 0.001$; and 3.2 vs. 1.7; $p = 0.06$. Histologic findings improved after the most restrictive diet in responders (49.8 vs. 4.1 eos/hpf; $p = 0.001$) and remained suppressed in the 10 initial responders maintaining compliance at the end of follow-up (5.2 eos/hpf).

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Conclusions—Among EoE patients responding to a FED and remaining adherent, maintenance dietary therapy produced durable long-term symptomatic, endoscopic, and histologic disease control. These long-term data confirm that a FED is an effective maintenance treatment option in select adults with EoE.

Keywords

dysphagia; food bolus impaction; topical corticosteroids

Introduction

Eosinophilic oesophagitis (EoE) is a chronic immune/antigen-mediated clinicopathologic disorder defined histologically by eosinophilic-predominant esophageal inflammation and clinically by oesophageal dysfunction. It is diagnosed when there are at least 15 eosinophils per high-power field (eos/hpf) on oesophageal biopsies and after exclusion of alternative etiologies of eosinophilia.^{1,2} EoE represents a major cause of oesophageal morbidity.^{3–5} The pathogenesis of EoE is multi-factorial, but clinical, histologic, and endoscopic improvement with dietary elimination strategies supports the role of food antigen sensitization in the etiology of the disorder.^{6–17}

While corticosteroids improve both the clinical and histologic features of EoE,^{18,19} there are appreciable rates of non-response to steroids,^{20,21} side-effects are possible,^{22–27} and EoE disease activity recurs after discontinuation of these drugs.^{28,29} In contrast, food elimination diets address the etiologic triggers of EoE, lack adverse side effects associated with medication, and may produce long-term remission. This makes dietary elimination an attractive treatment option. However, as compared with children, little is known about the long-term efficacy of this treatment strategy in adults.^{6–17}

Therefore, this study aimed to assess the overall long-term efficacy of food elimination diets in adults for treatment of EoE. We also aimed to evaluate the effectiveness of a food elimination diet in patients previously treated for EoE with topical steroids.

Materials and methods

We conducted a retrospective cohort study at the University of North Carolina (UNC) Hospitals from 2008 – 2017. The UNC institutional review board approved this study. Cases of EoE were diagnosed per consensus guidelines^{1,2} and identified from the UNC EoE Clinicopathologic database. The UNC EoE Clinicopathologic database was previously described.³⁰ Included EoE patients were 18 years or older at the time a food elimination diet was started, had no use of EoE-specific medications concurrently or within 6 weeks of food elimination diet, and had subsequent follow-up at UNC including endoscopy with biopsy. Patients with eosinophilic infiltration of additional segments of the gastrointestinal tract were also excluded from this study.

To help isolate the effect of a food elimination diet, data were abstracted from treatment periods when patients received a food elimination diet without concomitant steroids or second-line EoE therapies. However, patients who were previously treated with

corticosteroids or a second-line therapy were not excluded from the analysis. The standard of practice at UNC allows at least four weeks off steroids prior to food elimination diet initiation. Also, to help minimize misclassification and measurements biases, we did not analyze treatment intervals when patients were lost to follow up.

Two predominant strategies existed for initiating dietary elimination therapy over the study interval. The first strategy was targeted elimination therapy. Patients treated with targeted elimination underwent skin and/or radioallergosorbent testing, and foods with a positive reaction, as well as those identified from patient self-report as possible triggers, were eliminated from the diet. The second main strategy was an empiric 6-food elimination diet (6FED) for which patients eliminated dairy, wheat, eggs, soy, nuts and seafood. In a minority of patients, a 6FED was combined with additional targeted elimination of presumptive food triggers. All patients were offered consultation with a dietician, and most had at least one visit during which the specific diet was reviewed, nutritional information on alternatives to the eliminated food groups was provided, and additional published handouts and resources were given.^{31,32} After instituting dietary elimination, the clinical protocol was to repeat an upper endoscopy to assess endoscopic and histologic response after 6 weeks of treatment. For patients who had histologic response to a food elimination diet, defined as oesophageal biopsies with <15 eos/hpf,^{31,32} one food group was added back for 6 weeks, and endoscopy was repeated. This process was iterative and continued until all foods had been added back, which allowed for identification of specific triggers of EoE.

The food elimination diet of a minority of patients was modified or changed, as the diet did not produce a histologic response at the first post-treatment endoscopy (e.g. additional targeted elimination of suspected food triggers added to a 6FED). For the purposes of this paper, in these specific patients, the baseline symptomatic, endoscopic, and histologic data refer to findings before the initiation of any food elimination diet. Treatment responses were abstracted after the initiation of the second/modified (or most restrictive) dietary elimination strategy.

Using a standardized data collection form, patient demographics, symptoms, previous treatments, endoscopic findings, and outcomes (symptomatic global response [yes/no], endoscopic response [EoE Endoscopic Reference Score (EREFS)],³³ and histologic response [peak eosinophil count] were abstracted from the UNC Clinicopathologic database and electronic medical records. As this was a retrospective study and validated patient reported outcome measures were not uniformly applied in clinical settings, symptoms were coded using dichotomous variables signifying their presence or absence [yes/no] including global symptomatic response [yes/no per patient perception of disease activity at follow-up appointments]. The total EREFS score was calculated by adding the severity scores of the individual components of the EREFS score (edema 0–1, rings 0–3, exudates 0–2, furrows 0–2, strictures 0–1) and was abstracted retrospectively for each patient from scores that were noted at the time of the endoscopy.³³ Adherence was assessed utilizing an ordinal variable with three categories, good, partial and poor, based on clinical report from the patient and physician. Good compliance signified complete food elimination diet adherence; partial compliance signified food elimination diet adherence to 50% or more meals and snacks; poor compliance signified food elimination diet adherence to 0% – 50% of meals and

snacks. Follow-up data were collected for patients with a histologic response (<15 eos/hpf) to a food elimination diet during and after food reintroduction.

Descriptive statistics were used to characterize the cohort. We assessed the characteristics of the sample for missing data and extreme values. For continuous variables, the mean and standard deviation were determined. Frequencies were tabulated for categorical variables. Bivariate analysis was performed to describe the relationship between pre- and post-treatment outcome variables. Specifically, McNemar's χ^2 was utilized in the assessment of categorical variables such as pre- and post-treatment symptoms. Paired t-tests were used in the assessment of continuous variables such as pre- and post-treatment peak eosinophil counts and EREFS scores. All data analysis was performed using Stata 14.1 (StataCorp, College Station, TX).

Results

Baseline characteristics

A total of 52 patients who received a food elimination diet met inclusion criteria for analysis in this study. Among these 52 patients, 16 were included in a prior publication detailing the short-term outcomes to a food elimination diet (Figure 1).¹⁴ Throughout the study period, there were 3 missing values (2% missing) for histologic outcomes and 10 missing values (15% missing) for symptomatic global response. Approximately half of patients did not have an EREFS score calculated at the time of baseline and initial post-treatment endoscopy. However, only 4 observations (3% missing) were missing for gross endoscopic findings at baseline or follow-up assessments.

The mean age at the start of dietary elimination was 38.5 years, and most patients were female (60%) and white (92%) (Table 1). Formal food allergen testing, whether by patch, prick, or radioallergosorbent testing, was completed in 63% of patients. Of those, 79% had at least one food sensitivity identified from testing. At baseline endoscopy, rings and furrows were the most common features, and the mean total EREFS score was 4.1. The mean peak eosinophil count prior to food elimination diet treatment was 60.3 eos/hpf (Table 1). Prior to initiating a food elimination diet, there were 42 (81%) patients who previously received corticosteroids, which were discontinued for primary non-response or loss of response in 15 (36%), and by patient preference in the remainder (Table 2). Throughout the follow-up period, patients predominantly demonstrated partial to good adherence to a food elimination diet (94%).

Initial response to food elimination diet

There were 32 patients (62%) who were treated with a targeted elimination diet, 18 (35%) treated with a 6FED, and 2 (4%) who were initiated on a combined 6FED plus targeted elimination diet (Table 2). There were 9 patients in whom the initial food elimination diet was modified or changed, as they did not have a histologic response at the first post-treatment endoscopy (Table 2). Four were transitioned from a targeted diet to a 6FED; 1 was transitioned from a 6FED to a targeted diet with foods outside of the traditional six foods; 2 had a targeted diet added to a 6FED; and 2 patients had a 6FED added to a targeted diet.

A total of 73% of subjects reported a global improvement in symptoms (Figure 2a). For individual symptoms, there was statistical improvement in the presence of dysphagia ($p=0.005$). The total EREFS score also improved from baseline (4.1 vs. 2.7; $p = 0.001$), with significant improvements in the individual findings of exudates (0.71 vs. 0.46; $p = 0.03$), rings (1.23 vs. 0.77; $p = 0.001$), and furrows (1.18 vs. 0.69; $p = 0.003$) (Figure 2b). For the entire patient cohort, the mean of the peak eosinophil counts decreased from 60.3 eos/hpf to 44.8 eos/hpf after the most restrictive food elimination diet was implemented ($p = 0.18$) (Figure 3). However, 21 patients (40%) achieved a post-treatment eosinophil count of < 15 eos/hpf.

There were 8/18 patients initially receiving a 6FED, 11/32 patients initially receiving a targeted elimination diet, and 2/2 patients initially receiving a combined 6FED and targeted elimination who had a histologic response to therapy ($p = 0.84$). Of the 21 histologic responders, 8 (38%) were on a 6FED, 11 (52%) received targeted elimination and 2 (10%) received combined 6FED and a targeted elimination diet ($p = 0.51$). Among the 9 patients previously described in whom an initial food elimination diet was modified or changed, only 2 (22%) achieved a histologic response: one patient transitioned to a 6FED alone and 1 patient transitioned to a 6FED supplemented by a targeted elimination diet. Of the non-responders, treatments were similarly distributed with 6FED (34%), targeted elimination (52%), and combined diets (14%). Histologic responders and non-responders did not differ significantly by adherence (81% vs. 93% partial to good adherence in responders vs. non-responders; $p = 0.65$) nor did they differ substantially by prior corticosteroid exposure (74% non-responders with previous exposure versus 81% responders with previous exposure; $p = 0.88$). When analyzing patients with complete versus partial or non-adherence to a food elimination diet, the proportion of patients with and without histologic responses did not differ (81% vs. 81% complete adherence in responders vs. non-responders; $p = 0.98$).

After the most restrictive diet, 94% of responders reported a global improvement in symptoms, and only 11% reported dysphagia (95% baseline vs. 11%; $p = 0.005$). The total EREFS score and peak of the mean eosinophil count both significantly decreased from 3.2 to 0.7 ($p = 0.001$) and 49.8 to 4.1 eos/hpf ($p = 0.001$), respectively. For patients without a histologic response, the mean of the peak eosinophil counts increased from 67.7 eos/hpf to 75.5 eos/hpf after the most restrictive food elimination diet ($p = 0.82$). Additionally, 55% of non-responders indicated a global improvement in symptoms with 43% reporting dysphagia specifically (87% baseline vs. 43%; $p = 0.05$). Non-responders had a minimal and non-statistically significant improvement in the total EREFS score (4.3 vs. 4.0; $p = 0.14$), and none of the individual components of the EREFS severity scores improved after therapy in these patients.

Long-term dietary elimination outcomes

Nineteen of the responders (90%) underwent serial reintroduction of foods with identification of an allergic trigger(s). The most commonly identified food trigger was dairy (53%) followed by wheat (37%) and eggs (26%). There were 7 patients with a single food trigger, which was dairy in 5 cases (Figure 4a). For 10 patients, there were 2 food triggers with wheat being a trigger in 7 of 10. Additionally, there were 2 patients with three or more

food triggers. Of these 19 patients, there were 12 (63%) who had undergone formal allergen testing. Formal allergen testing correctly identified a causative trigger in 6 patients (50%) (Table 3). There were 9 patients treated with a targeted elimination diet in which a food trigger(s) was identified at the end of follow-up. Of interest, 5/9 (56%) had food antigens contained solely within a 6FED (eggs; wheat and eggs; wheat and dairy; soy, egg, seafood, and nuts; dairy), 2/9 (22%) had at least one food trigger included within a 6FED (*soy* and chicken; *dairy*, *nuts*, and multiple berries), and 2/9 (22%) had no food triggers found within a 6FED (pork; oats and beef). Dairy and wheat were also identified as the sole food triggers in the 2 patients treated with combined 6FED and targeted elimination diet.

At the end of the mean follow-up period of 24.9 months (range: 4.2 – 74.4 months), 10 of the initial 21 responders maintained a post-food elimination diet eosinophil count < 15 eos/hpf on follow-up biopsy. The loss of response in the other 11 patients was explained by poor compliance in 8 and planned reintroduction of food triggers in 3 but without subsequent endoscopy eliminating the trigger, respectively. Among the 15 patients with prior primary or secondary non-response to steroids, only 1 (6%) had a durable histologic response to a food elimination diet, compared to 40% (4/10) in steroid-naïve patients ($p = 0.28$). Of the 10 maintenance responders, 6 (60%) were initiated on a 6FED, and 4 (40%) were started on a targeted elimination diet. There was 1 (10%) maintenance responder for whom the initial food elimination diet strategy was modified. For this patient, the initial food elimination diet was transitioned from a 6FED to a 6FED with additional targeted removal of additional foods. At the end of follow-up, all but 1 patient opted to continue a FED rather than transition to an alternative therapy.

A global improvement in symptoms was documented for initial responders at the end of the follow-up period (67%) as well as for dysphagia individually (95% vs. 33%; $p=0.008$). Heartburn (37% vs. 8%; $p = 0.16$) and chest pain (21% vs. 0%; $p = 0.08$) trended toward durable improvements. Only 1 (8%) patient underwent oesophageal dilation during their final available endoscopy, compared with 27 (52%) prior to starting a food elimination diet ($p = 0.06$). Durable improvements were also documented for endoscopic findings for all initial responders at the end of follow-up. The total EREFS score was 1.7 compared to 3.2 at baseline ($p = 0.06$). Additionally, the EREFS exudates (0.33 vs. 0.67; $p = 0.17$), EFEFS rings (0.33 vs. 1.17; $p = 0.04$), and EREFS furrows (0.5 vs. 0.83; $p = 0.36$) component severity scores met or trended towards long-term significant improvements (Figure 2b). For the initial histologic responders, the mean of the peak eosinophil count was 31.3 eos/hpf at the end of the mean 24.9-month follow-up period, which compared with a pre-treatment peak eosinophil count of 49.8 eos/hpf ($p = 0.17$).

For the maintenance responders, dysphagia was significantly improved from pre-food elimination diet baseline (90% vs. 14%; $p = 0.03$) (Figure 2b) at the end of the follow-up period. These 10 patients also uniformly (100%) reported global improvement in symptoms. Additional upper gastrointestinal symptoms trended toward improvement at the end of follow-up for maintenance responders including chest pain (40% vs. 0%; $p = 0.08$), abdominal pain (10% vs. 0%; $p = 1.00$) and heartburn (40% vs. 14%; $p = 0.16$). Component EREFS scores were decreased from baseline at the end of follow-up for maintenance responders but did not reach statistical significance (Figure 2B). The final available mean

peak eosinophil count for the maintenance responders was 5.2 eos/hpf. This was a sustained improvement from their pre-food elimination diet peak eosinophil count of 44.4 eos/hpf ($p = 0.02$). The last available peak eosinophil count in the 11 initial responders with poor compliance or food reintroduction at the end of follow-up was 60.2 eos/hpf and similar to their pre-food elimination diet value of 55.8 eos/hpf ($p = 0.83$) (Figure 3). In the maintenance non-responders, initial symptomatic and endoscopic improvements were attenuated. There were 5 (45%) maintenance non-responders reporting continued global symptomatic improvement. However, though not as pronounced for maintenance responders, dysphagia (91% vs. 43%; $p = 0.08$), heartburn (36% vs. 0%; $p = 0.32$, and abdominal pain (27% vs. 14%; $p = 1.0$) all trended toward long-term improvements in histologic non-responders. The total EREFS severity score (3.2 vs. 1.9; $p = 0.14$) also trended toward a durable long-term improvement from baseline in the histologic non-responders.

Discussion

While dietary elimination therapy has been shown to be an effective treatment for eosinophilic oesophagitis, there are few long-term outcome data in adults. In this study, we aimed to determine the long-term clinical efficacy of food elimination diets in a cohort of adult patients with eosinophilic oesophagitis. We found that dietary therapy resulted in sustained symptomatic, endoscopic and histologic improvements in patients who remain compliant with eliminating known or suspected dietary triggers at a mean follow-up time of just over 2 years. In our study, only a minority of patients both responded to a food elimination diet and remained compliant with the diet throughout the 2-year follow-up of this cohort.

Elemental diets utilizing liquid amino acid-based formulations,^{7,36} targeted elimination diets excluding foods based on allergy testing,^{8–10} and empiric elimination diets excluding common food triggers without specific allergy testing^{11–14} have all been assessed as eosinophilic oesophagitis treatments. A meta-analysis of studies of adults showed that elemental diets were effective in 91% of patients, empiric elimination diets in 72%, and allergy test-directed diets in 46%.³⁴ There are no randomized clinical trials pertaining to the use of dietary therapy in management of eosinophilic oesophagitis. However, the data are strong and show excellent clinical and histologic response rates.³⁵ When food triggers are removed, it is reasonable to conclude that patients can enter long-term remission that does not require medicinal therapy. However, until more recently, this had not been substantiated in an adult eosinophilic oesophagitis cohort.^{13,17}

Prior to 2013, no data informed the long-term clinical effectiveness of a food elimination diet for adult eosinophilic oesophagitis patients but rather studies focused on the short-term ability of a food elimination diet to induce histologic remission.^{11,14,15} The first paper considering the long-term effectiveness of a food elimination diet analyzed a prospective cohort study of 67 patients.¹³ Similar to our data, this study demonstrated a sustained response in 15 adults who were followed for a mean period of approximately 2 years. This was a prospective experimental study of European patients, and it is possible that the results may not generalize to a 'real-world' US clinical cohort. Additionally, this cohort was only exposed to a 6 food elimination diet, and as such, these findings cannot be extrapolated to

the long-term effectiveness of a targeted elimination diet. A similar study was published in 2016, which included 56 adult patients treated with 6 food elimination diet, of whom 29 responded to 6 food elimination diet.¹⁷ Of these, 18 were followed for a mean period of 9.6 months and, again, similar to our data, just 10 remained in remission.

The response rates seen in our study (73% global symptomatic response; 40% histologic response < 15 eosinophils/high-power field after the most restrictive food elimination diet) are numerically lower relative to previously reported data. However, as opposed to prior studies, our study included patients who pursued dietary therapy after previously failing corticosteroids. As such, our population may have more resistant disease, which is less likely to respond to any available treatment modality. In our real-world cohort, we documented that each short-term responder maintained a long-term and durable histologic response if adherence to known food allergens was maintained over a mean follow-up period of over two years. Unfortunately, this adherence occurred in only a minority of initial responders. Additionally, durable and significant symptomatic and endoscopic improvements were recorded for all responders over the entire follow-up interval. We also found that patients without a histologic response to a food elimination diet reported improvements in symptomatic but not endoscopic endpoints. Given emerging natural history data suggesting that persistent esophageal eosinophilic infiltration places EoE patients at risk for ongoing fibrotic remodeling of the esophagus,^{34,35} our data emphasize the importance of assessing a histologic endpoint when examining outcomes of dietary therapy in EoE.

Limitations exist for this study. As this project was done in a retrospective manner, data extraction relied on chart review. This introduces the potential for misclassification and measurement biases into the study. Additionally, as data were not collected in a prospective manner and some data collection preceded the validation of symptom measures, standardized instruments were not used to abstract or record patient symptoms. As such, symptom findings should be interpreted with caution. This study also included patients who initiated a food elimination diet prior to widespread adoption of the eosinophilic oesophagitis endoscopic reference scoring system, which permitted 25 paired comparisons after food elimination diet initiation and 10 paired comparisons at the end of the follow-up period. However, these missing data reduce the power of statistical tests but not the validity of our conclusions. There are also multiple strengths for this study. This study represents one of the larger cohort studies analyzing dietary therapy in eosinophilic oesophagitis. Unlike previously reported studies, we also included patients utilizing a number of food elimination diet strategies. Additionally, as these results were from outside a clinical trial and included prior steroid non-responders, they may represent more of a 'real-world' response that is indicative of routine clinical practice.

In conclusion, dietary elimination produced a durable symptomatic and endoscopic response in a real-world cohort of adult eosinophilic oesophagitis patients followed for more than two years. Additionally, though adherence represents a real problem and limits the number of patients remaining on a food elimination diet long term, a sustained histologic response was documented in patients compliant with avoiding dietary triggers. Among patients with an initial treatment response to a food elimination diet, the long-term data within this study confirm that dietary elimination produces a durable clinical response.

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Figure 1.
Patient flow depiction throughout the treatment period.

Figure 2.
 (A) Symptom reporting across the study period for included patients receiving food elimination diets (FED). (B) EREFS score across the study period for included patients receiving food elimination diets (FED)

Figure 3.
Histologic findings across the study period for patients receiving food elimination diets (FED)

Figure 4.
Number of patients with a particular identified food allergen.

Table 1

Baseline characteristics and clinical findings (Number = 52)

Age when food elimination diet started (Mean years $\pm$ SD ¹)	38.5 $\pm$ 12.0
Length of follow-up (Mean patient months $\pm$ SD; range)	24.9 $\pm$ 19.8; 4.2 – 74.4
% Partial to good food elimination diet adherence	94
% Female	60
% White	92
% Atopic disease diagnosis	73
% Patch, prick, or RAST ² testing	63
% Patients with formal allergen testing prior to a targeted elimination diet	78
% Food allergy by formal testing	79
Baseline symptoms (%)	
Dysphagia	90
Heartburn	33
Chest pain	17
Abdominal pain	16
Baseline endoscopic findings (%)	
Rings	66
Furrows	70
Decreased vascularity	30
White plaques	34
Stricture	26
Total EREFS ³ (Mean $\pm$ SD) *	4.1 $\pm$ 2.1
Baseline histology findings (Mean eos/hpf $\pm$ SD)	60.3 $\pm$ 59.2

* Available for n = 25 patients

¹ SD: standard deviation;² RAST testing: radioallergosorbent testing;³ EREFS: EoE Endoscopic Reference Score

Table 2

Treatment history prior to and during food elimination diet initiation

Prior treatments	(%)
Corticosteroids	81
Fluticasone	48
Budesonide	56
Systemic steroids	6
LTA ¹	8
H2A ²	8
Dilation	52
1 ⁰ or 2 ⁰ loss of response to tCS or systemic steroids ³	15 (36%)
Initial food elimination diet strategy (%)	
Targeted (n = 32)	62
Six food elimination diet (n = 18)	35
Combined targeted + six food elimination diet (n = 2)	4
Modified diet after first non-response (n = 9)	17
Targeted diet to 6FED ⁴ (n = 4)	
6FED to targeted diet (n = 1)	
Targeted diet added to 6FED (n = 2)	
6FED added to targeted diet (n = 2)	

¹LTA: leukotriene antagonist;²H2A: histamine 2 receptor antagonist;³1⁰: no response to steroids, 2⁰: loss of response after initial improvement;⁴6FED: 6 food elimination diet

Table 3

Results of skin and radioallergosorbent testing for food and environmental allergens alongside identified food allergen triggers

Patient ID	Identified food allergen trigger(s) of EoE after food reintroduction	Skin testing results	Radioallergosorbent testing
2	Dairy	Negative histamine control	Negative environmental panel ¹ ; negative 'variety' of foods ²
4	Eggs	Environmental positives: dust mites, trees, grasses, weeds, English plantain, dog fennel, baccharis, mugwort, sheep sorrel Food positives: nuts, soybean, rice, lima beans, peas, sesame seeds	Not completed
5	Beef, oats	Negative histamine control	Positive for oat, beef, carrot
14	Pork	Environmental positives: maple mix, cocklebur Food positive: banana	Not completed
17	Eggs, nuts	Mites, trees, grasses	Not completed
21	Dairy	Environmental positives: Bacteria, fungi, trees, grasses, weeds Food positives: Bass, crab, almond, pecan, egg yolk, wheat, rice, oat, beef, banana, cantaloupe, tomato	Not completed
26 *	Dairy, wheat	Environmental positives: Maple and black widow Food positive: Milk	Not completed
27 *	Soy, egg, seafood, nuts	Food positives: Eggs, beef, lamb	Not completed
28	Wheat, egg	Negative for 48 environmental and 58 food allergens	Not completed
37 *	Dairy	Environmental positives: German cockroach, penicillium mix, epicoccum, rhizopus, candida, multiple trees mixes, multiple grasses, alternaria, fusarium, dust mite, hickory-pecan mix Food positives: peanut, shrimp, almond, egg yolk, milk, pineapple	Cow's milk
42 *	Dairy	Milk, peanut, salmon, chicken, soybean, clam, oyster, shrimp, tuna	Not completed
48 *	Dairy, fish	Testing results uninterpretable	Environmental positives: Alternaria, aspergillus, aandida, cat, dog, german cockroach Food positives: Cow's milk, malt, and barley

¹ Environmental panel: Multiple specific IgE's for individual allergens are tested for including trees, molds, grasses, weeds, perennial allergens, and miscellaneous allergens (i.e. latex, cotton crude, house dust, feather mix)

² Food testing: Multiple specific IgE's for food are tested for including almond, bakers yeast, beef, brazil nut, cacao, carrot, cashew nut, chicken meat, cheddar cheese, corn, egg white, egg yolk, hazelnut, mutton, oat, peanut, pork, soybean, strawberry, walnut, wheat

* Food trigger identified by allergen testing