Original Article

Oral Food Challenges After Treatment With Omalizumab in the Clinical Setting

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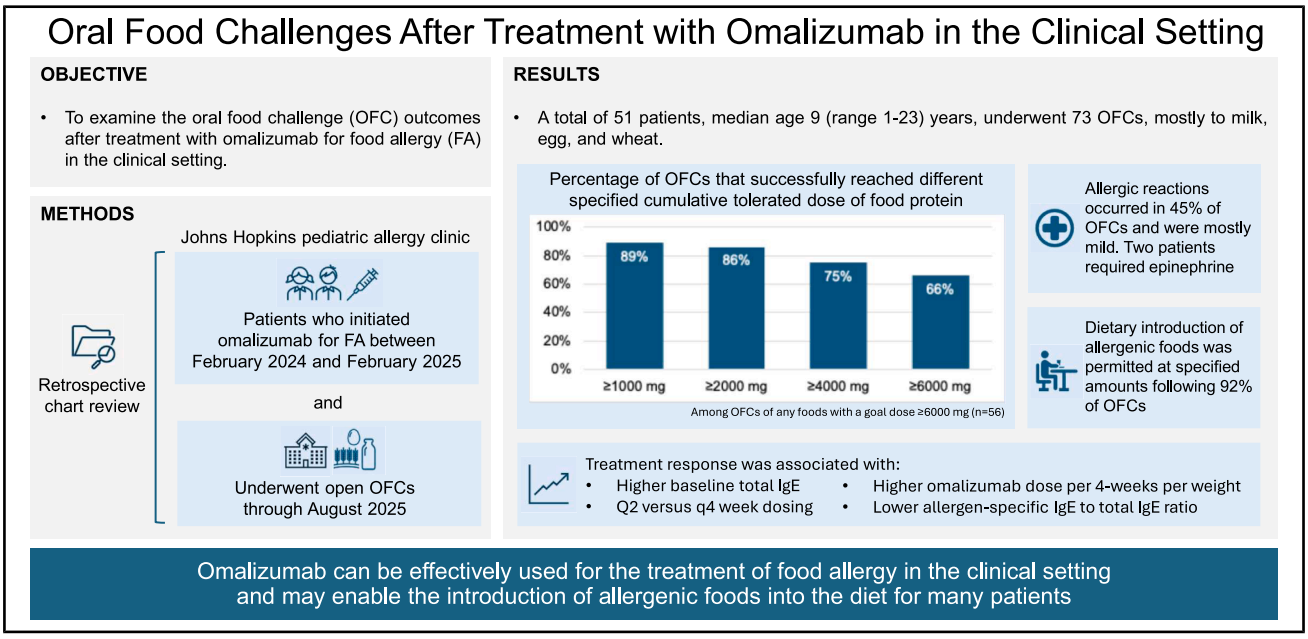
What is already known about this topic? The OUtMATCH trial demonstrated omalizumab's efficacy in increasing reaction thresholds to multiple foods in patients with food allergy (FA), leading to its approval from the Food and Drug Administration for the treatment of FA.

What does this article add to our knowledge? Real-world data on the use of omalizumab in the clinical setting are limited. We examined oral food challenge outcomes among patients treated with omalizumab and found similar results to those in the OUtMATCH trial.

How does this study impact current management guidelines? These findings demonstrate that omalizumab can be effectively used for the treatment of FA in the clinical setting and may enable the introduction of allergenic foods into the diet for many patients.

VISUAL SUMMARY



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Abbreviations used
CTD- cumulative tolerated dose
FA- food allergy
FDA- Food and Drug Administration
IQR- interquartile range
OFC- oral food challenge
OUtMATCH- Omalizumab as Monotherapy and as Adjunct Therapy to Multi-Allergen OIT in Food Allergic Participants

BACKGROUND: Although omalizumab is now approved for the treatment of food allergy, little is known about its use in the clinical setting.
OBJECTIVE: To examine the outcome of oral food challenges (OFCs) after treatment with omalizumab.
METHODS: We conducted a retrospective chart review of clinic patients who underwent OFCs after treatment with omalizumab, including cumulative tolerated doses and all adverse events.
RESULTS: A total of 51 patients (45% female; median age, 9 [range, 1-23] years; median total IgE, 512 [interquartile range, 285 to 1080] IU/mL) underwent 73 OFCs, with milk (n = 27), egg (n = 23), and wheat (n = 9) accounting for 81% of the OFCs. A reaction history was documented for 95% and all challenged foods had a positive allergen-specific IgE (median, 34 [interquartile range, 12 to >100] kUA/L). OFCs were performed at a median of 7 (range, 4-14) months after starting omalizumab. Among OFCs to any food with a goal dose ≥6000 mg (n = 56), 89% successfully consumed ≥1000 mg, 86% ≥2000 mg, 75% ≥4000 mg, and 66% ≥6000 mg. Allergic reactions occurred in 45% (n = 33) of all OFCs, with 21 treated with antihistamines and 2 treated with epinephrine. Dietary introduction of allergenic foods was permitted following 92% of OFCs. Omalizumab treatment response was associated with higher baseline total IgE, every 2-week dosing versus every 4-week dosing, higher total omalizumab dose per 4 weeks per weight, and lower allergen-specific IgE to total IgE ratio.
CONCLUSIONS: Omalizumab can be effectively used for the treatment of food allergy in the clinical setting and may enable the introduction of allergenic foods into the diet for most patients. **(J Allergy Clin Immunol Pract 2026;■:■-■)**

Key words: *Oral food challenge; Omalizumab; Food allergy; Anti-IgE; Predictors*

INTRODUCTION

The results of Omalizumab as Monotherapy and as Adjunct Therapy to Multi-Allergen OIT in Food Allergic Participants (OUtMATCH) stage 1 demonstrated omalizumab's efficacy in increasing the reaction threshold to multiple foods in patients with food allergy (FA).[1] As a result, omalizumab was approved by the Food and Drug Administration (FDA) in February 2024 for the reduction of allergic reactions that may occur with accidental exposure to 1 or more foods in patients aged 1 year and older with IgE-mediated FA, while still practicing strict food avoidance.[2,3] This approval represents a significant milestone in FA treatment and offers a long-awaited treatment option for patients and families. Since the FDA approval, many patients have initiated omalizumab for FA. However, data on its use for the treatment of FA in real-world clinical settings remain limited.[4]

Real-world data are essential for guiding the implementation of omalizumab, optimizing its use, and informing clinical practice.[5] Given the differences between controlled clinical trials and daily practice environments, it is also critical to verify how trial-based outcomes translate into clinical settings.[5-7] The application of omalizumab for FA continues to expand as new data emerge, including evidence from stage 3 of OUtMATCH demonstrating that omalizumab can enable safe introduction of allergenic foods into the diet in some patients.[8] Still, knowledge gaps remain in understanding omalizumab's full potential, as well as its limitations, in FA treatment.[4,6,9,10] Additional research is also needed to identify markers that can predict or assess treatment response, ideally without the need for oral food challenges (OFCs).[4,9,11,12]

Since its FDA approval in February 2024, omalizumab has been discussed as a treatment option for patients 1 year and older with IgE-mediated FA in the Johns Hopkins pediatric allergy clinic. In this retrospective study, we report the outcomes of OFCs among the first cohort of our patients with FA treated with omalizumab.

METHODS

Study design and population

From September to October 2025, we conducted a retrospective chart review of all Johns Hopkins pediatric allergy clinic patients who initiated omalizumab for IgE-mediated FA between February 2024 and February 2025. Further chart review was then completed on those who had an OFC between February 2024 through August 2025. Patients who had previously received omalizumab for other indications or in a research setting were excluded. The study was approved by the Johns Hopkins University Institutional Review Board.

FA was diagnosed on the basis of a convincing reaction history and/or testing including allergen-specific IgE, skin prick testing, and/or OFC. The initiation of omalizumab was guided by shared decision making with the patient and family.[5] Omalizumab dosing was determined by the FDA-approved omalizumab dosing table based on patient weight and baseline total IgE levels, ranging from 75 to 600 mg every 2 or 4 weeks.[2] Patients with baseline total IgE and body weight outside the omalizumab dosing table for FA who chose to proceed with omalizumab treatment were offered therapy through shared decision making and were dosed with the highest approved dose for their weight after receiving prior authorization.

Open OFCs

Open OFCs were offered at least 4 months after the initiation of omalizumab on the basis of the OUtMATCH protocol with the exact timing based on patient preferences and clinic scheduling availability.[1,5] Some patients with multiple FAs underwent more than 1 OFC to different foods.

Open OFCs were performed in a stepwise fashion[13] with some variations, but typically divided into 6 doses of 5%, 10%, 15%, 20%, 25%, and 25% of the OFC goal dose. The OFC goal doses

were guided by OUtMATCH[1] and previous OFC guidelines[13] and were tailored to individual patient goals and preferences, with some variation based on provider's discretion, reflecting the heterogeneity of clinical practice. The most common goal doses were a cumulative total of 6000 mg of milk, egg, or wheat protein. Smaller goal doses, or the introduction of milk in a baked form, were also used on the basis of the goals of the patient and family, such as to assess protection against accidental exposure. OFCs were stopped if dose-limiting symptoms[14] occurred, when the prespecified goal dose was achieved, or at the discretion of the provider (eg, refusal to eat more and shared decision making with the family). Mild symptoms such as localized hives, rhinorrhea, or mild abdominal discomfort are not typically considered dose-limiting,[14] but an OFC may still be stopped on the basis of patient preference in the clinical setting. The results of OFCs were measured as cumulative tolerated dose (CTD), defined as the total amount of food protein successfully ingested without dose-limiting symptoms.[14] If a patient completed the OFC without dose-limiting symptoms,[14] the CTD was recorded as the total amount consumed.

Symptoms and treatments given were recorded for every OFC. Symptoms were categorized on the basis of the Consortium for Food Allergy Research Grading Scale for Systemic Allergic Reactions, version 3.0.[14] Treatments administered for allergic reactions that occurred during OFCs were determined by symptom type, reaction severity, and the provider's clinical judgment.

Guided by the OFC results, dietary introduction of retail allergenic foods was allowed generally on the basis of the OUtMATCH protocol as well as individual preferences, with the maximum daily dose typically starting at 50% of the CTD and adjusted on the basis of clinical judgment and each patient's goals.[8,15] In cases of more severe reactions, the maximum daily dose was typically initiated at a lower percentage of the CTD and in some cases dietary introduction was not permitted. Specific plans for dietary introduction were highly individualized and, unlike OUtMATCH, could include baked forms of milk and egg. Precautions such as reducing or stopping the maximum daily dose during illness and caution with ingestion before exercise may be suggested. All patients were advised to carry intramuscular epinephrine at all times and to contact the care team for any concerns. Unlike OUtMATCH stage 3, omalizumab was continued after OFCs and during food introduction. After a period of successful dietary consumption, some patients may subsequently choose to discontinue omalizumab while continuing dietary consumption of allergenic foods under guidance.

Outcomes and variables

The primary outcome was the CTD during an OFC occurring while receiving omalizumab for FA, with success thresholds defined as CTDs of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein. Secondary outcomes included adverse events that occurred during OFCs, the maximum starting dose recommended for dietary introduction of allergenic foods following OFCs, and predictors associated with outcomes.

The variables for the predictor analysis included age, sex, weight, specific food challenged, allergen-specific IgE levels, baseline total IgE level, allergen-specific IgE to total IgE ratio, duration of omalizumab treatment before OFC, omalizumab dosing frequency, omalizumab total dose per 4 weeks per weight (mg/kg), and omalizumab total dose per 4 weeks (mg). Baseline total IgE and food-specific IgE levels were recorded from the most recent testing performed before the initiation of omalizumab.

Demographic variables, including participant race, ethnicity, and sex, were classified on the basis of their data in their electronic health record.

Statistical analysis

All analyses were intended to be descriptive. The primary outcome of CTD at OFCs was reported as the number and percentage of patients who successfully consumed a CTD of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein. The CTD was also reported individually for each OFC. When assessing aggregate outcomes of OFCs to any foods, baked milk OFCs (n = 3) were not included unless otherwise specified. Categorical variables (characteristics of patients and OFCs, adverse events, and treatment provided) were reported as counts and percentages. Continuous variables were presented as medians and interquartile range (IQR) or absolute range. For dietary introduction of allergenic foods, the recommended maximum daily dose was reported, and the ratio of recommended starting maximum dose to the CTD achieved during OFCs was calculated.

Exploratory analyses were conducted to examine potential variables associated with OFC outcomes using the Fisher exact test for categorical variables and the Wilcoxon rank sum test for continuous variables. Unadjusted P value less than .05 was considered to be statistically significant. For the predictor analyses, OFCs to any foods with a goal dose ≥6000 mg (n = 56) were used, with success thresholds defined as CTDs of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein. Allergen-specific IgE levels reported as greater than 100 kUA/L without exact values were treated as 100 kUA/L for analyses. Analyses were conducted using Stata 18 Statistical Software (StataCorp 2023, College Station, Texas).

RESULTS

Characteristics of patients and OFCs

A total of 51 patients were included (Table I). The median age at the time of initiating omalizumab was 9 years (range, 1-23 years); 45% were female. Most patients were White (71%) and non-Hispanic (90%), and had private insurance (98%). Most had multiple FAs (84%) with a median of 4 food allergens (IQR, 2-5) per patient. Tree nut (69%) and egg (67%) allergies were most common, followed by milk (55%), peanut (55%), sesame (33%), wheat (22%), shellfish (10%), fish (8%), and soy (8%). Atopic comorbidities were common. Seventeen patients underwent more than 1 OFC.

A total of 73 OFCs were performed to 10 different allergens, with milk (n = 27), egg (n = 23), and wheat (n = 9) accounting for 81% of the OFCs (Table II). A goal dose of ≥6000, ≥4000, and ≥1000 mg was used in 77% (56 of 73), 84% (61 of 73), and 92% (67 of 73) of OFCs, respectively. The median duration from the initiation of omalizumab to the OFCs was 7 months (range, 4-14 months). Sixty-nine of the 73 (95%) OFCs had a documented previous reaction history to the challenged food. All challenged foods had a positive allergen-specific IgE, and the median allergen-specific IgE levels for milk, egg, and wheat were 45 kUA/L (IQR, 12 to >100), 34 kUA/L (IQR, 16 to 58), and greater than 100 kUA/L (IQR, 31 to >100), respectively.

Outcomes of OFCs

Figure 1 and Table III summarize the OFC outcomes, showing the percentage of OFCs that successfully reached

TABLE I. Baseline characteristics of the patients who underwent OFCs after treatment with omalizumab in the clinical setting

Characteristics	n = 51
Age (y), median (range)	9 (1-23)
Age category (y), n (%)	
1-5	18 (35)
6-11	15 (29)
12-17	14 (27)
≥18	4 (8)
Sex, n (%)	
Female	23 (45)
Male	28 (55)
Race, n (%)	
Asian	6 (12)
Black or African American	5 (10)
White	36 (71)
Multiple	2 (4)
Other	2 (4)
Ethnicity, n (%)	
Not Hispanic or Latino	46 (90)
Hispanic, Latino, or Spanish origin	4 (8)
Unknown	1 (2)
Insurance, n (%)	
Private	50 (98)
Public	1 (2)
FA, n (%)	
Tree nuts*	35 (69)
Egg	34 (67)
Milk	28 (55)
Peanut	28 (55)
Sesame	17 (33)
Wheat	11 (22)
Shellfish	5 (10)
Fish	4 (8)
Soy	4 (8)
Other foods	20 (39)
Multiple food allergies	43 (84)
No. of food allergies, median (Q1, Q3)	4 (2, 5)
Atopic comorbidities, n (%)	
Asthma or wheezing	33 (65)
Atopic dermatitis	44 (86)
Environmental allergies	37 (73)
Weight (kg), median (Q1, Q3)	27 (17, 48)
Total IgE (IU/mL), median (Q1, Q3)†	512 (285, 1080)
Omalizumab dosing interval, n (%)	
Every 2 wk	23 (45)
Every 4 wk	28 (55)

*Different tree nut allergies were counted as 1 FA.
†Total IgE levels were measured at a median of 3 mo (range, 1-9 mo) before initiating omalizumab.

TABLE II. Characteristics of the OFCs after treatment with omalizumab in the clinical setting

Characteristics	All OFCs (n = 73)
Reaction history to challenged food, n (%)	
Yes	69 (95)
No	4 (5)
Allergen-specific IgE (kUA/L), median (Q1, Q3)	34 (12, >100)
Duration of omalizumab before OFC (mo), median (range)	7 (4-14)
Food challenged, n (%)	
Direct milk	24 (33)
Egg	23 (32)
Wheat	9 (12)
Soy	2 (3)
Peanut	2 (3)
Chicken	1 (1)
Cashew	3 (4)
Hazelnut	3 (4)
Sesame	2 (3)
Walnut	1 (1)
Baked milk	3 (4)
OFC goal dose (mg)	
600	3 (4)
1000	1 (1)
2000 (baked milk)	3 (4)
3000	5 (7)
4000	5 (7)
6000	55 (75)
9000	1 (1)

different specified CTDs. Fifty-six of all 73 (77%) OFCs had a goal of ≥6000 mg, among which 50 (89%) resulted in successful consumption of ≥1000 mg, 48 (86%) ≥2000 mg, 42 (75%) ≥4000 mg, and 37 (66%) ≥6000 mg. When extending the analysis to include all OFCs with a goal of ≥4000 mg (n = 61), 54 (89%) resulted in successful consumption of ≥1000 mg, 52 (85%) ≥2000 mg, and 46 (75%) ≥4000 mg. In addition, among the 67 of 73 (92%) OFCs with a goal dose of ≥1000 mg (excluding baked milk), 60 (90%) resulted in successful consumption of ≥1000 mg. Details of each individual OFC are provided in Table IV.

Fifty-nine of the 73 OFCs were performed to milk, egg, or wheat. There were 24 direct milk OFCs and 3 baked milk OFCs. Twenty-three of 24 direct milk OFCs had a goal dose of 6000 mg milk protein (6 oz of milk), among which 87% resulted in successful consumption of ≥1000 mg, 83% ≥2000 mg, 70% ≥4000 mg, and 61% ≥6000 mg (Figure 1 and Table III). There were 3 baked milk OFCs with CTDs of 320, 600, and 2000 mg (Table IV). Twenty-three egg OFCs were performed, all to direct egg (scrambled, hard boiled, or stove-top—cooked French toast) and all with a goal dose of 6000 mg egg protein (1 egg). Eighty-seven percent of the egg OFCs resulted in successful consumption of ≥1000 mg, 83% ≥2000 mg, 78% ≥4000 mg, and 65% ≥6000 mg. Eight of 9 wheat OFCs had a goal dose of 6000 mg wheat protein, among which 100% resulted in successful consumption of ≥2000 mg, 75% ≥4000 mg, and 75% ≥6000 mg. One patient was a toddler who had a goal of 4000 mg wheat protein, which was tolerated without symptoms (Table IV).

Figure 2 presents the outcomes of the 17 patients who underwent 2 or more OFCs. Most patients (10 of 17 [59%]) had the same CTDs across their OFCs. Three (18%) patients had the same CTDs across 2 of 3 of their OFCs, with a CTD difference of ≤2000 mg to their other OFCs. Two (12%) patients had a larger CTD difference of more than 2000 mg among their OFCs. In addition, 2 (12%)

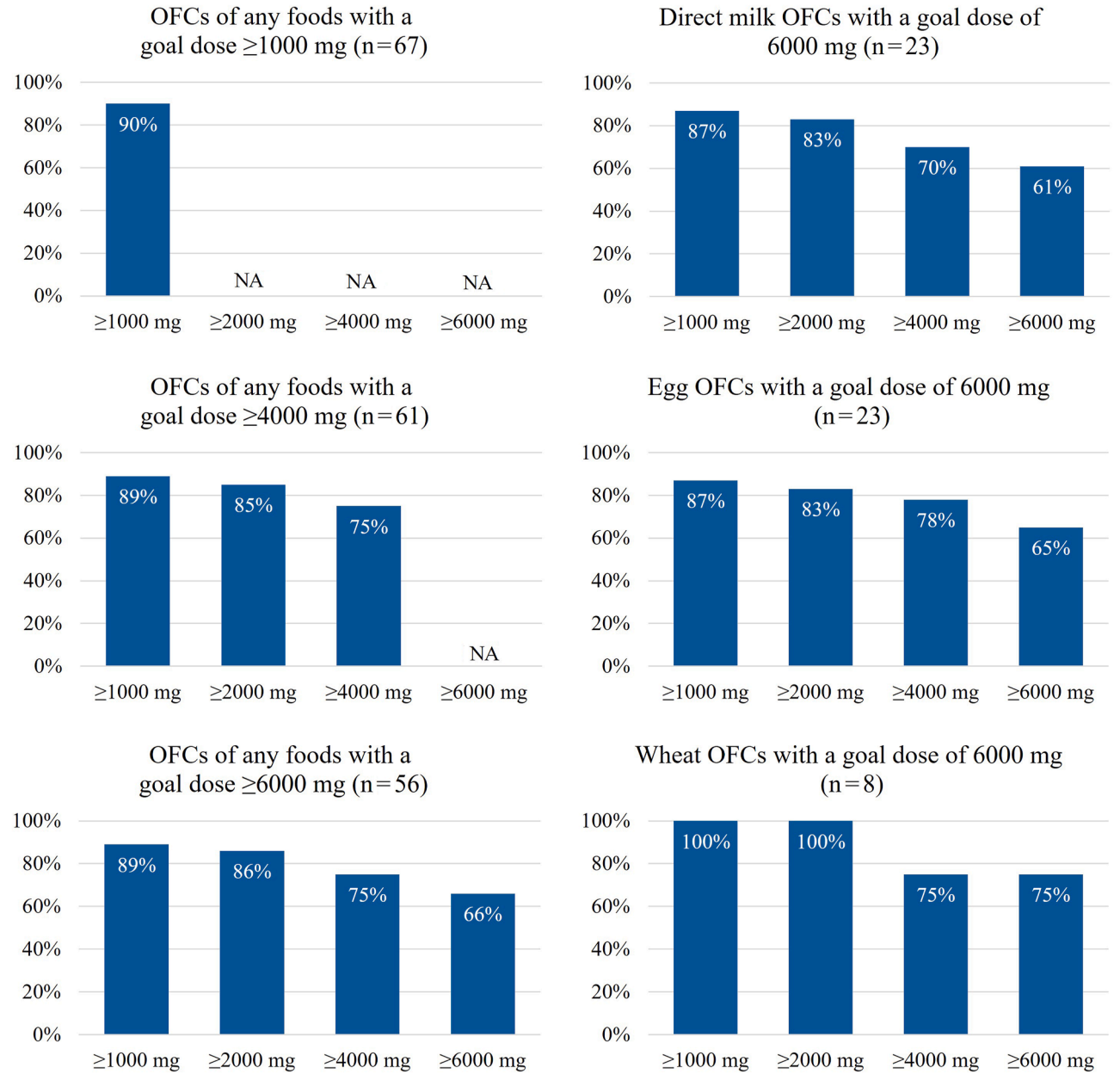

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FIGURE 1. Percentage of OFCs that successfully reached CTD ≥1000, ≥2000, ≥4000, and ≥6000 mg after treatment with omalizumab in the clinical setting. *NA*, Not applicable.

TABLE III. OFCs that successfully reached CTD of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein after treatment with omalizumab in the clinical setting

OFC type	CTD ≥ 1000 mg	CTD ≥ 2000 mg	CTD ≥ 4000 mg	CTD ≥ 6000 mg
OFCs of any foods with a goal dose ≥1000 mg (n = 67)	60 (90)	NA	NA	NA
OFCs of any foods with a goal dose ≥4000 mg (n = 61)	54 (89)	52 (85)	46 (75)	NA
OFCs of any foods with a goal dose ≥6000 mg (n = 56)	50 (89)	48 (86)	42 (75)	37 (66)
Direct milk OFCs with a goal dose of 6000 mg (n = 23)	20 (87)	19 (83)	16 (70)	14 (61)
Egg OFCs with a goal dose of 6000 mg (n = 23)	20 (87)	19 (83)	18 (78)	15 (65)
Wheat OFCs with a goal dose of 6000 mg (n = 8)	8 (100)	8 (100)	6 (75)	6 (75)

NA, Not applicable.
Data are presented as n (%).

TABLE IV. Characteristics and outcomes of all 73 OFCs after treatment with omalizumab in the clinical setting

Patient	Age (y) at therapy start	Foods challenged	Total IgE (IU/mL)	Allergen-specific IgE (kUA/L)	OFC goal (mg)	CTD (mg)	Symptom (grade)*	Dietary introduction amount (mg)
1	1	Milk	224	13.2	6000	6000	Negative	3000
2†	1	Milk	640	39.5	6000	6000	Negative	2000
2†	1	Egg	640	12.6	6000	6000	Negative	6000
3†	3	Milk	1219	11.0	6000	6000	Negative	3000
3†	3	Egg	1219	32.8	6000	6000	Negative	6000
4	4	Milk	1247	>100.0	6000	6000	Negative	3000
5	6	Milk	1123	95.0	6000	6000	Negative	3000
6†	12	Milk	1228	14.4	6000	6000	Negative	3000
6†	12	Egg	1228	>100.0	6000	6000	Negative	6000
7†	14	Milk	1196	45.1	6000	6000	Negative	3000
7†	14	Egg	1196	54.5	6000	6000	Negative	3000
8‡	14	Milk	1864	>100.0	6000	6000	Negative	3000
9†	14	Milk	686	2.1	6000	6000	Negative	4000
9†	14	Wheat	686	4.1	6000	6000	Negative	3000
10	15	Milk	337	8.6	6000	6000	Negative	3000
11	17	Milk	765	44.2	6000	6000	Negative	6000
12	5	Milk	1144	116.0§	6000	6000	1	2000
13†	6	Milk	1739	109.0§	6000	6000	1	3000
13†	6	Egg	1739	40.6	6000	6000	Negative	3000
14	17	Milk	288	19.2	6000	6000	1	4000
15†	2	Milk	452	5.2	6000	4500	Negative	2000
15†	2	Egg	452	12.4	6000	4500	Negative	1000
16†,‡	15	Wheat	2352	12.2	6000	6000	Negative	6000
16†,‡	15	Milk	2352	59.8	6000	4500	2	1000
16†,‡	15	Egg	2352	19.1	6000	6000	1	3000
17†	1	Milk	358	121.0§	6000	3300	1	1000
17†	1	Egg	358	8.5	6000	6000	Negative	3000
18	4	Milk	1847	>100.0	6000	3000	1	1000
19	11	Milk	831	39.3	6000	3000	2	1000
20	10	Milk	445	>100.0	6000	1800	3	500
21†	10	Milk	452	>100.0	6000	0‖	3	NA
21†	10	Baked milk	452	>100.0	2000	320	2	166 (baked milk)
22	17	Milk	540	>100.0	6000	300	3	NA
23	21	Milk	38	7.4	6000	0‖	1	NA
24†	1	Soy	294	1.0	4000	4000	Negative	2000
24†	1	Milk	294	10.3	4000	240	1	108
25†	7	Egg	38	6.2	6000	0‖	2	NA
25†	7	Baked milk	38	2.9	2000	2000	1	2000 (baked milk)
26	3	Baked milk	254	70.9	2000	600	2	500 (baked milk)
27†	1	Wheat	685	42.2	4000	4000	Negative	2000

27†	1	Egg	685	33.9	6000	6000	Negative	3000
27†	1	Chicken	685	0.4	9000	9000	Negative	9000
28	2	Egg	1716	215.0§	6000	6000	Negative	3000
29	3	Egg	1290	>100.0	6000	6000	Negative	3000
30†	14	Wheat	1037	>100.0	6000	6000	Negative	3000
30†	14	Egg	1037	55.9	6000	6000	Negative	6000
30†	14	Soy	1037	>100.0	6000	6000	Negative	6000
31	23	Egg	763	20.6	6000	6000	Negative	6000
32	1	Egg	121	12.3	6000	6000	1	3000
33	11	Egg	593	>100.0	6000	6000	1	6000
34	13	Egg	1156	60.5	6000	6000	2	3000
35	10	Egg	281	22.4	6000	4500	1	1500
36	3	Egg	111	38.9	6000	4500	2	1500
37	6	Egg	151	35.2	6000	3000	3	1500 (baked egg)
38	15	Egg	750	>100.0	6000	1800	3	1500 (baked egg)
39	17	Egg	87	9.0	6000	900	2	NA
40	10	Egg	595	33.9	6000	900	3	94 (baked egg)
41‡	6	Wheat	2286	1710.0§	6000	6000	Negative	3000
42	18	Wheat	119	30.8	6000	6000	Negative	3000
43	11	Wheat	744	>100.0	6000	6000	1	3000
44	9	Wheat	512	>100.0	6000	3000	1	1000
45	5	Wheat	627	>100.0	6000	3000	2	2000
46†	16	Peanut	461	33.5	4000	4000	1	500
46†	16	Cashew	461	1.8	3000	3000	Negative	1000
46†	16	Hazelnut	461	25.5	3000	3000	Negative	1000
47	1	Cashew	35	2.3	1000	1000	Negative	400
48†	4	Cashew	77	4.4	600	600	Negative	300
48†	4	Hazelnut	77	14.7	600	600	Negative	300
48†	4	Walnut	77	10.8	600	600	Negative	300
49†	7	Hazelnut	505	20.8	3000	3000	1	300
49†	7	Sesame	505	31.1	3000	3000	1	1500
50	18	Sesame	386	8.3	3000	3000	Negative	NA
51	8	Peanut	426	14.6	4000	4000	1	1000

CoFAR, Consortium for Food Allergy Research; *NA*, not applicable.

*Grading was based on the CoFAR Grading Scale for Systemic Allergic Reaction, version 3.0.

†Patients who underwent >1 OFC.

‡Patients with baseline total IgE and body weight outside the omalizumab dosing table for FA who chose to proceed with omalizumab treatment were offered therapy through shared decision making and were dosed with the highest approved dose for their weight after receiving prior authorization.

§Absolute allergen-specific IgE levels >100 kUA/L may be available for patients whose testing was performed at the Johns Hopkins DACI Reference Laboratory.

‖Reaction occurred after the first dose of 300 mg (5% of a goal dose of 6000 mg).

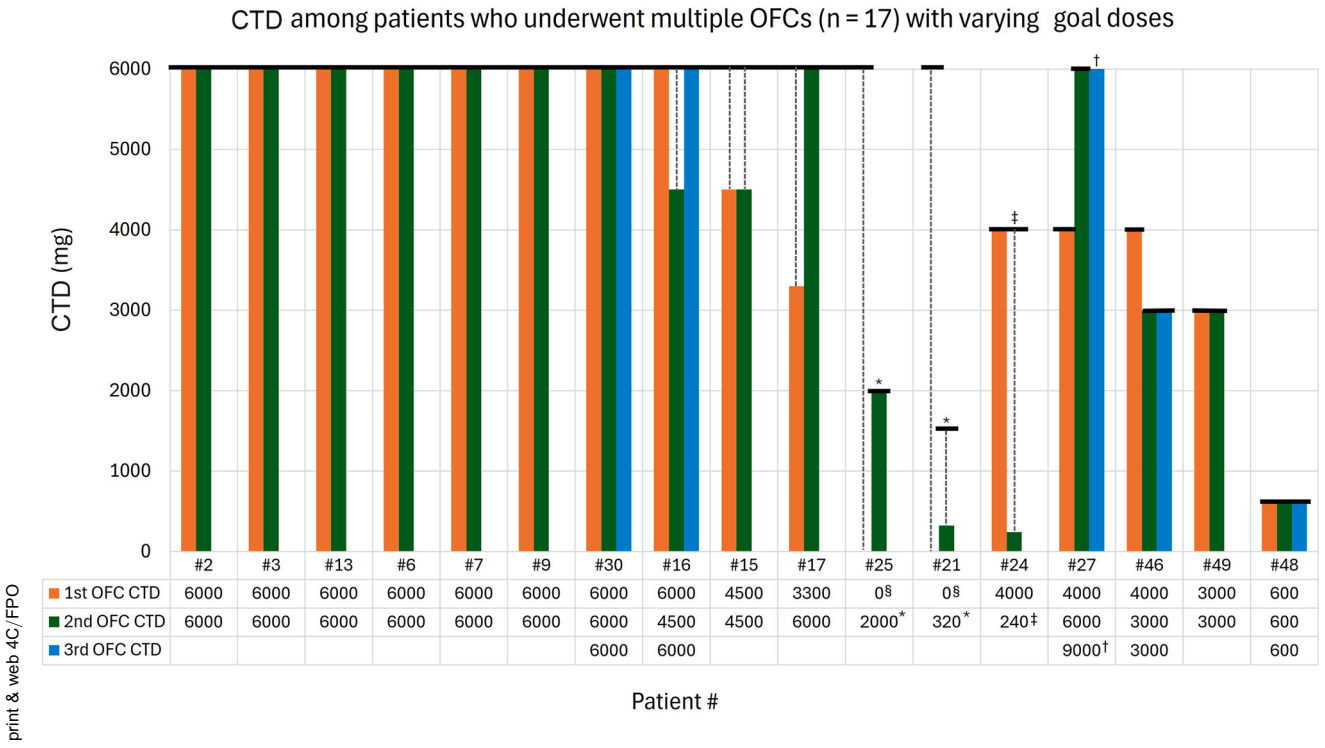

FIGURE 2. CTD among patients who underwent multiple OFCs (n = 17) with varying goal doses. The *black line* represents the OFC goal dose, and the *dotted line* represents the difference between the CTD and the goal dose. *Baked milk OFC. †Goal dose was 9000 mg. ‡Second OFC for patient 24 was stopped because of refusal to eat and not objective dose-limiting symptoms. §Reaction occurred after the first dose of 300 mg (5% of a goal dose of 6000 mg).

patients reacted to their first dose of 300 mg during their first OFC (patients 21 and 25 to milk and egg, respectively), and their subsequent OFCs were performed with baked milk; 1 patient reached a goal dose of 2000 mg of baked milk, whereas the other tolerated only 320 mg of baked milk.

Dietary introduction of allergenic foods was permitted following 92% (67 of 73) of all OFCs, including 89% (24 of 27) for milk, 91% (21 of 23) for egg, and 100% (9 of 9) for wheat. The recommended starting maximum daily dose was a median of 2000 mg for milk (range, 166 mg baked milk to 6000 mg direct milk), 3000 mg for egg (range, 94 mg baked egg to 6000 mg egg), and 3000 mg for wheat (range, 1000 to 6000 mg) (Table IV). The median ratio of recommended starting dose to CTD was 50% (IQR, 37%-51%) among the 67 OFCs in which dietary introduction was permitted.

Adverse reactions associated with OFCs

Allergic reactions occurred in 33 of 73 (45%) OFCs (Table V). Most were mild, with 18 of 73 (25%) classified as grade 1, 9 of 73 (12%) as grade 2, and 6 of 73 (8%) as grade 3. There were no grade 4 (life-threatening) reactions, hospitalizations, or deaths. The most common systems involved were upper respiratory (20 of 73 [27%]) and cutaneous (17 of 73 [23%]). Although some reactions were very mild or transient and did not require treatment, treatment was administered in 21 of 73 (29%) OFCs, including oral antihistamines (21 of 73 [29%]), albuterol (4 of 73 [5%]), and oral steroids (7 of 73 [10%]) (Table V). Intramuscular epinephrine was administered in 2 OFCs: one after consuming the first dose of 300 mg (milk) and the other after a CTD of 3000 mg (egg) (patients 21 and 37, respectively; Table IV). Reactions occurred after doses ranging from 300 to 6000 mg.

Predictor analysis

Among OFCs to any foods with a goal dose ≥6000 mg (n = 56), the success of consuming a CTD of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein was associated with higher baseline total IgE level ($P = .002$, $P = .003$, $P = .004$, and $P < .001$, respectively), every 2-week dosing versus every 4-week dosing ($P = .004$, $P = .016$, $P = .004$, and $P < .001$, respectively), higher omalizumab total dose per 4 weeks per weight (mg/kg) ($P = .005$, $P = .012$, $P = .004$, and $P < .001$, respectively), and lower allergen-specific IgE to total IgE ratio ($P = .022$, $P = .003$, $P < .001$, and $P = .003$, respectively) (Table VI; see also Figures E1-E3 in this article's Online Repository at www.jaci-inpractice.org). Omalizumab total dose per 4 weeks showed some association but was not consistent across different specified CTD success thresholds. Age, sex, weight, specific food challenged, allergen-specific IgE levels, and duration of omalizumab before OFC were not associated with omalizumab treatment response. A linear relationship ($r = 0.79$; $P < .001$) between the omalizumab total dose per 4 weeks per weight (mg/kg) and total IgE level was observed (see Figure E4 in this article's Online Repository at www.jaci-inpractice.org).

DISCUSSION

This study reviewed the OFC outcomes after at least 4 months of treatment with omalizumab for FA in patients at the Johns

TABLE V. Adverse events during OFCs after treatment with omalizumab in the clinical setting

Variable	All OFCs (n = 73)	OFCs of any foods with a goal dose ≥6000 mg (n = 56)	Direct milk OFCs with a goal dose of 6000 mg (n = 23)	Egg OFCs with a goal dose of 6000 mg (n = 23)	Wheat OFCs with a goal dose of 6000 mg (n = 8)
Developed symptom, n (%)	33 (45)	25 (45)	11 (48)	11 (48)	3 (38)
Severity based on the CoFAR Grading Scale, n (%)					
Grade 1	18 (25)	12 (21)	6 (26)	4 (17)	2 (25)
Grade 2	9 (12)	7 (13)	2 (9)	4 (17)	1 (13)
Grade 3	6 (8)	6 (11)	3 (13)	3 (13)	0 (0)
Grade 4	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Grade 5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Organ system involved, n (%)					
Cutaneous	17 (23)	15 (27)	8 (35)	6 (26)	1 (13)
Upper respiratory	20 (27)	16 (29)	6 (26)	8 (35)	2 (25)
Lower respiratory	6 (8)	6 (11)	3 (13)	3 (13)	0 (0)
Gastrointestinal	7 (10)	6 (11)	1 (4)	4 (17)	1 (13)
Cardiovascular	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Received treatment, n (%)					
Any medication	21 (29)	18 (32)	7 (30)	8 (35)	3 (38)
Oral antihistamine	21 (29)	18 (32)	7 (30)	8 (35)	3 (38)
Albuterol	4 (5)	4 (7)	2 (9)	1 (4)	1 (13)
Oral steroids	7 (10)	6 (11)	2 (9)	4 (17)	0 (0)
IM epinephrine	2 (3)	2 (4)	1 (4)	1 (4)	0 (0)

CoFAR, Consortium for Food Allergy Research; *IM*, intramuscular.

Hopkins pediatric allergy clinic. We observed that 89% of OFCs resulted in successful consumption of a CTD of ≥1000mg, 86% ≥2000 mg, 75% ≥4000 mg, and 66% ≥6000 mg. These outcomes are comparable with those reported in OUtMATCH stage 1, in which 80% consumed a CTD of 1044 mg for at least 1 food, 78% consumed 2044 mg, 75% consumed 4044 mg, and 66% consumed 6044 mg.[1] These findings demonstrate that omalizumab can be successfully used for the treatment of FA in the clinical setting, even permitting ingestion of serving size portions of allergenic foods in some patients.

The effectiveness observed in this study across different foods is also similar to the results from OUtMATCH. For example, the percentage tolerating 6044 mg of milk, egg, and wheat in OUtMATCH was 59%, 49%, and 67%, respectively, compared with 61%, 65%, and 75% in our cohort.[1] Although the sample size for other foods was very limited in our study, overall success was similar (Table IV).

In addition, there was a small subset of patients who were challenged to more than 1 food. Most patients had similar OFC outcomes across their OFCs. However, there were exceptions, and a few patients had relatively larger differences in their OFC outcomes across different foods. Knowledge in this area remains limited and more research is needed.

The potential risks associated with OFCs should always be considered in the shared decision-making process. Although no life-threatening events occurred, reactions were common and even grade 3 allergic reactions involving lower respiratory or more severe gastrointestinal symptoms were observed, including the need for epinephrine.

Omalizumab may help facilitate the introduction of allergenic foods into the diet, which may be a life-changing option for many patients.[8] Our approach in this regard has been to focus primarily on those foods that patients would mostly like to introduce into their diets, such as milk, egg, and wheat. Most of the patients in this study were permitted to introduce allergenic foods following their OFCs. Although a maximum dose was recommended for dietary introduction, the actual intake varied on the basis of the goals of the patient, with some seeking to eat unlimited amounts and others just hoping to worry less about smaller exposures. Long-term follow-up of dietary introduction of allergic foods will be an important next step determining whether patients maintain intake over time, to identify factors associated with successful consumption, and to ensure that this approach is safe far beyond the initial OFC.

Exploratory analyses of the OUtMATCH data set identified higher pretreatment baseline total IgE as a predictor of better omalizumab treatment response.[12] Similarly, in our study, a higher baseline total IgE was consistently associated with success across multiple thresholds, including CTDs ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein. Although these associations are consistent with data from OUtMATCH and appear real, they did not hold true for all patients and therefore should not be used in clinic as reliable predictors of treatment response at this time.

The other variables associated with omalizumab treatment response in our cohort are all intimately connected to total IgE levels, and so it is difficult to determine whether these variables and total IgE are actually independent predictors of response. A similar association between every 2-week dosing and treatment response was observed in OUtMATCH, although it was considered to be driven by total IgE levels.[12] The association with allergen-specific IgE to total IgE ratio may also be primarily driven by total IgE levels, because allergen-specific IgE alone was not associated with treatment response. Still, previous studies have suggested that the allergen-specific IgE to total IgE ratio could affect IgE-mediated basophil response during omalizumab treatment.[16,17] Notably, our analysis was limited by the lack of

TABLE VI. Predictors of successful consumption of a CTD of ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein among OFCs of any food with goal doses ≥6000 mg (N = 56) after treatment with omalizumab in the clinical setting

	CTD ≥ 1000 mg			CTD ≥ 2000 mg			CTD ≥ 4000 mg			CTD ≥ 6000 mg		
Variable	**Failure (n = 6)**	**Success (n = 50)**	***P* value***	**Failure (n = 8)**	**Success (n = 48)**	***P* value***	**Failure (n = 14)**	**Success (n = 42)**	***P* value***	**Failure (n = 19)**	**Success (n = 37)**	***P* value***
Age (y)	13.5 (10, 17)	9.5 (3, 14)	.067	12.5 (10, 17)	7.5 (3, 14)	**.038**	10 (6, 15)	10.5 (3, 14)	.501	10 (5, 13)	11 (3, 14)	.969
Sex			.691			.713			.99			.99
Female (n = 24)	2 (8)	22 (92)		4 (17)	20 (83)		6 (25)	18 (75)		8 (33)	16 (67)	
Male (n = 32)	4 (13)	28 (88)		4 (13)	28 (88)		8 (25)	24 (75)		11 (34)	21 (66)	
Weight (kg)	40 (34, 50)	27 (16, 48)	.103	40 (34, 46)	26 (15, 48)	.103	32 (24, 42)	26.5 (14, 52)	.670	30 (19, 40)	26.5 (13, 53)	.901
Food challenged			.779			.762			.951			.968
Milk (n = 23)	3 (13)	20 (87)		4 (17)	19 (83)		7 (30)	16 (70)		9 (39)	14 (61)	
Egg (n = 23)	3 (13)	20 (87)		4 (17)	19 (83)		5 (22)	18 (78)		8 (35)	15 (65)	
Wheat (n = 8)	0 (0)	8 (100)		0 (0)	8 (100)		2 (25)	6 (75)		2 (25)	6 (75)	
Soy (n = 1)	0 (0)	1 (100)		0 (0)	1 (100)		0 (0)	1 (100)		0 (0)	1 (100)	
Chicken (n = 1)	0 (0)	1 (100)		0 (0)	1 (100)		0 (0)	1 (100)		0 (0)	1 (100)	
Total IgE (IU/mL)	270 (50, 518)	764 (467, 1226)	**.002**	449 (75, 554)	798 (497, 1228)	**.003**	482 (203, 619)	1037 (605, 1228)	**.004**	452 (216, 611)	1037 (685, 1228)	**<.001**
Omalizumab dosing interval			**.004**			**.016**			**.004**			**<.001**
Every 2 wk (n = 32)	0 (0)	32 (100)		1 (3)	31 (97)		3 (9)	29 (91)		4 (13)	28 (88)	
Every 4 wk (n = 24)	6 (25)	18 (75)		7 (29)	17 (71)		11 (46)	13 (54)		15 (63)	9 (38)	
Omalizumab total dose per 4 wk (mg)	300 (150, 450)	450 (300, 750)	.093	450 (150, 488)	450 (300, 788)	.248	375 (150, 450)	525 (300, 1125)	**.025**	225 (150, 450)	600 (450, 1200)	**.002**
Omalizumab total dose per 4 wk per weight (mg/kg)	9 (3, 13)	22 (13, 29)	**.005**	13 (4, 14)	22 (12, 29)	**.012**	13 (8, 15)	23 (13, 29)	**.004**	12 (6, 14)	23 (14, 29)	**<.001**
Allergen-specific IgE (kUA/L)†	21 (8, 83)	42 (16, >100)	.300	67 (9, >100)	40 (14, >100)	.844	>100 (34, >100)	39 (13, >100)	.268	39 (17, >100)	41 (13, >100)	.826
Allergen-specific IgE to total IgE ratio†	0.17 (0.12, 0.19)	0.06 (0.03, 0.10)	**.022**	0.17 (0.13, 0.20)	0.06 (0.03, 0.10)	**.003**	0.17 (0.11, 0.21)	0.05 (0.02, 0.08)	**<.001**	0.16 (0.06, 0.21)	0.05 (0.02, 0.08)	**.003**
Duration of omalizumab before OFC (mo)	8 (5, 10)	7 (6, 8)	.654	6 (4, 9)	7 (6, 8)	.450	6.5 (5, 8)	7 (6, 8)	.517	7 (6, 9)	7 (6, 8)	.759

Data are presented as median (Q1, Q3) or n (%).

Bolded values indicate statistical significance ($P < 0.05$).

*The Fisher exact test or the Wilcoxon rank sum test was used.

†Allergen-specific IgE levels reported as >100 kUA/L without exact values were treated as 100 kUA/L for statistical analysis.

exact allergen-specific IgE levels for some patients with results reported as greater than 100 kUA/L. Finally, the relationship between CTD and the total omalizumab dose per 4 weeks per weight (mg/kg) appears real but is also directly dependent on the total IgE levels under the current omalizumab dosing scheme.[2]

There are limitations to this study. The sample size was relatively small, especially for foods other than milk, egg, and wheat. Future real-world studies with larger data sets may provide deeper insights into the use of omalizumab in treating FA and enable more rigorous predictor analyses. Because OFCs were not routinely performed before omalizumab treatment, it is possible that some patients were not even allergic to 1 or more foods and we cannot make any conclusions about changes in reaction thresholds within individual patients. The OFCs were not placebo-controlled and there was variability in the goal doses of the OFCs because of the heterogeneous nature of clinical objectives, which requires careful interpretation of the results. Some of the demographic characteristics of this population (predominately White and having private insurance) are not reflective of the broader FA community. Similarly, given that this study was performed at a tertiary referral center, the findings may not be fully generalizable to broader real-world settings. Finally, in this analysis, we defined success with various CTDs starting at 1000 mg; however, tolerating lower doses may also be considered success by many families and additional information on patient-centered outcomes is needed.

Overall, this study demonstrates that there was a high proportion of successful OFCs, including tolerating serving size amounts, in patients on omalizumab for FA in the clinical setting, with results comparable with those observed in the OUtMATCH trial.[1] Shared decision making with patients and families remains key to the use of omalizumab in FA.[5] Depending on individual goals and preferences, OFCs may help assess treatment response and allow safe introduction of allergenic foods into the diet for many patients. However, there are risks associated with OFCs even in the setting of omalizumab treatment, and all food introductions under consideration should be conducted in a setting prepared to treat reactions. More research is needed to identify biomarkers that can reliably predict omalizumab treatment response.

Since its approval in February 2024, omalizumab has greatly benefited many patients and families affected by FA. Continued real-world studies will be critical in refining the implementation of omalizumab, optimizing its clinical use, and bringing meaningful benefits to patients and families.

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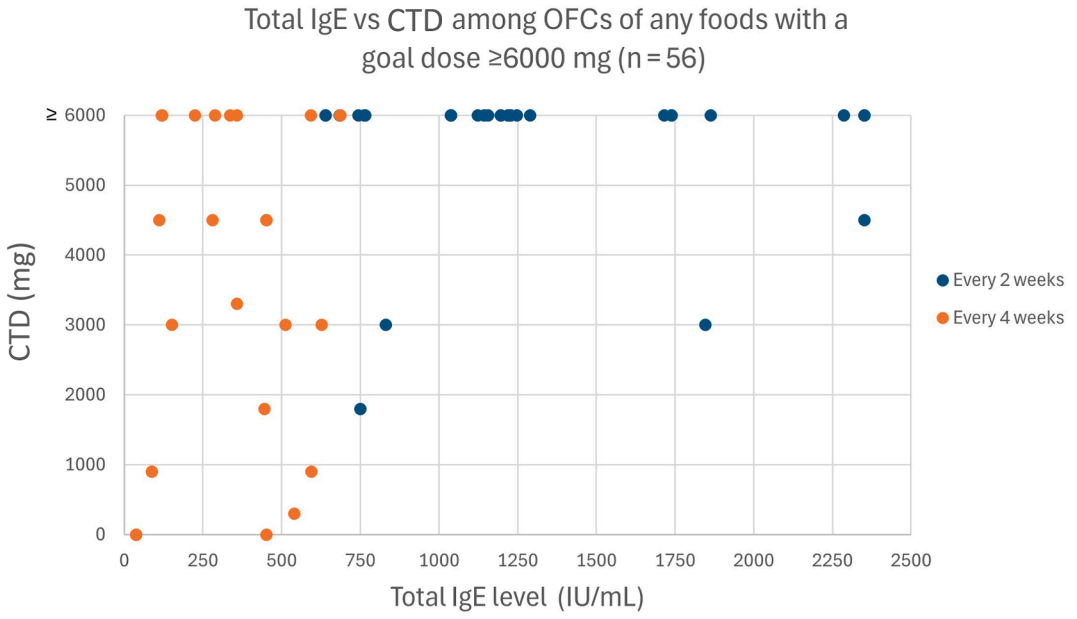

FIGURE E1. Total IgE level vs CTD among OFCs of any foods with a goal dose ≥6000 mg (n = 56). The success of consuming a CTD ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein was associated with higher baseline total IgE level ($P = .002$, $P = .003$, $P = .004$, and $P < .001$, respectively), and every 2-week dosing vs every 4-week dosing ($P = .004$, $P = .016$, $P = .004$, and $P < .001$, respectively).

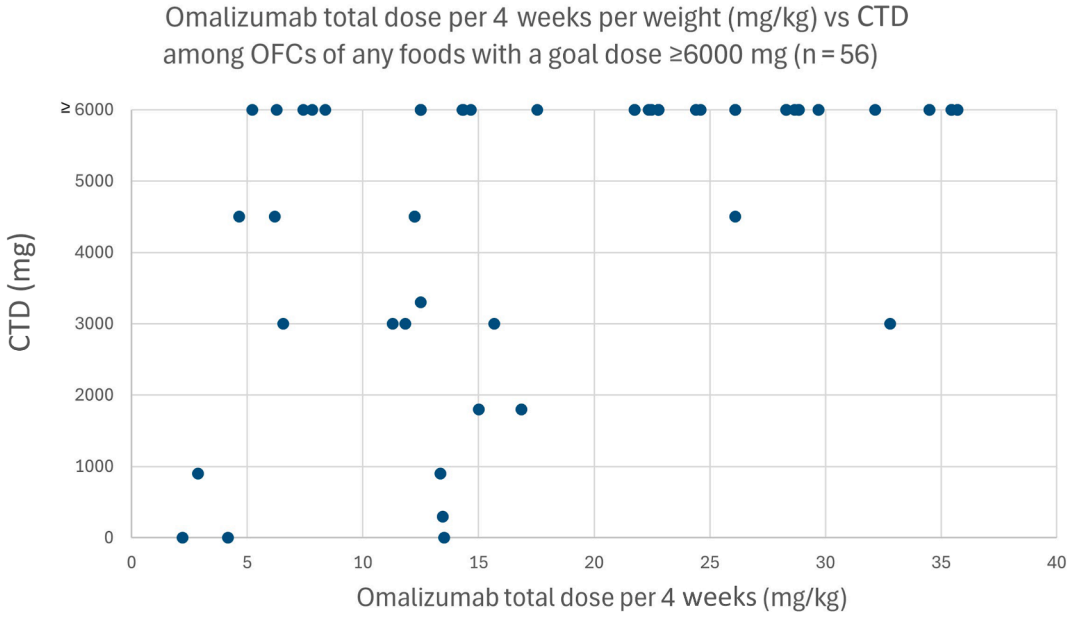

FIGURE E2. Omalizumab total dose per 4 weeks per weight (mg/kg) vs CTD among OFCs of any foods with a goal dose ≥6000 mg (n = 56). The success of consuming a CTD ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein was associated with higher omalizumab total dose per 4 weeks per weight (mg/kg) ($P = .005$, $P = .012$, $P = .004$, and $P < .001$, respectively).

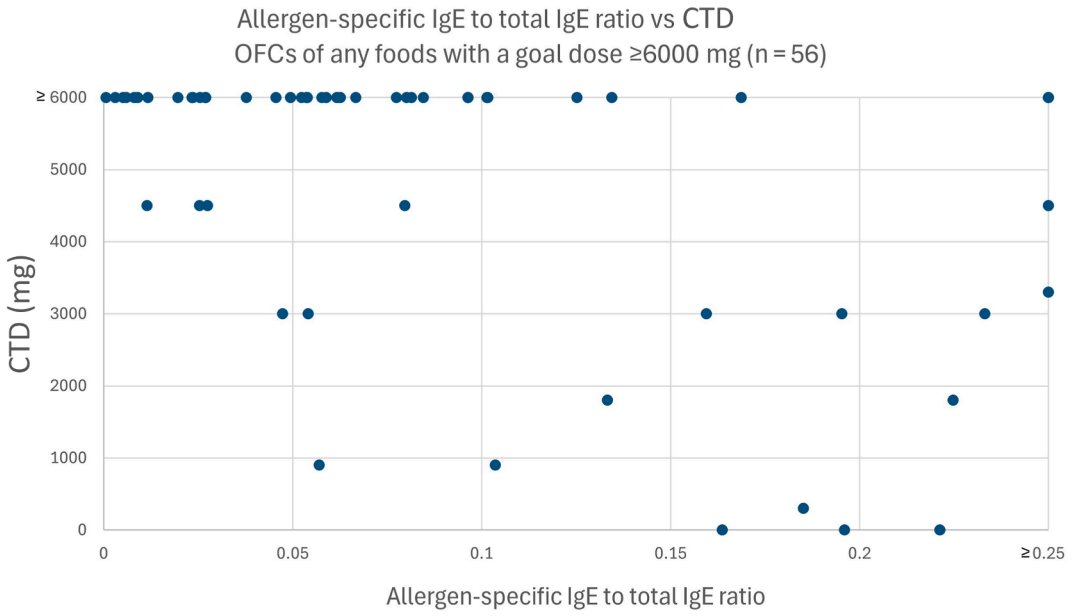

FIGURE E3. Allergen-specific IgE to total IgE ratio vs CTD among OFCs of any food with a goal dose ≥6000 mg (n = 56). The success of consuming a CTD ≥1000, ≥2000, ≥4000, and ≥6000 mg food protein was associated with lower allergen-specific IgE to total IgE ratio ($P = .022$, $P = .003$, $P < .001$, and $P = .003$, respectively).

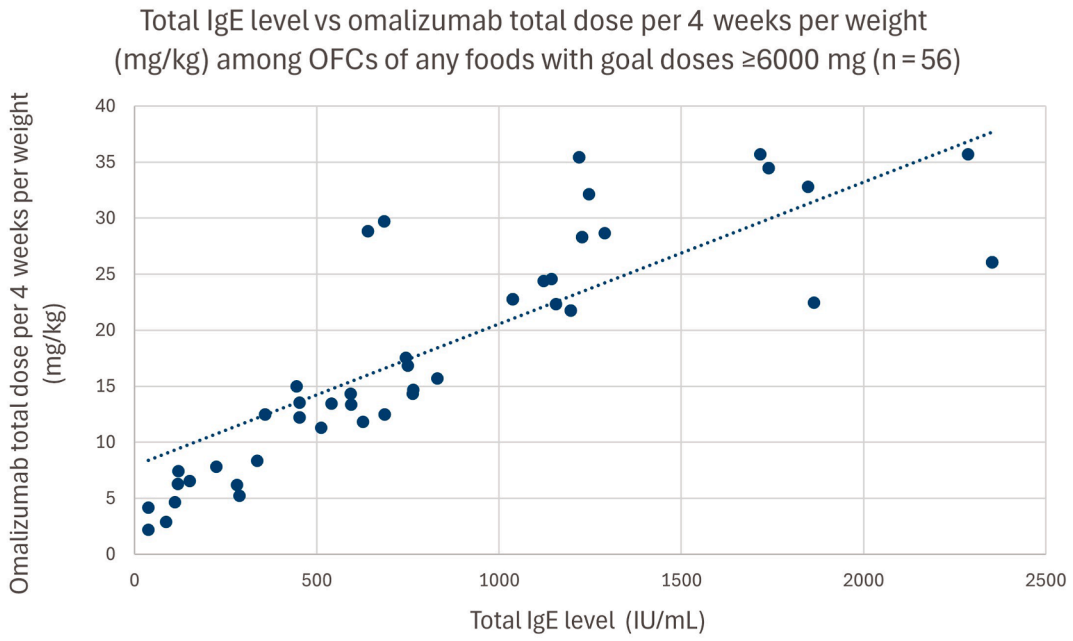

FIGURE E4. Total IgE level vs omalizumab total dose per 4 weeks per weight (mg/kg) among OFCs of any food with a goal dose ≥6000 mg (n = 56). Omalizumab total dose per 4 weeks per weight (mg/kg) is dependent on the total IgE level under the current dosing scheme, and a linear relationship was observed.