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Patterns of food allergen sensitization and co-sensitization in Jordan: A laboratory-based analysis

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Abstract

Background: Food allergy is an increasing global health concern, yet laboratory-based data on food allergen sensitization in Jordan remain limited.

Objective: To estimate the prevalence and burden of sensitization to common food allergens among patients undergoing serum specific IgE (sIgE) testing in Jordan, and to characterize co-sensitization patterns in routine clinical practice.

Methods: We retrospectively reviewed patients who underwent a standardized 34-food allergen sIgE panel between 2021 and 2024. Sensitization more frequently associated with clinical symptoms was defined a priori as Class ≥ 2; analyses were repeated at Class ≥ 1 as a sensitivity analysis. Patients were categorized as non-sensitized, monosensitized, oligosensitized (2–4 allergens), or polysensitized (≥ 5). Allergen-specific prevalence was estimated with Wilson 95% confidence intervals, and co-sensitization was explored using correlation matrices and hierarchical clustering.

Results: Among 405 patients (13,770 tests), 28.4% were sensitized to at least one food allergen (n = 115); most had no or a single positive result, whereas 6.7% (n = 27) were polysensitized. Shellfish (8.2%; 95%CI 5.8–11.4), cow's milk (7.4%; 5.2–10.5), and egg white (6.9%; 4.8–9.9) were most prevalent. No significant differences were observed by age or sex after adjustment for multiple comparisons. Co-sensitization analysis identified interpretable clusters, particularly among nuts/seeds, cereals, and selected animal-derived allergens. Similar patterns were observed at Class ≥ 1.

Conclusion: These laboratory-based findings may support diagnostic testing, counseling, and allergy service planning in Jordan.

Key words: Food allergy, specific IgE, sensitization, co-sensitization, Jordan

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Introduction

Food allergy is an immune-related negative response, which is repeatedly observed following exposure to certain foods. The onset of reactions mediated by IgE is usually rapid, and the reactions mediated by non-IgE can be more delayed, both responses are clinically relevant, but affect different underlying mechanisms.[1] Clinical assessment requires the distinction between immunologically mediated food allergies and non-immunologic food intolerance since the outcomes of risk evaluation, patient counselling and therapeutic stewardship differ significantly.[1,2] Serum allergen-specific IgE (sIgE) and skin prick testing (SPT) are commonly used in this analysis to identify sensitization, whereas a confirmatory test of clinical allergy in equivocal cases is the oral food challenge (OFC).[1,3]

The global literature is clear about the public health significance of food allergy and its heterogeneous expression across regions. Systematic reviews and large epidemiological studies consistently report a substantial burden of food allergy in both children and adults, with reactions concentrated in a core set of foods (e.g., cow's milk, egg, peanut, tree nuts, fish, shellfish, wheat, soy), while emphasizing that prevalence estimates and clinical severity vary across settings and over time.[2,4] At the severe end of the spectrum, food-induced anaphylaxis is well described, and culprit foods depend on local patterns that directly influence prevention measures and emergency preparedness.[4,5] These observations support the need for geographically sensitive real-world data to guide clinical practice and healthcare system planning. Several laboratory approaches are available for assessing IgE sensitization. Automated singleplex immunoassays, such as ImmunoCAP and related platforms, provide standardized allergen-specific IgE measurements and are widely used in clinical practice because of their reproducibility and clinical interpretability.[2] Classical immunoblotting characterizes IgE binding to allergen extracts and is used mainly in research, whereas standardized multiplex line immunoblot panels are widely used in routine practice for simultaneous, semiquantitative screening against many allergens, albeit with lower quantitative resolution than singleplex assays. Component-resolved diagnostics further refine sensitization assessment by measuring IgE responses to individual allergenic molecules rather than whole extracts, which can improve interpretation in cases involving cross-reactivity, pollen-food syndrome, or risk stratification. However, component-resolved testing is not universally available in routine practice and may be limited by cost, panel availability, and local laboratory infrastructure.[2,4]

In the present study, sensitization was assessed using a standardized multiplex line immunoblot food panel, which is well suited to describing real-world sensitization patterns but, being extract-based and semiquantitative, does not provide the quantitative resolution of singleplex assays or the molecular detail of component-resolved diagnostics.[4]

Because sIgE is frequently requested as broad panels in routine practice, aggregated laboratory outputs can also provide a pragmatic view of local sensitization patterns.[2] Importantly, guidelines emphasize that sensitization alone does not equate to clinical allergy; diagnosis requires clinical correlation and, when indicated, oral food challenge.[1-3]

In addition to individual allergens, many patients exhibit sensitization to multiple foods. This polysensitisation may be based on concurrent exposures, common protein families, or cross-reactive IgE, and has practical implications on the choice of tests and framing of counselling. Data-driven approaches, including correlation matrices and hierarchical clustering, organize allergens into interpretable groups that reflect underlying relationships and can guide more efficient evaluation.[6] Complex patterns are summarized into visual representations, including clustered heatmaps, which are useful to both clinicians and researchers, providing a network-level view that supplements single-allergen summaries.[6]

Jordan has a growing clinical need for contemporary, locally relevant data on food-allergen sensitization. Prior work from Jordan demonstrated measurable sIgE sensitization among patients evaluated for suspected food allergy, with patterns suggesting age- and sex-related differences and pointing to commonly implicated foods in that setting.[7] Yet these findings predate the most recent years and do not cover the full breadth of real-world testing since 2020. Given variability across regions and over time in both prevalence and culprit foods,[4,5] there is a clear rationale for updated laboratory-based analyses from Jordan to inform clinical practice, patient counselling, and health-system planning.

Accordingly, the present study analyses routinely collected laboratory data from Jordan to quantify the prevalence and burden of sensitization more frequently associated with clinical symptoms, defined a priori as IgE Class ≥ 2 as the primary endpoint, and to evaluate whether the main descriptive and co-sensitization patterns remained consistent when a lower Class ≥ 1 threshold was used in sensitivity analysis. We estimate per-allergen prevalence with 95% confidence intervals, describe patient-level sensitization burden, and examine co-sensitization structure using correlation and hierarchical clustering to identify interpretable allergen groupings. We further assess associations with demographic factors (sex and age group) using appropriate statistical comparisons and multiple-testing control. By situating these findings within the international literature and the Jordanian context,[7] our goal is to provide a rigorous, clinically meaningful picture of food-allergen sensitization patterns that can guide care in Jordan and contribute to the broader evidence base.

Methods

Study design, setting, participants, and data source

We analyzed consecutive serum-specific IgE (sIgE) food panels performed at Mega Lab Medical Laboratories (MegaLabs), a national private laboratory network with branches across Jordan (e.g., Amman, Irbid, Zarqa, and additional governorates). MegaLabs serves outpatient clinics, emergency departments, and private practices. We included all panels using the standardized 34-allergen food panel conducted between 1 January 2021 and 31 March 2024. Serum allergen-specific IgE was measured using the EUROLINE Food line immunoblot panel (EUROIMMUN Medizinische Labordiagnostika AG, Lübeck, Germany), a CE-marked in vitro diagnostic membrane-based assay in which serum is incubated with allergen-coated test strips and bound IgE is detected by an enzyme-labelled anti-human IgE conjugate with a colorimetric substrate, the band intensity being quantified by reflectance scanning (EUROLineScan). The panel comprised 34 food allergen reagents (individual allergens together with defined fish, shellfish, and meat mixes) and a cross-reactive carbohydrate determinant (CCD) marker. This is a semiquantitative method; results were reported as ordinal EAST (enzyme-allergo-sorbent test) classes 0–6, equivalent in concentration grades to the RAST system and defined by the manufacturer (kU_a/L) as:

Class 0 (< 0.35, negative), Class 1 (0.35 to < 0.70), Class 2 (0.70 to < 3.50), Class 3 (3.50 to < 17.50), Class 4 (17.50 to < 50.00), Class 5 (50.00 to < 100.00), and Class 6 (≥ 100.00), reflecting increasing allergen-specific IgE reactivity. The source dataset contained one record per patient–allergen test with a laboratory-reported IgE Class (0–6). Demographics included sex and age group at the time of testing. Inclusion criteria were: (i) complete 34-allergen food panel and (ii) recorded age. If a patient had multiple panels within the study window, we retained the earliest complete panel and excluded subsequent repeats to avoid correlated outcomes. Records with missing sex or age were excluded. Because this is a service-based cohort from a national private laboratory, estimates reflect laboratory-based sensitization frequencies among tested patients, not community prevalence.

Outcomes and definitions

The primary endpoint was sensitization more frequently associated with clinical symptoms, defined a priori as sIgE Class ≥ 2 to at least one allergen. This threshold was selected because the manufacturer's interpretive scheme designates Class 1 as a very low antibody titer for which sensitization is frequently asymptomatic, whereas Class ≥ 2 indicates an existing sensitization that is more often accompanied by clinical symptoms (particularly toward the upper part of each class); a Class ≥ 2 cutoff has also been used in previous laboratory-based sensitization studies and is broadly consistent with the convention that higher sIgE levels confer greater probability of clinical reactivity, while still acknowledging that sensitization alone does not equate to clinical food allergy. To assess whether the observed allergen ranking and co-sensitization patterns were dependent on this cutoff, we performed a sensitivity analysis using a lower positivity threshold of Class ≥ 1. In this context, sensitivity analysis refers to repeating the main descriptive and co-sensitization analyses using Class ≥ 1 instead of Class ≥ 2. Sensitization burden was defined as the number of allergens positive per patient at the specified threshold. Patients were categorized as non-sensitized (0 positive allergens), monosensitized (1 positive allergen), oligosensitized (2–4 positive allergens), or polysensitized (≥ 5 positive allergens).

Statistical analysis

Allergen-specific prevalence at Class ≥ 2 was defined as the proportion of patients in the full cohort (n = 405) with a positive result for that allergen at the specified threshold. Wilson 95% confidence intervals were computed for proportions.[9] For age-stratified food-group analyses, prevalence was calculated using all patients within each age group as the denominator. Age- and sex-stratified comparisons (any sensitization and allergen-wise prevalence) were assessed using χ^2 tests as appropriate. For allergen-wise subgroup comparisons, multiplicity was controlled using the Benjamini–Hochberg false discovery rate procedure across the full set of allergen tests within each analysis ($\alpha = 0.05$).[10]

To characterize co-sensitization structure, we constructed a patient-by-allergen binary matrix indicating positivity at the specified threshold and computed pairwise phi coefficients (φ), which are equivalent to Pearson correlations for binary variables. Correlation matrices were visualized as heat maps and allergens were grouped using average-linkage hierarchical clustering based on a $1 - \varphi$ dissimilarity matrix to highlight allergen sets with similar co-occurrence patterns. This approach has been used to reveal clinically meaningful sensitization clusters.[6]

Reporting standards and ethics

The manuscript adheres to the STROBE (STrengthening the Reporting of Observational Studies in Epidemiology) guidance for observational studies, including explicit definitions of outcomes, exposures, and potential confounders; precise participant flow; and handling of missing data.[8] All procedures complied with local ethical oversight; data were de-identified prior to analysis. This retrospective analysis used fully de-identified laboratory records from the source lab. The study protocol was reviewed and approved by the Ethical Committee of the University of Petra, Amman, Jordan (Approval No. O/3/10/2025). Because only de-identified secondary data were used and no direct patient contact occurred, the Committee waived the requirement for informed consent in accordance with national regulations and the Declaration of Helsinki. Data handling followed MegaLabs' internal data security policies; all analysis files contained no direct identifiers, and results were reported in aggregate to minimise re-identification risk.

Results

Cohort and testing overview

The final analytical sample included 405 patients who underwent a standardized 34-allergen food panel, yielding 13,770 patient–allergen observations (**Table 1**). All retrieved panels had complete age-group and sex data, and no repeat panels required exclusion after retaining the earliest complete panel per patient. After minor allergen-label standardization, all analyses were performed on long-format data with complete IgE class values ranging from 0 to 6.

Table 1. Cohort characteristics of patients undergoing serum allergen-specific IgE testing in Jordan (2021–2024).

Characteristic	N	%
Total patients	405	100
Infant (0–2 y)	30	7.40
Child (3–15 y)	108	26.66
Adult (> 15 y)	267	65.92
Female	230	56.79
Male	175	43.21

Sensitization by age and sex

At the primary threshold (Class ≥ 2), 115 of 405 patients (28.4%) were sensitized to at least one food allergen, whereas 290 patients (71.6%) were not sensitized to any tested allergen. Sensitization burden was generally limited: 52 patients (12.8%) were monosensitized, 36 patients (8.9%) were oligosensitized to 2–4 allergens, and 27 patients (6.7%) were polysensitized to five or more allergens. Thus, although more than one quarter of tested patients had at least one positive result, broad polysensitization was observed in a smaller subset of the cohort.

Because cell counts at the primary Class ≥ 2 threshold were small in some demographic strata (particularly the infant group, n = 30), the age- and sex-stratified analyses are presented at the Class ≥ 1 sensitivity threshold, which preserves more positive observations and improves the stability of stratified estimates; the primary Class ≥ 2 endpoint remains the basis for overall and per-allergen prevalence. Using this threshold, age-stratified and sex-stratified proportions of any sensitization showed modest descriptive differences, with numerically higher values in children and in males (**Figure 1A–B**). Formal subgroup comparisons were conducted as described in the Statistical analysis section, and all allergen-wise subgroup inferences were interpreted after Benjamini–Hochberg false-discovery-rate correction.

Allergen-specific prevalence and class distribution

Ordered allergen-specific prevalence is presented in **Figure 2** using the Class ≥ 1 sensitivity threshold, which provided the full ranking across all 34 panel allergens; prevalence was calculated using the full cohort as the denominator (n = 405), not only individuals sensitized to at least one allergen. At this threshold, the leading sensitizers were shellfish (9.4%; 95%CI: 6.9–12.6), potato and cow's milk UHT (each 8.4%; 95%CI: 6.1–11.5), and egg white (8.1%; 95%CI: 5.9–11.2). At the primary Class ≥ 2 threshold, the most prevalent sensitizers were shellfish (8.2%; 95%CI: 5.8–11.4), cow's milk (7.4%; 95%CI: 5.2–10.5), and egg white (6.9%; 95%CI: 4.8–9.9); shellfish and egg white were therefore among the leading sensitizers at both thresholds. Other leading allergens included selected nuts, seeds, cereals, and plant-derived foods, although prevalence estimates were generally low to moderate across the panel.

Figure 3 summarizes the distribution of IgE classes among patients with positive results at the Class ≥ 1 threshold for the ten most frequent allergens. This analysis describes the intensity distribution among positive results rather than prevalence in the full cohort. Most positive results were concentrated in the lower IgE classes (Classes 1–2), whereas a smaller subset of allergens—notably shellfish and egg white—showed a comparatively higher proportion of Class ≥ 3 responses (**Figure 3**). In the extracted laboratory dataset, shellfish was available only as a single composite "shellfish mix" reagent (as were the fish and meat reagents) rather than as separate shrimp, crab, clam, or other shellfish components; therefore, species-level sub-stratification was not possible. Both egg white and egg yolk were available as separate panel items. At the Class ≥ 1 sensitivity threshold shown in **Figure 2**, sensitization prevalence was 8.1% (95%CI: 5.9–11.2) for egg white and 3.5% (95%CI: 2.1–5.7) for egg yolk; at the primary Class ≥ 2 threshold, the corresponding values were 6.9% (95%CI: 4.8–9.9) for egg white and 2.7% (95%CI: 1.5–4.8) for egg yolk.

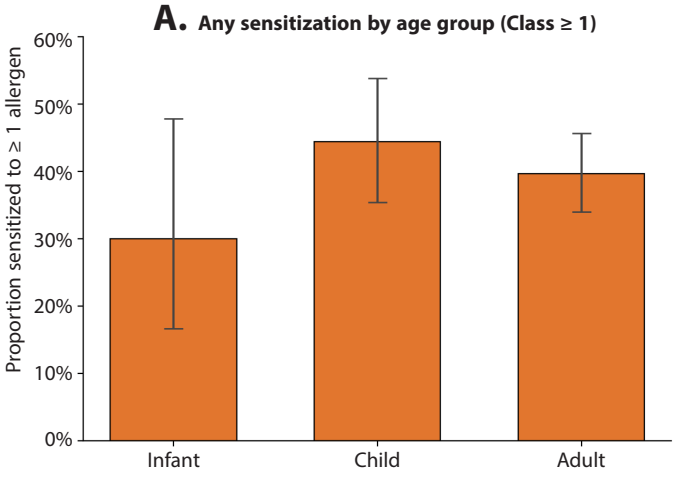

Figure 1A. Any sensitization by age group (Class ≥ 1 sensitivity analysis).
Bar chart showing the prevalence of patients with at least one positive allergen at the Class ≥ 1 sensitivity threshold across age strata (Infant, Child, Adult). Error bars represent Wilson 95% confidence intervals.

Figure 1B. Any sensitization by sex (Class ≥ 1 sensitivity analysis).
Bar chart showing the prevalence of patients with at least one positive allergen at the Class ≥ 1 sensitivity threshold by sex (Female, Male). Error bars represent Wilson 95% confidence intervals.

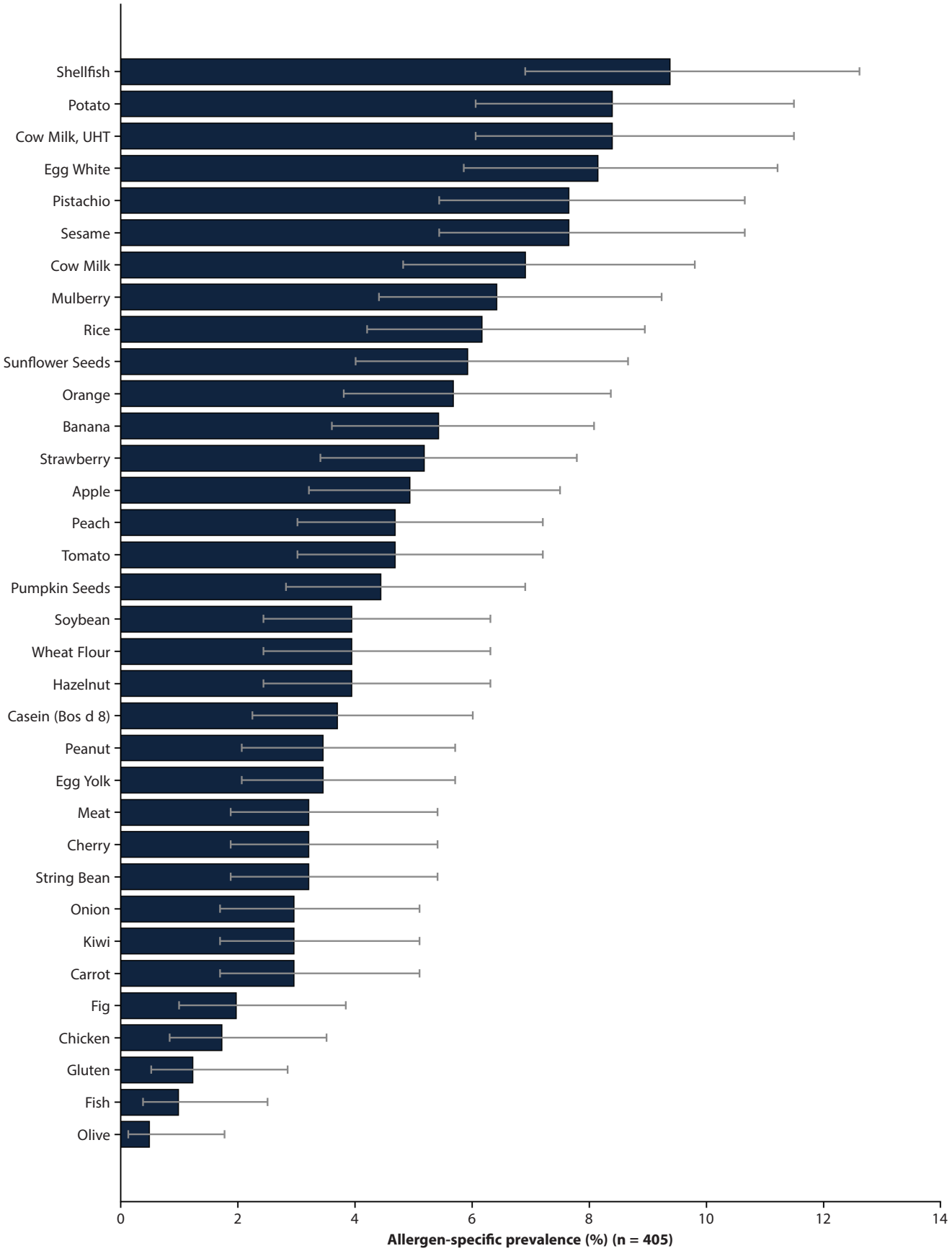

Figure 2. Allergen-specific prevalence (Class ≥ 1 sensitivity analysis), ordered.
Horizontal bar chart showing per-allergen prevalence for all 34 panel allergens using the Class ≥ 1 sensitivity threshold, calculated with the full cohort as the denominator (n = 405) and ordered from highest to lowest. Error bars represent Wilson 95% confidence intervals.

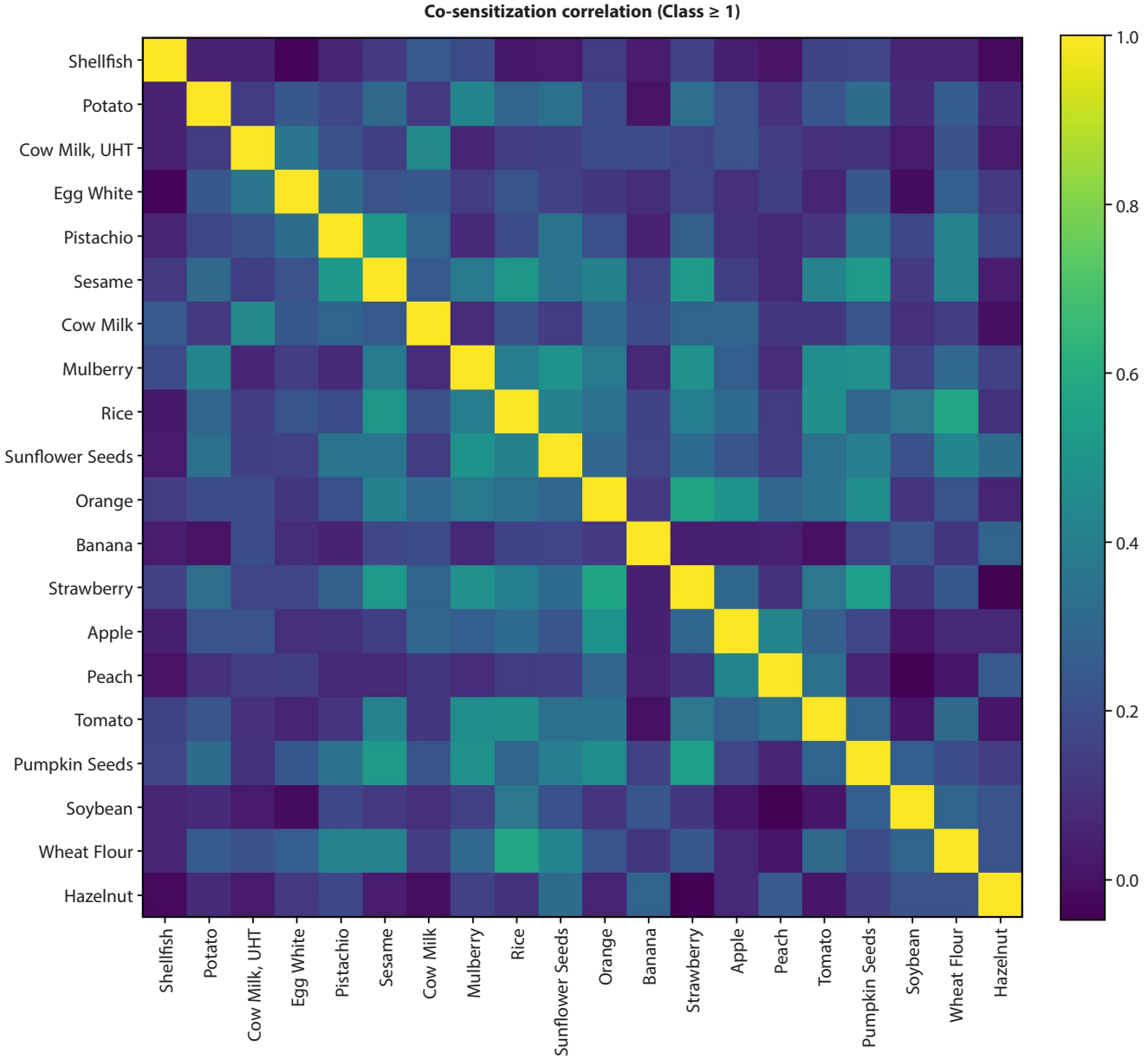

Figure 3. Within-allergen IgE class distribution (Classes 1–6) for the ten most frequently positive allergens (Class ≥ 1 sensitivity threshold).

Heat map in which each row is one allergen and the color of each cell encodes the percentage of that allergen's positive results falling in IgE Classes 1–6 (values across each row total 100%). Warmer colors indicate a higher proportion of positive results in that class; shellfish and egg white show a comparatively greater proportion of higher-class (≥ 3) responses.

Food-group prevalence by age

Figure 4 summarizes food-group sensitization prevalence across infant, child, and adult groups at the Class ≥ 2 threshold. Prevalence was calculated using all patients within each age group as the denominator. Dairy and nuts/seeds were relatively prominent among children, whereas adults showed comparatively higher prevalence for some fruit and vegetable categories. However, these patterns should be interpreted descriptively because the study was not powered primarily for age-specific food-group comparisons. Statistical comparisons across age groups were performed using χ^2 tests with false-discovery-rate correction where applicable; no age-group difference remained statistically significant after multiplicity adjustment.

Co-sensitization structure

The co-sensitization heat map for the 20 most prevalent allergens is shown in **Figure 5** using the Class ≥ 1 threshold. This lower threshold was used to provide sufficient positive observations for exploratory co-sensitization mapping. The matrix demonstrated interpretable but generally modest correlation patterns, including co-occurrence among milk-related and egg-related allergens and broader clustering among selected plant-derived foods. These findings suggest that co-sensitization existed in clinically recognizable groups, although the correlations should be interpreted descriptively rather than as evidence of shared molecular mechanisms.

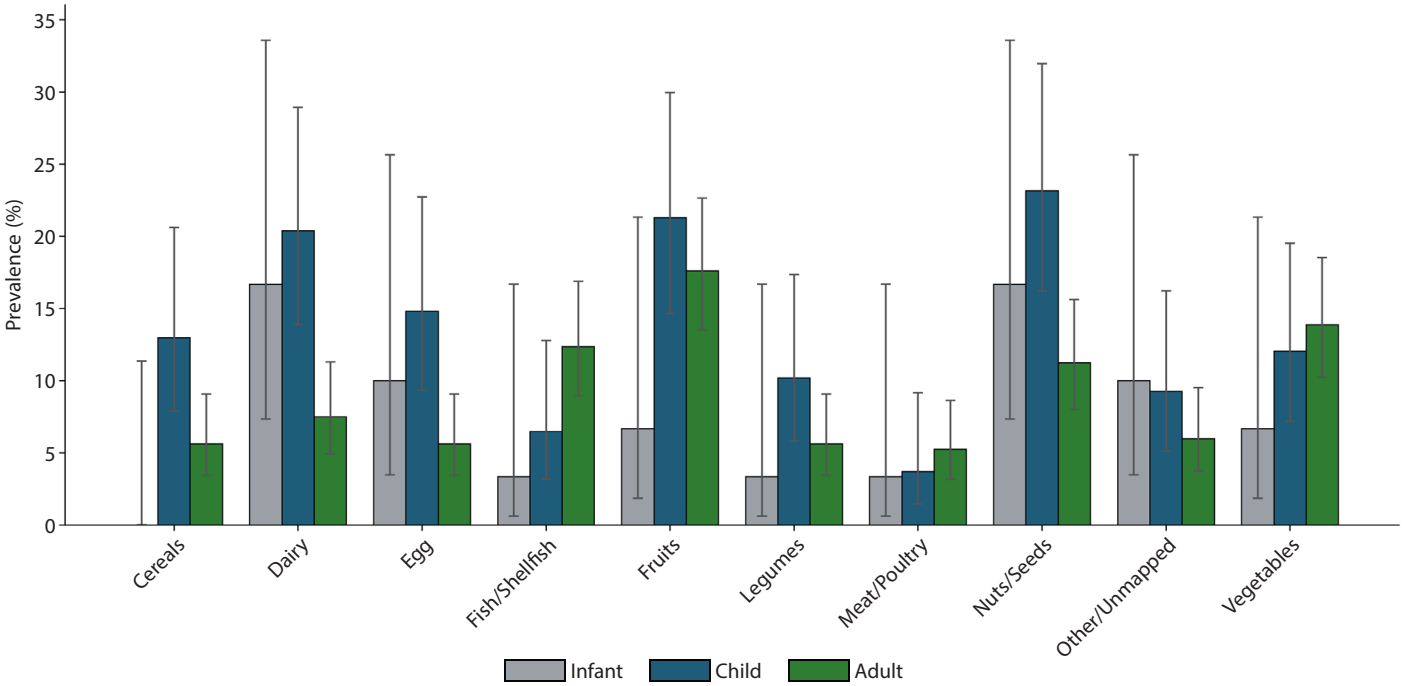

Figure 4. Food-group sensitization prevalence by age group (Class ≥ 2).
Grouped bars by food group with three bars per group (Infant, Child, Adult). Values indicate the percentage of patients sensitized to at least one allergen within each food group at the primary threshold (Class ≥ 2). Error bars represent Wilson 95% confidence intervals.

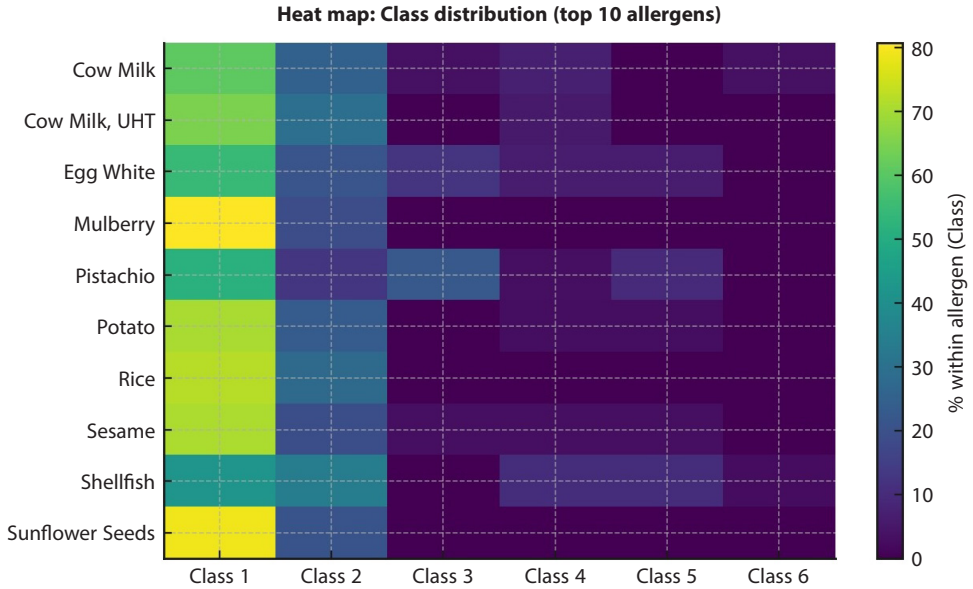

Figure 5. Co-sensitization heat map (φ) — top 20 allergens by prevalence (Class ≥ 1 sensitivity analysis).
Heat map of pairwise phi coefficients (φ) summarizing co-sensitization among the top 20 allergens using the Class ≥ 1 sensitivity threshold. Allergens are ordered by average-linkage hierarchical clustering based on a 1 − φ dissimilarity matrix.

Discussion

In this Jordanian laboratory cohort, 28.4% of clinically tested patients were sensitized to at least one food allergen at the primary Class ≥ 2 threshold. Most patients were either non-sensitized or had a limited sensitization burden, whereas polysensitization to five or more allergens was observed in a smaller subset of the cohort. The allergen ranking and co-sensitization structure were broadly consistent when the analyses were repeated using the lower Class ≥ 1 threshold, suggesting that the main descriptive findings were not artifacts of a single cutoff. However, these findings should be interpreted as laboratory sensitization patterns rather than clinically confirmed food allergy; clinical history and, when appropriate, oral food challenge remain essential for diagnosis.[1,3]

The results are consistent with, but not identical to, previous Jordanian data. Abu-Dayyeh et al. reported that approximately one quarter of tested patients had at least one positive food-specific IgE result, with higher rates among males and younger age groups, and identified cow's milk, pistachio, soybean, cherry, and orange among the most frequent sensitizers.[7] In the present study, cow's milk and several nuts/seeds also appeared among the leading sensitizers; however, age- and sex-based differences did not remain statistically significant after adjustment for multiple comparisons. Several factors may explain this discrepancy. First, the present analysis used a more recent laboratory-based dataset and a standardized 34-food panel, whereas earlier estimates may have reflected different referral pathways, testing indications, allergen panels, and positivity thresholds. Second, the cohort was dominated by adults, with smaller infant and child subgroups, which may have reduced statistical power to detect age-specific differences. Third, demographic differences in sensitization are not uniform across settings and may be influenced by dietary exposures, comorbid atopic disease, medication use, healthcare access, and clinician test-ordering patterns. Therefore, the absence of statistically significant age- or sex-based differences in this cohort should not be interpreted as evidence that age and sex are clinically irrelevant, but rather as a finding specific to this tested population.

The present findings should also be interpreted within the broader global pattern of geographic variation in food allergen sensitization. Internationally, cow's milk, egg, peanut, tree nuts, fish, shellfish, wheat, and soy are repeatedly identified as major food allergens, although their relative importance differs by age, geography, diet, diagnostic method, and case definition.[2,4] Using serum IgE in a standardized manner, the EuroPrevall study reported food-sensitization prevalence ranging from 11.0% to 28.7% across European pediatric centers, while challenge-confirmed allergy remained considerably lower (1.9–5.6%), underscoring that sensitization substantially exceeds clinically confirmed allergy.[11] The prominence of cow's milk and egg white in this cohort is consistent with the central role of milk and egg sensitization reported internationally, particularly in pediatric and mixed-age populations. The relatively high ranking of shellfish is also consistent with global reports identifying shellfish as an important allergen in many adult and mixed-age cohorts. In contrast, the contribution of selected nuts, seeds, cereals, fruits, and vegetables may reflect local dietary exposures, regional food availability, and the composition of the laboratory panel used in routine practice. These comparisons support the need for locally generated data because global allergen rankings cannot be assumed to apply uniformly across countries or healthcare settings.[4,5]

A useful contribution of this work is the exploratory depiction of co-sensitization using correlation-based hierarchical clustering. The heatmap identified clinically interpretable groupings, including cereals, nuts/seeds, and selected animal-derived allergens. These patterns may help clinicians recognize common co-sensitization profiles and may inform more focused testing strategies in routine practice. Nevertheless, clustering based on extract-level sIgE results remains descriptive and should not be interpreted as proof of shared molecular mechanisms or clinically relevant cross-reactivity. Confirming such mechanisms would require component-resolved diagnostics, inhibition studies, or other molecular and functional approaches.[6]

For clinicians and laboratories, the findings suggest several practical implications. First, local sensitization profiles can help guide pre-test counselling and interpretation of broad food panels, particularly when clinical history is unclear. Second, because most sensitized patients had a limited number of positive allergens, counselling should emphasize the distinction between sensitization and clinical allergy to reduce unnecessary dietary restriction. Third, the observed co-sensitization patterns may support more targeted follow-up testing, including component-resolved diagnostics when clinically indicated and available.

Strengths and limitations

Strengths of this study include the use of a standardized 34-food allergen panel, a prespecified primary threshold for sensitization more frequently associated with clinical symptoms (Class ≥ 2), uncertainty quantification using Wilson 95% confidence intervals, false-discovery-rate correction for multiple subgroup comparisons, and an interpretable clustering framework for exploring co-sensitization patterns.[1,3,6]

Several limitations should also be considered. First, this was a retrospective analysis of routine laboratory records; therefore, the dataset did not include standardized clinical histories, reaction severity, timing of symptoms, oral food challenge outcomes, dietary avoidance, medication use, or comorbid atopic diseases such as asthma, allergic rhinitis, or atopic dermatitis. These unmeasured factors may have influenced both the likelihood of testing and the observed sensitization profile. Second, ethnicity, socioeconomic status, geographic residence, and detailed referral indications were not available, so residual confounding could not be assessed. Third, because this was a service-based sample from a private laboratory network, the estimates should be interpreted as sensitization frequencies among clinically tested patients rather than population prevalence in Jordan.

Fourth, serum sIgE sensitization does not establish clinical food allergy. Positive results require interpretation alongside clinical history and, when appropriate, oral food challenge.[1,3] Fifth, sensitization was assessed using a semiquantitative extract-based line immunoblot (EUROLINE), which reports ordinal EAST classes rather than continuous concentrations (manufacturer-stated accuracy ±1 class) and does not incorporate component-resolved diagnostics, quantitative singleplex assays such as ImmunoCAP, or functional testing. Consequently, we could not distinguish primary sensitization from cross-reactivity—including reactivity to cross-reactive carbohydrate determinants—or evaluate molecular risk markers. Sixth, some clinically useful subgroup analyses were limited by the structure of the source panel shellfish was available only as a single composite "shellfish mix" reagent rather than as separate shrimp, crab, clam, or other shellfish components, precluding species-level analysis. Finally, while clustering highlights co-sensitization structure, it remains descriptive; mechanistic inference would require molecular or functional confirmation.

Conclusions

This analysis of routine laboratory data provides an updated description of food allergen sensitization among clinically tested patients in this Jordanian laboratory cohort. Overall sensitization prevalence was modest, and most patients had no sensitization or a limited sensitization burden, whereas broad polysensitization was confined to a smaller subset. The leading sensitizers included shellfish, cow's milk, and egg white, and exploratory clustering identified co-sensitization patterns involving nuts/seeds, cereals, and selected animal-derived allergens. These findings build on previous Jordanian evidence and are broadly consistent with international patterns, while also reflecting local testing practices and dietary exposures. Because the study was laboratory-based, the results should be used to support clinical interpretation, counselling, and service planning rather than to estimate national food allergy prevalence. Future studies should link laboratory sensitization with clinical history, oral food challenge outcomes, and component-resolved diagnostics to better define clinically confirmed food allergy phenotypes in Jordan.

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Competing interests

The authors declare that they have no competing interests.

Author contributions

Ahmad Al Athamneh conceptualized the study, designed the methodology, supervised the work, interpreted the findings, and drafted the manuscript. Anas Khaleel contributed to study design, interpretation of the results, and critical revision of the manuscript. Leena Ahmad contributed to data interpretation and critical revision of the manuscript. Saba Alshatali contributed to formal analysis and interpretation of the findings. Abdel Fawaz Bagoudou contributed to methodological input and critical revision of the manuscript. Raneen Alkhriesat and Rama Badah contributed to data acquisition, laboratory data curation, and data validation. All authors reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

Availability of data and materials

De-identified data underlying the analyses are available from the corresponding author upon reasonable request, subject to institutional and laboratory data-sharing policies.

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