APPENDIX 4 - SUMMARY TABLES FOR EACH STUDY INCLUDED IN THE REVIEW

These tables provide the summary information for each study that was included in this review during the data extraction stage. The ‘study type’ section describes the research approach used and the overall study aim. The ‘strengths/limitations’ section only provides those strengths and limitations that were reported in the study. The ‘comments’ in ‘study quality and applicability’ provide limitations/strengths identified by the reviewer in addition to those reported in the study. These studies are ordered by research question.

1. RISKS POSED TO PEOPLE WITH FHS BY NEW/NOVEL FOODS AND/OR PROCESSES

Study reference:	van Putten, M., Frewer, L., Gilissen, L., Bart, G., Peijnenburg, A. and Wichers, H. (2010). Stakeholder and consumer views regarding novel hypoallergenic foods. British Food Journal, 112 (9), pp. 949-961.
Study type:	Qualitative study to assess whether novel hypoallergenic foods will be accepted by food chain actors and consumers.
Study population:	UK
Publication date:	2010
Study quality and applicability:	Very low **Comments:** Lots of factors considered but cannot be generalised as the sample number are low. Also stakeholders were recruited off contact lists so there could be bias in participant selection.

Key themes/ topics:	Knowledge/Opinions on Novel Foods/Processes
Method:	Stakeholder opinions (collated using semi-structured interviews) regarding the acceptability of novel hypoallergenic foods were assessed. Three focus groups were applied to understand the opinions of food allergic consumers. **Sample size:** n=16
Findings:	Food allergic consumers expressed a preference for a “cure” for food allergy. However, they acknowledged that hypoallergenic foods had the potential to improve the quality of lives of food allergy sufferers through increasing dietary variation and reducing restrictions on product selection. Stakeholders supported the introduction of novel foods (although this support was not universal), assuming that the products were acceptable to food allergic consumers, consumers in general and regulators.
Strengths/ Limitations:	Limitations: Results of study cannot be extrapolated to the general population because of the small sample size of the stakeholder groups.
Relevant outcomes:	Results of study are indicative of potentially important factors determining societal acceptance of novel hypoallergenic foods in the future.

Study reference:	Jędrusek-Golińska, A., Piasecka-Kwiatkowska, D., Zielińska, P., Zielińska-Dawidziak, M., Szymandera-Buszka, K., & Hęś, M. (2019). Soy Preparations Are Potentially Dangerous Factors in the Course of a Food Allergy. Foods (Basel, Switzerland), 8(12), pp. 665.

Study type:	Cross-sectional study to check consumers' awareness of potential risks of soy preparations added to numerous food products, depending on respondents' education, and to evaluate immunoreactive properties of chosen soy preparations.
Study population:	Poland
Publication date:	2019
Study quality and applicability:	Very low **Comments:** There is little variety in the survey respondents. Not likely to be representative of the population as these students would be more aware of allergens and the importance of checking food labels. Also small sample size of survey.
Key themes/ topics:	Knowledge/Opinions on Novel Foods/Processes
Method:	An anonymous questionnaire was distributed to respondents who were aged 23–28 years old, lived in Poland, and were graduates or students in their last year of food technology, medicine, and university of technology, to capture awareness of risk of soy preparations. **Sample size:** n=251
Findings:	Soy preparations contain immunoreactive proteins that may be the source of hidden allergens, even though they are not recognised as dangerous by well-educated respondents, who often or usually read labels of food products they buy.

Strengths/ Limitations:	Strength: Questionnaire piloted on 19 people to check that questions made sense and that correct information would be gathered. Limitation: Only targeted specific types of people, so results likely to not be representative of entire population.
Relevant outcomes:	Importance of educating consumers to read food labels prior to purchasing food. This is especially important for those with food hypersensitivities.

Study reference:	Santerre, C. R., & Machtmes, K. L. (2002). The impact of consumer food biotechnology training on knowledge and attitude. Journal of the American College of Nutrition, 21(3 Suppl), pp. 174S–177S.
Study type:	Pretest-posttest study to determine whether consumer's knowledge and attitudes would be influenced by food biotechnology training.
Study population:	USA
Publication date:	2002
Study quality and applicability:	Very low **Comments:** Respondents mainly from groups studying food and nutrition issues, which is not representative of population and may already have high pre-existing knowledge. Study sponsored by a

	private food biotechnology company which may bias the publication. Results were hand tabulated (subject to human error).
Key themes/ topics:	Knowledge/Opinions on Novel Foods/Processes
Method:	Pre- and post-tests were administered to participants to assess knowledge and attitudes before and after the training, which ranged from 45 to 80 minutes in length. **Sample size:** n=576
Findings:	Prior to training, only 25% believed that biotechnology was unlikely to add new allergens to food supply which increased to 63% after training.
Strengths/ Limitations:	Limitation: As the time between pre- and post-tests were limited, some of the change could be attributed to exposure to the pre-test. Reliability of the data was also not obtained.
Relevant outcomes:	Consumers' food biotechnology knowledge can change when provided science-based information on them, which can make them more accepting.

Study reference:	Brzozowski B. (2018). Impact of food processing and simulated gastrointestinal digestion on gliadin immunoreactivity in rolls. Journal of the Science of Food and Agriculture, 98(9), pp. 3363-3375
Study type:	Protein analysis study to understand how thermal changes in the spatial structure of proteins and their hydrolysis can lead to a masking or degrading of immunoreactive peptides.
Study population:	Poland

Publication date:	2018
Study quality and applicability:	Low **Comments:** In temperatures of up to 90 °C in an environment of pH 3 decreases the immunoreactivity of gluten by one-third which could account for some of the results reported. No tests to see whether this will translate into allergic reactions in humans.
Key themes/ topics:	Impact of Thermal Processing on Allergenicity of Foods
Method:	The strain of LAB L. acidophilus 5e2 was kept frozen at –35 °C on MR-broth with the addition of glycerol. Before the experiment, bacteria were double-passaged on MRS-broth for 12 h at 37 °C. Intracellular peptides were isolated and a stationary culture was produced for testing. Wheat flour was modified with these peptides and the immunoreactivity of the modified wheat was tested
Findings:	The addition of prolyl endopeptidase (PEP), comprising peptidases isolated from Lactobacillus acidophilus 5e2 (LA) or transglutaminase (TG) in the course of fermentation, decreases its immunoreactivity by 83.9%, 51.9% and 18.5%, respectively. The study showed that enzymatic pre-modification of proteins during the process of dough fermentation decreases their immunoreactive potential, such that fewer peptides recognised by R5 antibodies are released during the digestion process from the bread matrix.
Strengths/ Limitations:	Strengths: Repeated tests to ensure reliability Limitations - As a result of the low extracellular activity of enzymes synthesised by these microorganisms, the degradation of proteins occurs in 24–48 hours. Study also recognises that in temperatures of up to 90 °C in an environment of pH 3 decreases the immunoreactivity of gluten by one-third which could account for some of the results reported.

Relevant outcomes:	Immunoreactivity of protein in bread when undergoing thermal processing

Study reference:	Cuadrado, C., Cabanillas, B., Pedrosa, M.M., Varela, A., Guillamón, E., Muzquiz, M., Crespo, J.F., Rodriguez, J. and Burbano, C. (2009), Influence of thermal processing on IgE reactivity to lentil and chickpea proteins. Mol. Nutr. Food Res., 53, pp. 1462-1468.
Study type:	Protein analysis study to assess changes in the IgE-binding capacity of lentil and chickpea proteins by means of thermal-processing techniques such as boiling and autoclaving.
Study population:	Spain
Publication date:	2009
Study quality and applicability:	Low **Comments:** Study quality reasonable, but not all changes could be accounted for and the methods did not eliminate several immunoreactive proteins found in chickpeas and lentils.
Key themes/ topics:	Impact of Thermal Processing on Allergenicity of Foods
Method:	The SDS-PAGE and IgE-immunoblotting patterns of chickpeas and lentils were analyzed before and after boiling (up to 60 min) and autoclaving (1.2 and 2.6 atm, up to 30 min). **Sample size**: n = 49 individual sera

Findings:	Results indicated that some of these treatments reduce IgE binding to lentil and chickpea, the most important being harsh autoclaving. However, it should be noted that several extremely resistant immunoreactive proteins still remained in these legumes even after this extreme treatment.
Strengths/ Limitations:	Limitations: several extremely resistant immunoreactive proteins still remained in these legumes after thermal processing. Aggregation and differential solubility were not the sole causes of large amount of modifications of allergenic proteins observed upon processing, the researchers were unable to determine why this occurred.
Relevant outcomes:	Immunoreactivity of protein in chickpeas and lentils when undergoing thermal processing

Study reference:	Richard, C., Jacquenet, S., Sergeant, P., & Moneret-Vautrin, D. A. (2015). Cross-reactivity of a new food ingredient, dun pea, with legumes, and risk of anaphylaxis in legume allergic children. European annals of allergy and clinical immunology, 47(4), pp. 118–125.
Study type:	Cross-sectional study to evaluate the cross-reactivity between dun pea and other legumes and to search for modification of allergenicity induced by food technologies.
Study population:	France
Publication date:	2015
Study quality and applicability:	Very low

	Comments: Small sample size. Unclear selection method of patients other than that they have the food allergy of interest. Allergy determined by sin prick tests rather than DBPCFC.
Key themes/ topics:	Sensitivity to New/Novel Foods
Method:	A series of patients with legume and/or peanut allergy was studied. They underwent skin tests to peanut and a panel of legumes including dun pea. Specific IgE to dun pea and cross-reactivity to peanut allergens, particularly to Ara h 1, were evaluated by ELISA. Proteins and allergens of different pea extracts were studied by SDS-PAGE and immunoblots. **Sample Size**: n = 36
Findings:	7.7% of severe food anaphylaxis cases were due to legumes. Patients with isolated legume allergy had positive prick tests to dun pea, whereas patients with isolated peanut allergy had negative prick tests. Cross-reactivity between sIgE to peanut and dun pea was observed, and more frequently than expected (96%) peanut-allergic patients with legume sensitization or allergy had sIgE to Ara h 1.
Strengths/ Limitations:	Limitations: Small sample size, Unclear selection criteria
Relevant outcomes:	There is a risk of dun pea allergy in legume-allergic patients and in a subset of peanut-allergic patients.

Study reference:	Polikovsky, M., Fernand, F., Sack, M., Frey, W., Müller, G., & Golberg, A. (2019). In silico food allergenic risk evaluation of proteins extracted from macroalgae Ulva sp. with pulsed electric fields. Food chemistry, 276, pp. 735–744.

Study type:	Protein analysis study provides an assessment of allergens present in proteins extracted from seaweed.
Study population:	Israel
Publication date:	2019
Study quality and applicability:	Very Low **Comments**: Limitation in methodology has the potential to produce misleading results. Limited generalisability as only studied one protein source.
Key themes/ topics:	Allergenicity of New/Novel Foods & Processes
Method:	Chemical-free green macroalgae Ulva sp. protein extraction by osmotic shock combined with pulsed electric fields (PEF) followed by hydraulic pressure. The extracted proteins were identified and annotated to allergens using sequence similarity. The allergenicity potential of PEF extracted proteins was compared to osmotic shock extracts and complete Ulva sp. proteome, extracted with the thermochemical method.
Findings:	The PEF extracts contained ‘superoxide dismutase’ (SOD), a known food allergen, osmotic shock extract contained ‘troponin C’, and thermochemical extract contained two additional potential food allergens ‘aldolase A’ and ‘thioredoxin h’. Study identified known and additional potential food allergens in macroalgae protein.
Strengths/ Limitations:	Limitation: The use of Bradford assay with the BSA standard curve in this study for protein quantification has limitations. When quantifying algae proteins and other stains reported in the literature, it showed significantly higher protein yields on the same samples possibly due to variation in the amino acid composition

Relevant outcomes:	Presents evidence for macroalgae proteins to be a potential cause an allergic reaction done in silico, which should be considered when packaging foods.

Study reference:	Rudnicka, A., Słowik, M., & Hozyasz, K. (2017). Bread from bake-off technology. Preliminary study of accessibility and composition. Journal of Paediatrics, 92(2), pp. 156-163.
Study type:	Food analysis study to analyse the assortment of 'bake-off bread' in selected supermarkets and discount stores and preliminary assessment of safety of consuming bake-off products, especially for children.
Study population:	Poland
Publication date:	2017
Study quality and applicability:	Low **Comments**: Indirect as analysing food additives and concluding that it could cause food hypersensitivities as it a potential food allergen. No testing with the samples on whether it could actually cause allergic reactions.
Key themes/ topics:	Allergenicity of New/Novel Foods & Processes
Method:	The availability of 'bake-off bread' in selected supermarkets and discount stores was assessed. Bread composition, food additives and mixes for bakery products were analysed. **Sample Size**: n = 277 food samples

Findings:	84.8% of bake-off products were produced by combined use of 29 food additives, which is a potential food allergen.
Strengths/ Limitations:	Limitation: None reported.
Relevant outcomes:	Use of food additives in “bake-off” technology could cause allergic reactions.

Study reference:	Garino, C., Mielke, H., Knüppel, S., Selhorst, T., Broll, H., & Braeuning, A. (2020). Quantitative allergenicity risk assessment of food products containing yellow mealworm (Tenebrio molitor). Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association, 142, 111460
Study type:	Quantitative risk assessment on the allergenicity of yellow mealworm-based food products
Study population:	Germany
Publication date:	2020
Study quality and applicability:	Low **Comments**: Methods all based on secondary data instead of primary. Limited generalisability as study only focused on yellow mealworm. However, there is dose-response gradient curve presented.
Key themes/ topics:	Allergenicity of New/Novel Foods & Processes

Method:	Applied the concepts of stochastic quantitative food allergenicity risk assessment (FARA) to describe present and future scenarios of exposure to foods containing Tenebrio molitor, the yellow mealworm
Findings:	Mealworm-based food products can be a major risk for individuals allergic to crustaceans to develop symptoms after the consumption of a dose lower than a serving size. Other allergic consumers could also be at risk.
Strengths/ Limitations:	Limitation: None reported.
Relevant outcomes:	Quantitative assessment of risk of allergenicity clearly describes the problem, thus facilitating the decision making of the risk manager, and assists with allergen management procedures.

Study reference:	Jacobson M. F. (2003). Adverse reactions to a new food ingredient. The American journal of medicine, 115(4), pp. 334.
Study type:	Retrospective study to assess consumers' allergic reaction to Quorn, a meat substitute product.
Study population:	U.K.
Publication date:	2003
Study quality and applicability:	Very low

	Comments: Self-reported data on allergic reaction and symptoms which is subjective and biased, no allergic reaction testing was done. Survey also asked about previous experiences with Quorn which could result in recall bias.
Key themes/ topics:	Sensitivity to New/Novel Foods
Method:	A telephone survey of British consumers was conducted and questions were asked on history of adverse reactions to Quorn. Sample Size: **n = 1004**
Findings:	Sensitivity to the meat substitute was at least as common as other allergens and 67% of consumers who consumed the product had experienced vomiting.
Strengths/ Limitations:	Limitations: None reported
Relevant outcomes:	Meat substitute products can cause allergic reactions.

Study reference:	Reyes, T. F., Chen, Y., Fraser, R. Z., Chan, T., & Li, X. (2021). Assessment of the potential allergenicity and toxicity of Pichia proteins in a novel leghemoglobin preparation. Regulatory toxicology and pharmacology: RTP, 119, 104817.

Study type:	Protein analysis study about the potential allergenicity of a new of soy leghemoglobin protein preparation and its associated Pichia proteins
Study population:	USA
Publication date:	2021
Study quality and applicability:	Moderate **Comments**: Methodology is detailed and there are good validation methods. However, the study was funded by a private company producing meat substitute products and samples were also provided by funding source, which could potentially lead to bias in reported results.
Key themes/ topics:	Allergenicity of New/Novel Foods & Processes
Method:	The potential allergenicity and toxicity of a soy leghemoglobin protein from a new production process were analysed using bioinformatics, proteomics and a pepsin digestion assay on leghemoglobin, and residual host proteins. Three legehmoglobin samples provided.
Findings:	1. Seven Pichia proteins, each representing ≥1% of total protein content, showed no significant sequence matches to any known allergens except for one. 2. Soy leghemoglbin and Pichia proteins were also rapidly digested.
Strengths/ Limitations:	Strengths: Various validation methods used Limitations: None reported.

Relevant outcomes:	New production process of soy leghemoglobin protein preparation is unlikely to pose any risks to consumers with FHS.

Study reference:	Venkataratnam, H., Cahill, O., Sarangapani, C., Cullen, P.J., & Barry-Ryan, C. (2020). Impact of cold plasma processing on major peanut allergens. Sci Rep, 10.
Study type:	Experiment study investigating the efficacy of cold plasma on major peanut allergens
Study population:	Ireland
Publication date:	2020
Study quality and applicability:	High **Comment**: The study shows a clear cause and effect in the underlying biological mechanisms, which agrees with previous research in the area
Key themes/ topics:	Novel food process
Method:	Cold plasma treatment, ELISA, statistical analysis
Findings:	Cold plasma is effective at reducing peanut protein solubility and causes changes in allergen structure leading to reduced antigenicity.

Strengths/ Limitations:	None reported
Relevant outcomes:	Cold plasma processing reduces peanut allergenicity

Study reference:	Dong, X., Wang, J. & Raghavan, V. (2020). Effects of high-intensity ultrasound processing on the physiochemical and allergenic properties of shrimp. Innovative Food Science & Emerging Technologies, 65.
Study type:	Experiment study evaluating the impacts of the high-intensity ultrasound processing (0, 5, 10, 15, 20 min, at room temperature) on the physiochemical and allergenic properties of shrimp samples.
Study population:	Canada
Publication date:	2020
Study quality and applicability:	High **Comment**: The study shows a clear cause and effect in the underlying biological mechanisms
Key themes/ topics:	Novel food process
Method:	Ultrasound processing conducted with a probe at 20-kHz frequency, 400 w. 50 mL of samples were treated by ultrasonic processer with the duty cycle at 50% for 0 min (US0), 5 min (US5), 10 min (US10), 15 min (US15), and 20 min (US20), respectively. A protein assay it was used to determine total soluble

	protein of shrimp samples. SDS-PAGE was performed to extract protein and Sandwich ELISA was used to determine tropomyosin content of shrim samples. Secondary structure and microstructure was analysed
Findings:	Allergenicity decreased with increasing treatment time, and the best hypoallergenic effect showed at 20 min with a 76% reduction of tropomyosin. At 20 min, the total soluble protein content decreased by 28.26%, while the in vitro digestibility, peptide content, total antioxidant capacity strengthened by 7.53%, 0.81%, and 71.29%, respectively.
Strengths/ Limitations:	None reported
Relevant outcomes:	The high-intensity ultrasound as a novel non-thermal processing technique exhibits great potential in reducing the allergenicity of food products.

2. IMPROVING TRACEABILITY OF ALLERGENS IN THE FOOD SUPPLY CHAIN

Study reference:	Maurer, J., Byrd-Bredbenner, C., & Grasso, D. (2007). “Ask before You Eat”—Development of an Educational Campaign on Food Allergies. Social Marketing Quarterly, 13(2), pp. 48–70.
Study type:	Qualitative study analysing the effect of educational marketing campaign.
Study population:	US
Publication date:	2007
Study quality and applicability:	Very Low **Comment**: no comparison group used, small sample, only qualitative techniques used
Key themes/ topics:	Beyond allergy labelling
Method:	Interviews with caregivers assessed on knowledge of FAs; how they would supervise eating situations involving children with FAs; importance they placed on knowing how to prevent triggering FA reactions; and desired format for information delivery. Sample size: n=32
Findings:	The food allergy knowledge level of the total group of randomly surveyed state residents improved significantly. Significant increases were also noted in most subgroups.
Strengths/ Limitations:	Limitations: no comparison group.

Relevant outcomes:	Experts and caregivers both identified fact sheets as preferred educational materials.

Study reference:	Miles, S., Erkka, V. & Lynn, F. (2006). Communication needs and food allergy: A summary of stakeholder views. British Food Journal, 108, pp. 795-802.
Study type:	Stakeholder consultation to elicit information about the specific information needs of different stakeholders and end-users.
Study population:	UK
Publication date:	2006
Study quality and applicability:	Very Low **Comment**: Qualitative study, no information of sample surveyed provided or what methods were used to recruit stakeholders.
Key themes/ topics:	Difference in communication needs
Method:	A stakeholder consultation was conducted to solicit the views of different stakeholders regarding what information they required
Findings:	Some information needs were common across all stakeholders and end-users. An example is the need for information about the causes and symptomology of food allergy. Some specific information needs for different stakeholders were also identified:

	1) The industrial sector requires more information about clear guidelines for labelling practices. 2) Allergic consumers and health professionals require more information about symptomology, treatment and prevention. 3) Regulators need information from risk assessors regarding issues key to the implementation of an effective regulatory framework, at a more detailed level of technicality than that required by other stakeholders (for example, consumers).
Strengths/ Limitations:	None reported
Relevant outcomes:	Targeted information strategies may be the most resource-efficient way to effectively communicate to different stakeholders about food allergy. However, information channels best suited to specific stakeholder needs remain to be investigated and exploited.

3. RISKS POSED DUE TO SHARED PRODUCTION OF FOODS, AND HOW CAN THESE BE MITIGATED

Study reference:	Koerner, T. B., Cleroux, C., Poirier, C., Cantin, I., La Vieille, S., Hayward, S., & Dubois, S. (2013). Gluten contamination of naturally gluten-free flours and starches used by Canadians with celiac disease. Food additives & contaminants. Part A, Chemistry, analysis, control, exposure & risk assessment, 30(12), pp. 2017–2021.
Study type:	Analysis of gluten contamination of flour to obtain a large national picture of the extent of gluten cross-contamination of naturally gluten-free flours and starches used in the diet of individuals with CD.

Study population:	Canada
Publication date:	2013
Study quality and applicability:	Very Low **Comment**: Results may not be generalisable beyond Canada. The study does not focus on where cross-contamination occurred and so applicability is limited.
Key themes/ topics:	Cross-contamination during food production
Method:	Food samples were purchased from eight Canadian cities and via the internet during the period 2010–2012 and analysed for gluten contamination. Sample size: n=640
Findings:	1) 61 of the 640 (9.5%) samples were contaminated above the Codex-recommended maximum level for gluten-free products (20 mg kg–1) with a range of 5–7995 mg kg–1. 2) For the ingredients that were labelled gluten-free the contamination range (5–141 mg kg–1) and number of samples were lower (3 of 268). This was consistent over time, with approximately the same % of samples above 20 mg kg–1 in both the initial set and the subsequent lot. 3) Of the naturally gluten-free flours and starches tested that do not contain a gluten-free label, the higher fibre ingredients would constitute the greatest probability of being contaminated with gluten above 20 mg kg–1

Strengths/ Limitations:	Limitations: This study was relatively small and may not accurately represent the gluten contamination of naturally gluten-free grains, starches, seeds and nuts in general. Approximately 75% of the first set of flour and starch samples has duplicate lot information and the vast majority of these were negative in both lots. There were a small number of products (n = 15) that were positive in one lot and negative in the second.
Relevant outcomes:	People with FHs may be at risk from naturally gluten free flours and starches due to gluten cross contamination at various levels. The lowest level and occurrence of contamination was found in those ingredients that are labelled gluten-free while the highest occurrence and level was found in those ingredients with a precautionary label.

Study reference:	Vincentini, O., Izzo, M., Maialetti, F., Gonnelli, E., Neuhold, S., & Silano, M. (2016). Risk of Cross-Contact for Gluten-Free Pizzas in Shared-Production Restaurants in Relation to Oven Cooking Procedures. Journal of food protection, 79(9), pp. 1642–1646
Study type:	Evaluation of gluten cross contact during preparation procedures. Aims: To evaluate the risk of gluten cross contact of GF pizzas in relation to the preparation procedures, thus aiming at identifying a safe procedure for cooking GF pizzas.
Study population:	Italy
Publication date:	2016
Study quality and applicability:	Low

	Comment: Recruitment procedures for restaurants are unclear. Findings may not be generalisable beyond Italy.
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)
Method:	<u>First stage:</u> Procedure 1: WB and GF pizzas were cooked simultaneously in the same oven. Before the GF pizzas were placed in the oven, they were put in a pan with 2.5-cm-high edges, to further minimize the risk of gluten cross-contact. The cooking surface of the oven was equally divided for the two types of pizzas, one or two GF pizzas on the left and one or two WB pizzas on the right. Procedure 2: WB and GF pizzas were cooked alternately in the same oven, with a batch of GF pizzas followed by a batch of WB pizzas. Procedure 3: WB and GF pizzas were cooked in two different ovens, one dedicated to GF pizzas and one dedicated to WB pizzas. <u>Second stage:</u> GF pizzas were collected from five different pizza houses during working days, when the restaurants were open to customers, to evaluate the possible contamination under real working conditions.
Findings:	All the results, except one related to a pizza cooked according to the Procedure 1, show a gluten concentration in pizzas below 20 ppm. All the samples taken from pizzas prepared in those "real" settings had gluten concentrations below 20 ppm.

Strengths/ Limitations:	Limitations: 1) Results varied among pizza houses, so, the adherence to the procedures may vary among the restaurants involved. 2) Case-control evaluation was not performed to confirm any findings on the impact that the use of wheat flour for rolling out WB pizzas has on the gluten cross-contact of GF pizzas. 3) Only a single slice from each pizza was analysed as it was assumed one slice has the same probability of being in contact as the whole pizza.
Relevant outcomes:	Health risks to consumers with FHs from cross contact in shared production restaurants can be reduced when specific requirements are complied with, the simultaneous cooking of GF and WB pizzas is a procedure as safe as having an oven dedicated to GF pizzas or the alternate cooking of GF and WB pizzas in the same oven.

Study reference:	Ortiz J.C., Galan-Malo P., Garcia-Galvez M., Mateos A., Ortiz-Ramos M., Razquin P., Mata L. (2018). Survey on the occurrence of allergens on food-contact surfaces from school canteen kitchens. Food Control, 84, pp. 449-454.
Study type:	Evaluation of allergen residues on food contact services in school canteens to obtain an overview of the current situation in school kitchens to help establish objective measures in allergen control plans.
Study population:	Spain
Publication date:	2018
Study quality and applicability:	Low

	Comment: Samples were taken from school canteens from the Hortaleza District of Madrid, Spain and may not be generalisable beyond this region.
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)
Method:	621 food-contact surfaces from 50 school canteens were analysed by using LFIA and ELISA tests to detect milk, egg and gluten in school kitchens. Food contact surfaces were selected and analysed in situ by using a rapid LFIA test. Leftover sample was sent to a lab where an ELISA test was performed to confirm results. The study included food-contact surfaces of general use and surfaces for exclusive use in meals free of specific allergens. These food-contact surfaces were selected and analysed in situ by using a rapid LFIA test during the visits to kitchens. Leftover sample was sent to a laboratory where an ELISA test was performed to confirm results.
Findings:	1) Out of 621 analysed surfaces (213 samples for milk and egg and 195 samples for gluten) none of them were found to contain milk with the rapid tests. 2) The presence of egg and gluten was detected in 15 and 45% of the food-contact surfaces, respectively. The results obtained with ELISA showed also a low occurrence for milk (6%) but higher for egg (24%) and gluten (57%). 3) For some specific food-contact surfaces the occurrence reached up to 40%.
Strengths/ Limitations:	Limitations: Conclusions should be adapted to the characteristics of each kitchen, particularly when menus or culinary practices are very different from those made in the kitchens included in the present study.
Relevant outcomes:	Findings suggest consumers with FHs may be at risk from cross-contamination during food preparation in school canteens.

	Current cleaning procedures as well as the subsequent manipulation of surfaces are not adequate for the control of allergen residues in canteens.

Study reference:	Studerus, D., Hampe, E. I., Fahrer, D., Wilhelmi, M., & Vavricka, S. R. (2018). Cross-Contamination with Gluten by Using Kitchen Utensils: Fact or Fiction?. Journal of food protection, 81(10), pp. 1679–1684.
Study type:	Experimental trial (analysis of kitchen ware) to determine whether cross-contamination occurs through shared domestic kitchenware and, if so, which cleaning method is most reliable for avoiding this cross-contamination.
Study population:	US
Publication date:	2018
Study quality and applicability:	Low **Comments**: Findings apply only to the tested scenarios.
Key themes/ topics:	Cross-contamination during food production
Method:	Kitchenware (wooden spoon, colander, ladle, and knife) previously used to cook and/or prepare GC foods was used for the preparation of GF foods (bread and pasta). The gluten concentration of the GF foods was then determined using an established enzyme-linked immunosorbent assay. A PCR assay was also used to detect the presence of wheat ω-gliadin DNA in the food samples. Three cleaning methods were

	assessed to determine the concentrations of gluten and wheat DNA in GF foods cooked with utensils cleaned directly after the preparation of GC foods.
Findings:	1) Gluten was not detected in relevant and quantifiable amounts in the samples (<20 mg/kg). 2) The cleaning method used did not influence gluten concentrations: all samples contained <10 mg/kg. 3) Based on PCR analyses, the only sample with lower cycle threshold (CT) values (i.e., higher concentration of wheat DNA) was from the contaminated ladle used to serve GF pasta.
Strengths/ Limitations:	Limitations: the inability to investigate all of the innumerable possible scenarios under which gluten contamination can occur. Cross-contamination can happen during every preparation and cooking step, and the focus of this study was on a few of the common and relevant situations. Carefully chosen approach including optimal homogenization of the samples, two sensitive and well established methods of determining gluten or wheat concentrations in samples, and a quality control aspect for the sample extraction methods with proof of the analytical recovery rate.
Relevant outcomes:	Kitchen equipment and utensils used for GC food may not pose such a high risk for CeD patients as do wheat flour and bread crumbs.

Study reference:	Weisbrod, V. M., Silvester, J. A., Raber, C., Suslovic, W., Coburn, S. S., Raber, B., McMahon, J., Damast, A., Kramer, Z., & Kerzner, B. (2020). A Quantitative Assessment of Gluten Cross-contact in the School Environment for Children With Celiac Disease. Journal of pediatric gastroenterology and nutrition, 70(3), pp. 289–294.

Study type:	Experimental study measuring gluten transfer from school supplies to GF foods that a child with CD may eat; also measuring efficacy of washing techniques to remove gluten from hands and tables.
Study population:	US
Publication date:	2020
Study quality and applicability:	Low Comment: low generalisability
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)
Method:	Five experiments measured potential gluten cross-contact in classrooms: Play-Doh (n=30); baking project (n=30); paper mâché (n=10); dry pasta in sensory table (n=10); cooked pasta in sensory table (n=10). 30 participants ages 2 to 18 were enrolled. Following activities, gluten levels were measured on separate slices of GF bread rubbed on participant's hands and table surfaces. Participants were assigned one of three handwashing methods (soap and water, water alone, or wet wipe). Repeat gluten transfer measurements were taken from hands and tables. Gluten measurements made using R-Biopharm R7001 R5-ELISA Sandwich assay.
Findings:	1) Paper mâché, cooked pasta in sensory tables, and baking project resulted in rates of gluten transfer far greater than the 20ppm threshold set by Codex Alimentarius Commission. However, Play-Doh and dry pasta resulted in few gluten transfers to GF bread >20ppm.

	2) Soap and water were consistently the most effective method for removing gluten, although other methods (e.g. wet wipes) proved as effective in certain scenarios.
Strengths/ Limitations:	Limitations: Subsampling of homogenized foods and relatively small sample size for some scenarios. No test for the level of gluten possibly transferred from low risk supplies to the hands of children with CD nor how much could be consumed from actions like thumb sucking and nail biting. Strengths: The lower bound of the 95% confidence interval was 85% which allowed for identification of high-risk activities.
Relevant outcomes:	The study highlights possible contamination of surfaces which may be used to consume food by children with CD so probably so may have some (low) applicability to the research question. School supplies that are dry had very low gluten transfers while materials that were wet and/or sticky tended to cling to the hands of children and table surfaces. Play-Doh and dry pasta were associated with the lowest risk of gluten exposure. A child who vigorously or exuberantly interacts with gluten-containing materials may experience a greater risk of gluten transfer, as was observed during the baking and cooked pasta activities. Soap and water, water alone, or wet wipes were sufficient to create safe surfaces after Play-Doh activities.

Study reference:	Parsons K., Brown L., Clark H., Allen E., McCammon E., Clark G., Oblad R., Kenealey J. (2020), Gluten cross-contact from common food practices and preparations.

Study type:	Experimental/sample analysis study determining if three common food practices lead to gluten cross-contact in gluten-free processed foods.
Study population:	US
Publication date:	2020
Study quality and applicability:	Low **Comment**: Unclear how restaurants and homes from which samples were taken were selected. Possible strengths: All tests were run after thorough cleaning of work surfaces, tools, and surroundings to prevent gluten cross-contact. All samples were in closed containers or test tubes at all times except for when additional test materials were added to test tubes. Methods were consistent for all samples.
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)
Method:	Three different practices were examined for gluten cross-contact: 1) gluten-free foods fried in a fryer also used for gluten containing foods; 2) gluten-free bread toasted in a toaster also used for gluten-containing bread; 3) and popular sandwich spreads applied with a knife used on gluten-containing bread (mayonnaise, jam, and peanut butter).

	ALLER-TEK™ Gluten ELISA test kit and the sandwich ELISA RIDASCREEN Gliadin test kit was used. Samples came from restaurants (shared fryer) or home environments (shared toaster and sandwich spread).
Findings:	The practices examined resulted in small amounts of gluten cross-contact, although the majority of the results (93.6%) showed no significant cross-contact. Mayonnaise and peanut butter samples were contaminated with gluten above the limit designated by the FDA as gluten-free <20 kg/mg (ppm).
Strengths/ Limitations:	Limitations: 1) The ELISA assay method is limited by the efficacy of the gluten extraction. 2) Because the study was limited to 1-g and 0.25-g sample sizes, the absence of gluten in the tests does not necessarily indicate an absence of gluten in another portion of the product. 3) Sample collection and sample size are restricted.
Relevant outcomes:	Findings highlight food preparation practices which may risk cross-contamination. The practices of: gluten-free foods fried in a fryer also used for gluten containing foods, gluten-free bread toasted in a toaster also used for gluten-containing bread, and popular sandwich spreads applied with a knife used on gluten-containing bread resulted in small amounts of gluten cross-contact.

Study reference:	Weisbrod V.M., Silvester J.A., Raber C., McMahon J., Coburn S.S., Kerzner B. (2020), Preparation of Gluten-Free Foods Alongside Gluten-Containing Food May Not Always Be as Risky for Celiac Patients as Diet Guides Suggest.
Study type:	Experimental/sample analysis study quantifying gluten transfer when GF foods are prepared alongside gluten-containing foods, also assessing the efficacy of cleaning methods for kitchen equipment/utensils.

Study population:	US
Publication date:	2020
Study quality and applicability:	Low **Comment**: There is limited information on the samples and where they came from. The authors point out that cross-contact will inevitably vary in different kitchen environments.
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)
Method:	Three scenarios were developed to assess gluten transfer and efficacy of washing methods during food preparation: cooking pasta, toasting bread, and slicing cupcakes. Samples were individually packaged in plastic bags with randomized sample numbers. Entire items were homogenized for analysis. Gluten content was assayed using an R5 sandwich ELISA (R7001; R-Biopharm, Darmstadt, Germany), which has a limit of detection of 5 ppm gluten by Bia Diagnostics (Colchester, VT). Control samples were also tested. Quantity of gluten for samples was categorized as <5 ppm, 5–10 ppm, 10–20 ppm, or >20 ppm. Confidence intervals are based on binomial distribution.
Findings:	Control samples of GF pasta, bread, and cupcakes all tested below the limit of detection. Gluten was detected in all pasta samples cooked in water used for gluten containing pasta (33.9 ppm to 115.7 ppm). Rinsing pasta under running tap water reduced gluten content to <20 ppm. The 2 samples with detectable gluten had only 5.1 ppm and 17.5 ppm gluten. Rinsing pots with water alone after cooking gluten-containing pasta was as effective as scrubbing with soap and water to prevent detectable gluten transfer. Toasting in a shared toaster was not associated with gluten transfer >20 ppm; the 3 samples with

	detectable gluten had levels ranging only from 5.1 ppm to 8.3 ppm gluten. Although 28 of 30 cupcake samples had detectable gluten transfer, only 2 of 28 tested >20 ppm. All 3 knife-washing methods were effective in removing gluten.
Strengths/ Limitations:	Limitations: small sample size, subsampling of homogenized foods, and use of sandwich rather than competitive enzyme-linked immunosorbent assay, which is able to detect hydrolyzed gluten.
Relevant outcomes:	Findings suggest some risk to consumers during preparation of gluten-free foods from cross-contamination with gulten-containing food.

Study reference:	Añíbarro B., Seoane F.J., Múgica M.V. (2007), Involvement of hidden allergens in food allergic reactions.
Study type:	Retrospective study reviewing of the role of hidden allergens (their importance, the types of food involved, and the severity of reactions) in allergic reactions in our geographical area.
Study population:	Spain
Publication date:	2007
Study quality and applicability:	Very Low **Comment**: Data came from one allergy unit covering a region of Spain, which limits generalisability. Retrospective study – recall bias.
Key themes/ topics:	Cross-contamination in food preparation environments (kitchens)

Method:	Over a five year period, a total of 530 food reactions were reviewed. Diagnosis of food allergy was made following the recommendations of the European Academy of Allergology and Clinical Immunology Nomenclature Task Force. A food reaction was considered as being caused by a hidden allergen when we highly suspected or demonstrated the involvement of foods, flavourings or additives that were not specified on the ingredients label by mistake or omission, or when ingestion went unnoticed due to personal carelessness, misunderstanding, misinformation, or contamination. All patients in whom the cause of the reactions remained unknown were excluded from the study.
Findings:	Of the 530 food allergic reactions analyzed, 119 (22.4%) were considered to be due to hidden allergens. The reactions due to hidden allergens were frequently multiple. The mean number of food reactions was 1.98 per patient. Of all the hidden food allergic reactions reviewed, 45.3% were induced by fish and shellfish due to the presence of Anisakis simplex larvae. Thirty-nine % of the soy-allergic patients had some reaction caused by soy as a hidden allergen. Reactions by hidden fruits were very uncommon (2.8%). Nuts were the second cause (25%) of allergic reactions, acting as hidden allergens in 11 cases (8.4%). The most frequent sources of hidden nuts were chocolates, cookies, pastries and cakes.
Strengths/ Limitations:	Limitations: Undiagnosed cases are a real possibility, so the incidence could be still higher than was found due to difficulty of diagnosis.
Relevant outcomes:	Some reactions are reported due to contamination during food preparation such as storage containers and risks due to cross-contamination during food preparation. Patients with high sensitivity to fruits suffered reactions from unnoticed sources, usually from utensil contamination. Reactions to fish or shellfish occur by ingestion of small quantities of allergens due to container or grill contamination, contaminated oil use or

	by the unexpected inhalation of cooking vapours. One reaction was probably due to contamination by incomplete cleaning of the containers previously used for serving infusions containing honey. The reactions were more frequently the result of contamination or carelessness on the part of the patient than incorrect labelling.

Study reference:	Stephan, O., Weisz, N., Vieths, S., Weiser, T., Rabe, B., & Vatterott, W. (2004). Protein quantification, sandwich ELISA, and real-time PCR used to monitor industrial cleaning procedures for contamination with peanut and celery allergens. Journal of AOAC International, 87(6), pp. 1448–1457.
Study type:	Food sample analysis study evaluating the risk of carryover contaminations and to test the possibility of monitoring a cleaning process with a simple Bradford assay.
Study population:	Germany
Publication date:	2004
Study quality and applicability:	Very Low **Comment**: Low sample size and has errors in methodology which could contaminate results
Key themes/ topics:	Effectiveness of cleaning strategies
Method:	Washing water samples taken after different cleaning steps and follow-up products were analysed for the presence of celery and peanut traces with a celery-specific real-time PCR and a peanut-specific sandwich ELISA. PCR and ELISA were compared with a nonspecific protein assay to evaluate whether the detection

	of protein traces can be a fast and cost-effective method for monitoring the effectiveness of wet cleaning procedures. WCRs with high contents of peanut and celery were processed by the slurry preparation equipment. Samples of the washing water and of the artificial follow-up product were collected from 4 different production processes and was analysed for the presence of peanut or celery by specific methods. Washing water was tested for protein traces by a commercial Bradford assay.
Findings:	1) All washing water samples taken during the prewash procedure were positive by ELISA and by the Bradford assay. The concentration of peanut protein measured by ELISA varied between 98.5 and 1379 g/mL. These results were in good correlation with the protein concentrations measured by the Bradford assay. 2) The washing water samples collected after the alkaline and acidic wash procedure were all negative by both ELISA and Bradford. Surprisingly, one follow-up product (FP 2) was contaminated with 1.1 ppm peanut protein. This contamination could be traced back to an application error during the manufacturing process. 3) In each of the washing water samples from the prewashing procedure we observed protein contaminations ranging from 2.4 to 12.6 g/mL. In all samples taken after the alkaline and acidic cleaning, no protein contaminations were observed. In addition, the follow-up products were tested negative for celery in all cases.
Strengths/ Limitations:	Limitations: application error; cleaning procedures done insufficiently resulting in residues of peanut mush.

Relevant outcomes:	The applied cleaning process was effective, and it is possible to monitor the cleaning process with a simple Bradford assay for total protein.

Study reference:	Størsrud, S., Malmheden Yman, I. & Lenner, R.A. (2003). Gluten contamination in oat products and products naturally free from gluten. Eur Food Res Technol, 217, pp. 481–485.
Study type:	Experimental/sample study analysing oat products and products naturally free from gluten to determine the degree of contamination
Study population:	Sweden
Publication date:	2003
Study quality and applicability:	Low **Comment**: Samples came from grocery stores and health food shops in Sweden, which may limit generalisability to other countries.
Key themes/ topics:	Cross-contamination during food production
Method:	A total of 88 oat products and 22 products based on maize, rice, millet or buckwheat were analysed, using a commercially available ELISA with a monoclonal antibody to gliadin. The ELISA is quantitative with a detection limit of 20 mg/kg gluten. Some of the positive samples were also analysed for the presence of DNA from wheat, barley or rye.

Findings:	13% of the oat products had gluten content over 200 mg/kg. Of the products naturally free from gluten 14% had a gluten content over 200 mg/kg. There was a tendency for higher levels of contamination with increased processing.
Strengths/ Limitations:	None reported
Relevant outcomes:	Contamination can probably occur at several stages, during growth, harvesting and transport as well as during milling and further processing. The more processing, the higher the risk for contamination. There is no guarantee that oat products and products naturally free from gluten do not contain other cereals, which could be harmful for patients with CD.

Study reference:	Blom, W. M., Kruizinga, A. G., Rubingh, C. M., Remington, B. C., Crevel, R., & Houben, G. F. (2017). Assessing food allergy risks from residual peanut protein in highly refined vegetable oil. Food and chemical toxicology: an international journal published for the British Industrial Biological Research Association, 106(Pt A), pp. 306–313
Study type:	Risk assessment study assessing the predicted % of objective allergic reactions associated with residual peanut protein in refined non-peanut vegetable oil used as an ingredient in consumer food products.
Study population:	UK/The Netherlands (European study)

Publication date:	2017
Study quality and applicability:	Low **Comment**: Samples came from commercial batches obtained by FEDIOL, the European Vegetable Oil and Proteinmeal Association, from member companies across Europe.
Key themes/ topics:	Cross-contamination during food production
Method:	Probabilistic risk assessment was applied to several scenarios involving food products made with vegetable oils. Variables considered: a) the estimated production scale of refined peanut oil, b) estimated cross-contact between refined vegetable oils during production, c) the proportion of fat in representative food products and d) the peanut protein concentration in refined peanut oil. Samples of highly refined neutralised, bleached and deodorised (N/RBD) food-grade peanut oil from commercial batches were obtained by FEDIOL, the European Vegetable Oil and Proteinmeal Association, from member companies across Europe.
Findings:	For all products examined the predicted risk of objective allergic reactions in peanut-allergic users of the food products was extremely low. The number of predicted reactions ranged depending on the model from a high of 3 per 1000 eating occasions (Weibull) to no reactions (LogNormal). Significantly, all reactions were predicted for allergen intakes well below the amounts reported for the most sensitive individual described in the clinical literature. We conclude that the health risk from cross-contact between vegetable oils and refined peanut oil is negligible.
Strengths/ Limitations:	None reported

Relevant outcomes:	The predicted number of allergic reactions from residual refined peanut oil in production of foods was extremely low. All reactions were predicted for peanut protein doses well below the eliciting dose of known most sensitive individuals. The health risk from cross-contact between vegetable oils and refined peanut oil is negligible. The authors conclude that the findings would not call for precautionary allergen labelling of the food products containing these oils as an ingredient, applying the VITAL®2.0 Reference Doses as benchmarks.

Study reference:	Röder, M., Ibach, A., Baltruweit, I., Gruyters, H., Janise, A., Suwelack, C., Matissek, R., Vieths, S., & Holzhauser, T. (2008). Pilot plant investigations on cleaning efficiencies to reduce hazelnut cross-contamination in industrial manufacture of cookies. Journal of food protection, 71(11), 2263–2271. https://doi.org/10.4315/0362-028x-71.11.2263
Study type:	Cross-contamination analysis study to investigate effectiveness of different cleaning methods to reduce Hazelnut Cross-Contamination (HNCC) in industrial cookie manufacturing
Study population:	Germany
Publication date:	2008
Study quality and applicability:	Moderate Comment: Done in a pilot plant (pre-commercial plant) so not tested on an industrial scale. However, large samples were collected and analysed (>600).

Key themes/ topics:	Effectiveness of cleaning strategies
Method:	A product change from cookies with 10% hazelnut to cookies without hazelnuts was simulated on pilot plant equipment. The extent of HNCC was analysed by enzyme-linked immunosorbent assay (ELISA) for each production device (kneaders, rotary molder, wire cutting machine, and steel band oven) and various cleaning procedures used between products. This was done repeatedly with both finely ground and roughly chopped hazelnuts. Three different cleaning protocols were performed for the mixers: 1)Manual scraping only 2) Manual scraping plus cleaning with 52uC hot water 3) Manual scraping plus cleaning with 52uC hot water andexcessive final rinse with hot water After kneading, samples of approximately 120 g were drawn from the spiral kneader 5 times and from the z-kneader 10 times from different areas of the kneader bowls. HNP for standard preparation was quantified with a commercial Bradford protein assay and the HNP-specific sandwich ELISA was performed after each test.
Findings:	The highest HNCC was found after mechanical scraping: Up to 100 mg/kg hazelnut protein was found in the follow-up product after processing. After additional cleaning with hot water, the HNCC decreased regardless of the processing device to levels at or below 1 mg/kg hazelnut protein. The application of an appropriate wet cleaning procedure (manual scraping plus cleaning with 53 degrees Celsius hot water) in combination with quantitative monitoring of the cleaning efficiency reduced the

	hazelnut protein cross-contamination to a level at which severe hazelnut-related allergic reactions are unlikely to occur.
Strengths/ Limitations:	None reported
Relevant outcomes:	Hazelnut cross-contamination due to shared production equipment can cause severe reactions but this risk can be reduced with wet cleaning and quantitative monitoring of cleaning efficiency.

Study reference:	Kiyota, K, Sakata, J, Satsuki-Murakami, T, et al. (2018). Evaluation of cleaning methods for residual orange extract on different cookware materials using ELISA with profilin allergen indicator. J Food Process Eng, 41:e12652. https://doi.org/10.1111/jfpe.12652
Study type:	Cross-contamination analysis study to evaluate different cleaning methods for residual orange extract using ELISA
Study population:	Japan
Publication date:	2018
Study quality and applicability:	Moderate **Comment**: Not tested in an industrial scale. Does not talk about sample size of orange extracts used. However, does not appear to have issues in methodology.
Key themes/ topics:	Effectiveness of cleaning strategies

Method:	Developed a novel enzyme-linked immunosorbent assay system using a rabbit polyclonal antibody against a recombinant orange profilin allergen. Using this assay system with a limit of quantification of 2,500 mg/mL,residual orange extract on the cookware surfaces was measured using swabbing tests. Cleaning methods tested was rinse alone and foam and rinse, with no treatment used as control
Findings:	Rinsing with 1 L of water showed a >95% removal efficiency for stainless steel and glass cookware, whereas half the PP and wood cookware required scrubbing with a detergent-containing sponge for complete cleanliness.
Strengths/ Limitations:	None reported
Relevant outcomes:	Wet cleaning methods need to be used and different materials may require different cleaning methods.

4. COMMUNICATING RISK, SO THAT CONSUMERS WITH FHS CAN BE CONFIDENT THAT THE FOOD THEY ARE PROVIDED IS SAFE

Study reference:	Wen, H., Kwon, J. (2016). Food Allergy Risk Communication in Restaurants. Food Protection Trends, 36(5), pp. 372-383.
Study type:	Qualitative study to identify restaurant managers' risk perceptions and operational issues related to communications about food allergy risks
Study population:	U.S.
Publication date:	2016

Study quality and applicability:	Very Low **Comment**: Possible bias in recruitment as participants were offered a $20 gift card as a token of appreciation. Use of self-report measures, which is less robust. Very small sample size and only based on full-service restaursnts, which limits generalisability and lowers accuracy of results.
Key themes/ topics:	Recommendations for improving communication of risk by FBOs
Method:	16 managers from different full-service restaurants were recruited through purposive sampling to recruit managers from different types of restaurants, (chain-operated and independently-owned restaurants). Interview questions were based on mental model interview guidelines and conducted over the phone. Transcripts were analysed using thematic analysis.
Findings:	Most participants (n = 10) were aware of the severity of food allergy reactions and the importance of avoiding cross-contacts in restaurants as a means of preventing food allergy reactions. Although risk communication is important to prevent allergic reactions, some participants (n = 5) perceived that customers bore more responsibility than servers when communicating allergen-free requests. Managers provided little training to service staff on food allergies and risk communication, with some thinking this type of training has low significance in restaurants.
Strengths/ Limitations:	Limitations: The convenience sampling and the small number of participants limit the generalizability of this study. Self-reported food allergy risk perceptions and risk communication-related procedures and protocols may have been affected by the social desirability bias.
Relevant outcomes:	Findings highlight gap in awareness of risk communication and absence of two-way communication between servers and customers

Study reference:	Begen FM, Barnett J, Payne R, Roy D, Gowland MH, Lucas JS (2016) Consumer Preferences for Written and Oral Information about Allergens When Eating Out. PLoS ONE, 11(5).
Study type:	Qualitative study to explore the allergen-related information delivery preferences of FA/FI populations when eating out or ordering takeaway foods.
Study population:	UK
Publication date:	2016
Study quality and applicability:	Very Low **Comment**: Self-reported data (especially on FA/FI status) which could have multiple biases and qualitative analysis which is subjective in nature. Small sample size which limits generalisability and lowers accuracy of results.
Key themes/ topics:	Preferences of consumers/FBOs in communicating risk to consumers with FHs.
Method:	In depth semi-structured interviews with 60 adults reporting FA/FI, and 15 parents/carers of children aged up to 17 years with FA/FI. Questions were on food allergen information resources and preferences
Findings:	Participants described written food allergen information resources in terms of day to day ‘use’, the ‘adequacy’ of the information, and ‘preferences’ for information provision. Participants preferred FBOs to communicate allergen risk through written information but also valued staff use of simple, proactive face to face strategies to make enquiries and reassure customers.

Strengths/ Limitations:	Strengths: Insights gained through the in-depth analysis of FA/FIs information preferences when eating out Limitations: Self-reported measures were used to assess FA/FI status. Unable to account for the impact of demographic factors such as sex, age and region of residence within the UK.
Relevant outcomes:	Preference of customers on food allergen information from FBOs

Study reference:	Wen, H., Lee, Y. M. (2019). Effects of message framing on food allergy communication: A cross-sectional study of restaurant customers with food allergies. International Journal of Hospitality Management.
Study type:	Cross-sectional study to compare the persuasiveness of gain-framed and loss-framed messages in encouraging food allergy communication
Study population:	U.S.
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Small sample size and only based in full-service restaurants, which could limit generalisability.
Key themes/ topics:	Preferences of consumers/FBOs in communicating risk to consumers with FHs.

Method:	Participants were customers with food allergies in U.S. full-service restaurants over the age of 18 with food allergies, recruited through an online crowdsourcing platform in the U.S. In total, 291 valid responses were collected. The online survey collected data on: demographic characteristics, perceptions of the risks involved in dining out at restaurants, perceptions of different types (i.e., gain-framed and loss-framed) of food allergy messages on restaurant menus and perceived effectiveness of different types of food allergy communication strategies using a 7-point Likert scale from 1 being “very ineffective” to 7 being “very effective”.
Findings:	Approximately 70% of participants had experienced food allergy reactions in restaurants, but less than 15% of them could always communicate with restaurant employees before placing food orders. Overall, participants perceived dining out as somehow risky. The results showed that customers’ attitudes toward the gain-framed messages were more positive compared to their attitudes toward the loss-framed message, as they perceived the gain-framed message more useful, good, pleasant, and wiser. Fear, attitudes toward the messages, the perceived effectiveness of the messages, and the severity of one’s food allergies were significant predictors of customers’ intentions to communicate.
Strengths/ Limitations:	Limitations: Participants were recruited by a market research company; thus only respondents whose contact information already existed in the company’s database were included. The study examined only self-reported data, which may be affected by the social desirability bias. Indirect as behavioural intentions could be different from actual communication behaviour. Study only based in full-service restaurants, which could limit generalisability.
Relevant outcomes:	Findings highlight communication preferences of consumers in restaurants

Study reference:	Wen, H., & Kwon, J. (2019) Food allergy information sharing and communication strategies in full-service restaurants in the U.S. Journal of Foodservice Business Research, 22(1), pp. 50-65.
Study type:	Cross-sectional study to explore how restaurant staff shares food allergy information with and communicate risks to customers with food allergies.
Study population:	U.S.
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Small sample size and only based in full-service restaurants, which could limit generalisability.
Key themes/ topics:	Preferences of consumers/FBOs in communicating risk to consumers with FHs.
Method:	The target population of this study was restaurant servers employed in full-service restaurants in the U.S. Participants were recruited via a professional online survey company through their online restaurant server panels. 316 usable survey responses were included in the final data analyses. Participants were asked first to indicate which communication strategies were used in the restaurant where they were currently employed and then to rate the effectiveness of each strategy listed.
Findings:	Nearly half of the respondents (n = 155, 49.1%) indicated that their restaurants' menus had listed all or most of the food ingredients in each menu item. 169 respondents (53.5%) reported that their employers did not provide any information related to food allergens on their menus. 116 participants (36.7%) reported that their restaurants' menus included a statement or disclaimer about food allergies and provided these

	statements on the questionnaire. Even though servers perceived the written protocol as the third most effective communication strategy, only 81 (25.6%) participants indicated that their restaurants have a written protocol in place.
Strengths/ Limitations:	Limitations: The self-reported responses may have been influenced by a social desirability bias. The % of participants with food allergies was higher than the national data so may not be representative of the restaurant employee population.
Relevant outcomes:	Participants perceived the 3 most effective communication strategies as: informing customers when the food preparer is unable to provide allergen-free meals, including a statement on the menu to advise customers to notify the server if anyone has a food allergy, and having a written protocol with standard procedures for serving customers with food allergies in place.

Study reference:	Begen, F. M., Barnett, J., Payne, R., Gowland, M. H., DunnGalvin, A., & Lucas, J. S. (2018). Eating out with a food allergy in the UK: Change in the eating out practices of consumers with food allergy following introduction of allergen information legislation. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology, 48(3), pp. 317–324.
Study type:	Mixed methods study to investigate the impact of EU Food Information to Consumers legislation on the behaviours, experiences and attitudes of consumers with food allergy when eating out.
Study population:	UK
Publication date:	2018

Study quality and applicability:	Very Low **Comment**: Study based on self-reported data (especially diagnosis of FA/FI) which is subject to different biases and is usually not as robust. Small sample size, which could limit generalisability and lower accuracy of results.
Key themes/ topics:	Preferences of consumers/FBOs in communicating risk to consumers with FHs.
Method:	Participants were recruited from across the UK. In-depth interviews were carried out with 28 participants pre and post legislation and analysed using the framework approach. Self-reported surveys were completed by 129 participants pre and post legislation, and responses were subject to quantitative analyses.
Findings:	Improvements in allergen information provision and raised awareness of food allergy in eating out venues were reported following introduction of EU FIC. Whilst participants favoured written allergen information, they expressed greater confidence in communicating with eating out staff and in trusting the allergen information that they provided. Improvements were judged to be gradual, sporadic or inconsistent in implementation.
Strengths/ Limitations:	Strength: Self-reporting FA status allowed capture of the variety of eating out experiences across the spectrum of food allergy severity and diagnostic certainty Limitations: Participants self-reported their food allergy status, and a minority were self-diagnosed, risking over-reporting of food allergy. It was not possible to account for differences between those who eat out and order takeaway and individuals with food allergy who never eat out. Attrition rates in this study were relatively high (67%) as is the case in many longitudinal studies. Cannot rule out the possibility of bias in returning sample.

Relevant outcomes:	Whilst participants continued to favour written allergen information, they expressed greater confidence in communicating with eating out staff and in trusting the allergen information that they provided.

Study reference:	Abbot, J. M., Byrd-Bredbenner, C., & Grasso, D. (2007). “Know before You Serve”: Developing a Food-Allergy Fact Sheet. Cornell Hotel and Restaurant Administration Quarterly, 48(3), pp. 274–283.
Study type:	Qualitative study to examine the information and communication challenges regarding food allergens- including knowing what foods cause the most trouble and how to avoid cross-contamination and to create a fact sheet that depicts the suspect foods and explains specifically how to avoid triggering food allergies in guests.
Study population:	U.S.
Publication date:	2007
Study quality and applicability:	Very Low **Comment**: Small sample size of panel, baseline interviews, and focus groups. Self-reported data which is less likely to be robust. Data is qualitative, which may be subjective in nature. Findings may not be generalisable beyond New Jersey/the U.S.
Key themes/ topics:	Recommendations for improving communication of risk by FBOs
Method:	An advisory panel of 25 people was established to guide the development of the fact sheet and ensure that it was complete, accurate, and appropriate to the target audience's needs. The development of the

	fact sheet followed a five stage process: Review of existing literature, Baseline interviews and focus groups (28 interviews and 3 focus groups), as well as the input from the advisory panel and included questions on how food-service personnel prefer food-allergy messages to be delivered, including format (e.g., posters, electronic means), layout (e.g., size, graphics), tone (i.e., positive or negative), and language.
Findings:	The advisory panel proposed that the fact sheets should do the following: (1) convey the seriousness of food allergies; (2) provide step-by-step food-handling instructions on how to prevent a food allergic reaction; and (3) educate food-service employees never to guess whether a food is safe for a customer, but instead to ascertain the ingredients and preparation. The panel recommended that the fact sheet contain pictures, symbols, or graphs to help convey the messages and be written in both English and Spanish. Important messages for food-service employees about preventing triggering food allergic reactions include: listen carefully to customer requests, honor customer requests, symptoms of an allergic reaction, what to do in case of an emergency. The advisory group preferred the design with ease of readability and visually highlighted steps. They thought it essential to add the symptoms of a food allergic reaction, wanted photos where food was easy to identify with enough examples of common foods that contained the allergen.
Strengths/ Limitations:	None reported
Relevant outcomes:	Development of fact sheets that are bilingual, have symbols, and are readable.

Study reference:	Pratten J.D., Towers N. (2004), Food allergies and the UK catering industry: A study of the training needs for the industry to serve those with food allergies. Journal of European Industrial Training, 28(6).
Study type:	Mixed methods study to investigate how well the hospitality industry can cope with special dietary requests.
Study population:	U.K.
Publication date:	2004
Study quality and applicability:	Very Low **Comment**: Small sample size. Self-reported data which is less likely to be robust. Data is qualitative, which may be subjective in nature. Findings may not be generalisable beyond the small market town and holiday resorts the study is based in. No details are given of how the data were analysed. No quotes are given as evidence.
Key themes/ topics:	Factors influencing effectiveness of FBOs' risk information/communication with consumers who have FHs.
Method:	Proprietors of two restaurants and the licensees of 35 public houses in a small market town in the North West of England took part in structured interviews. Interview questions covered: the sort of food which the outlet served, how the licensee viewed the importance of food to the overall trade of the establishment, the knowledge of the proprietor relating to allergies, attitudes to customers requesting special diets, the process of passing on the request from the customer to the cook and the ability of the chef to provide the meal considered. A second, more limited survey was undertaken in a north-eastern seaside holiday resort. The interviewer observed the interaction between the customers and the staff, and then posed questions of the waiting staff.

Findings:	Only two of those interviewed recognised the term “coeliac”, but more understood “gluten free” and more knew the potential harm of nuts, but few were fully aware of the extent of allergic reactions. Many felt that it was up to the customer to make their demands totally clear. In the second survey, participants were clearly accustomed to dealing with special needs, and staff clearly passed these on accurately, with appropriate food being served. A key problem that emerged was the system of communication. Customers placed their orders with waiting or bar staff, and so it was vital that they then reported the requests accurately to the kitchens.
Strengths/ Limitations:	Limitations: Small sample size, restaurants could be used to serving customers with FHs. Cities and rural areas not considered.
Relevant outcomes:	Communication between serving staff and kitchen staff is vital

Study reference:	Barnett, J., Leftwich, J., Muncer, K., Grimshaw, K., Shepherd, R., Raats, M. M., Gowland, M. H., & Lucas, J. S. (2011). How do peanut and nut-allergic consumers use information on the packaging to avoid allergens?. Allergy, 66(7), pp. 969–978.
Study type:	Qualitative study to understand the complex risk assessment decisions made by peanut and nut-allergic adults when purchasing food, with particular reference to use of printed package information.
Study population:	U.K.
Publication date:	2011

Study quality and applicability:	Very Low **Comment**: Extremely small sample size, which could limit generalisability and lower accuracy of results. Self-reported data which is less likely to be robust. Data is qualitative, which may be subjective in nature.
Key themes/ topics:	Factors influencing effectiveness of FBOs' risk information/communication with consumers who have FHs.
Method:	32 participants took part who were 16 years or older and had a clinical history compatible with IgE-mediated reactions to peanuts or tree nuts. Their behaviour and 'thinking aloud' were recorded during their normal food shop, followed by a semi-structured interview. Participants were asked whether they would eat each food, with particular reference to their allergy. They were given 13 potentially problematic packaged foods, and asked if they would purchase the product and what their reasons were.
Findings:	Some participants used the ingredients list as their primary check for allergens, but most used the allergy advice box. Package-based information was generally considered reliable, but some supermarket and brand labels were trusted more than others. Images and product names were used to draw inferences about the presence of nuts. A number of improvements were suggested by participants, particularly a request for more 'nut free' labelling.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight how customers food shop and their attitudes towards printed package information

Study reference:	Verstappen, J., Mirosa, M., & Thomson, C. (2018). Using the Systems-Practice Framework to Understand Food Allergen Management Practices at College Catering Operations: A Qualitative Study. Journal of the Academy of Nutrition and Dietetics, 118(3), pp. 421–430.
Study type:	Qualitative study to examine the factors affecting allergen management practices, particularly pertaining to college foodservices.
Study population:	New Zealand
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Extremely small sample size, which could limit generalisability and lower accuracy of results. Self-reported data which is less likely to be robust. Data is qualitative, which may be subjective in nature. May not be generalisable beyond college catering operations.
Key themes/ topics:	Factors influencing effectiveness of FBOs' risk information/communication with consumers who have FHs.
Method:	The study used an ethnographic approach and systems-practice theory as a framework for data collection and organizing results. Data collection techniques included document analyses, observations focus groups with foodservice workers, and interviews with foodservice managers (n=21).
Findings:	Factors which influence the effectiveness of communication of risk from the perspective of food service managers and staff include: communication from residents and hall management, the availability and friendliness of foodservice staff and the ease of the colleges' systems, college size and residents' attitudes and the level of responsibility they took for their special dietary requirements..

Strengths/ Limitations:	Limitations: This research was only conducted in three colleges, overseen by one catering company, and at one location in New Zealand, so results cannot be generalized. Research only looked at the food service management and staff's point of view. Research used a qualitative method and ethnographic approach.
Relevant outcomes:	Effective risk communication of food allergies from catering operations

5. ALLERGEN LABELLING, INCLUDING PRECAUTIONARY ALLERGEN ("MAY CONTAIN") LABELS

Study reference:	Allen, K. J., Remington, B. C., Baumert, J. L., Crevel, R. W., Houben, G. F., Brooke-Taylor, S., Kruizinga, A. G., & Taylor, S. L. (2014). Allergen reference doses for precautionary labeling (VITAL 2.0): clinical implications. The Journal of allergy and clinical immunology, 133(1), pp. 156–164.
Study type:	Database study aimed to establish reference doses for 11 commonly allergenic foods to guide a rational approach by manufacturers based on all publicly available valid oral food challenge data
Study population:	Worldwide
Publication date:	2014
Study quality and applicability:	Low **Comment**: Secondary data used but allergy diagnosis is confirmed with oral food challenge. However, gold standard of DBPCFC is not used.

Key themes/ topics:	Effectiveness of PAL statements
Method:	Reference doses were developed from statistical dose distribution modelling of individual thresholds of patients in a dataset of more than 55 studies of clinical oral food challenges. Sufficient valid data were available for peanut, milk, egg, and hazelnut to allow assessment of the representativeness of the data used.
Findings:	The data were not significantly affected by the heterogeneity of the study methodology, including little effect of age on results for those foods for which sufficient numbers of adult challenge data were available (peanut and hazelnut). Thus, by combining data from all studies, the eliciting dose for an allergic reaction in 1% of the population estimated for the following were 0.2 mg of protein for peanut, 0.1 mg for cow's milk, 0.03 mg for egg, and 0.1 mg for hazelnut.
Strengths/ Limitations:	Limitation: Derived reference doses are based on controlled clinical challenge trials that might differ in several important respects from community exposures experienced by patients with food allergy.
Relevant outcomes:	Findings will enable manufacturers to apply credible precautionary labelling and provide increased consumer confidence in their validity and reliability

Study reference:	Remington, B. C., Baumert, J. L., Blom, W. M., Houben, G. F., Taylor, S. L., & Kruizinga, A. G. (2015). Unintended allergens in precautionary labelled and unlabelled products pose significant risks to UK allergic consumers. Allergy, 70(7), pp. 813–819.

Study type:	Risk assessment study investigating the risk of an allergic reaction within the milk-, wheat-, hazelnut- and peanut-allergic populations when ingesting UK foods across multiple product categories with and without precautionary allergen labelling.
Study population:	UK
Publication date:	2015
Study quality and applicability:	Low **Comment**: Not an experimental study so automatically graded as 'low'. Not graded down due to low risk of bias.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Allergen risk assessment using probabilistic techniques (ELISA) which enable the estimation of the residual risk after the consumption of a product that unintentionally contains an allergen. This is used to analyse product categories with and without PAL.
Findings:	Within this selection of UK products, the majority that tested positive for an allergen contained a concentration of allergen predicted to cause a reaction in >1% of the allergic population. The concentrations of allergens measured were greater than the VITAL 2.0 action levels and would trigger precautionary allergen labelling. This was found for products both with and without precautionary allergen labelling.
Strengths/ Limitations:	None reported

Relevant outcomes:	The need for the food industry and regulators to adopt a transparent, risk-based approach, such as VITAL, for the communication of the risk associated with potential cross-contact that could occur in the processing facility or production chain.

Study reference:	Blom, W.M., van Dijk, L.M., Michelsen-Huisman, A., Houben, G.F., Knulst, A.C., Linders, Y.F.M., Verhoeckx, K.C.M., Holleman, B.C. and Lentz, L.R. (2021), Allergen labelling: Current practice and improvement from a communication perspective. Clin Exp Allergy, p. 1-11.
Study type:	Mixed methods evaluation study that analyses current status of communicating allergen information on food labels and provides practical recommendations for improving the label format based on communication theory.
Study population:	Netherlands
Publication date:	2021
Study quality and applicability:	Very Low **Comment**: Qualitative techniques are subjective in nature and may be less robust. Sample sizes are also small and only based on three retailers in Netherlands, which might limit generalisability.
Key themes/ topics:	Improving existing allergen labelling practices for more effective communication
Method:	Product labels (n = 288) of seven food categories from private label products and brands were obtained at three retailers in the Netherlands. Information regarding the 14 EU-regulated allergens was evaluated by

	the frequency of emphasizing allergens in the ingredient list, use of precautionary allergen labelling (PAL), icons and an allergen information section. Effectiveness of communication was assessed evaluating readability and findability of information on allergens using principles of Gestalt and Cognitive Load theories.
Findings:	A separate allergen information section was present on most private label products. This section could, but not necessarily did, repeat allergens from the ingredient list and/or give a PAL. Brands often provided a PAL at the end of the ingredient list. Part of the products displayed an icon at different locations of the label. Label background, a lack of cohesion and variation in location of topics hamper the identification of relevant information on allergens by (allergic) consumers.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight effective methods of PAL

Study reference:	Noimark, L., Gardner, J., & Warner, J. O. (2009). Parents' attitudes when purchasing products for children with nut allergy: a UK perspective. Pediatric allergy and immunology: official publication of the European Society of Pediatric Allergy and Immunology, 20(5), pp. 500–504.
Study type:	Cross-sectional study aiming to understand and quantify the attitudes of parents of children with nut allergy towards labels informing that the product could contain nuts.
Study population:	UK

Publication date:	2009
Study quality and applicability:	Very Low **Comment**: Small sample size and participants are from the same clinic in London, which could have low generalisability. Self-reported data means there is potential for several biases. SPT used to confirm allergies but not DBPCFC or oral food challenge.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Anonymous questionnaire distributed to (n = 184) parents of children with nut allergies to assess attitude on allergen labelling. Diagnosed nut allergy used [previous reaction to a peanut/tree nut or/ with a positive peanut/tree nut skin prick test (SPT) equal to or larger than a 10% histamine control].
Findings:	Findings show 80% of parents would not purchase a product labelled 'not suitable for nut allergy sufferers' or 'may contain nuts'. However, other labels including 'this product does not contain any nuts but is made in a factory that uses nuts', 'cannot guarantee is nut free' and 'may contain traces of nuts' were avoided by only around 50% of parents
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight attitudes of parents of children with FHs towards labelling

Study reference:	Voordouw, J., Cornelisse-Vermaat, J.R., Yiakoumaki, V., Theodoridis, G., Chryssochoidis, G., & Frewer, L.J. (2009). Food allergic consumers' preferences for labelling practices: a qualitative study in a real shopping environment. International Journal of Consumer Studies, 33, pp. 94-102.
Study type:	Mixed methods study investigating whether information provided through current labelling practices meets the need of food allergic consumers.
Study population:	Europe
Publication date:	2009
Study quality and applicability:	Very Low **Comment**: Not clear how questionnaires were analysed. Extremely small sample, which could limit generalisability. Subjective analysis for the qualitative section.
Key themes/ topics:	Symbols as an effective way to communicate allergens on food labelling; Improving existing allergen labelling practices for more effective communication
Method:	A total of 40 participants (20 adult food allergy suffers and 20 parents of food allergic children) from Greece and Netherlands. Purchasing behaviour of participants were observed. Interviews and questionnaires were then conducted on their attitudes towards allergen labelling
Findings:	1. Both Greek and Dutch consumers favoured symbolic labelling of allergens.

	2. It was reported that inappropriate use of fonts, colours and languages, application of precautionary labelling and lack of harmonization in labelling practices across countries can cause (un)necessary dietary restrictions for food allergic consumers.
Strengths/ Limitations:	None reported
Relevant outcomes:	Amendments in food policies need to be made at a European level

Study reference:	Zurzolo, G. A., Mathai, M. L., Koplin, J. J., & Allen, K. J. (2013). Precautionary allergen labelling following new labelling practice in Australia. Journal of paediatrics and child health, 49(4), pp. 306–310.
Study type:	Cross-sectional study to assess prevalence and types of precautionary labelling statements for common food allergens and investigate uptake of the Voluntary Incidental Trace Allergen Labelling (VITAL - a risk management tool to assist with declaring possible presence of allergens in food)
Study population:	Australia
Publication date:	2013
Study quality and applicability:	Very Low **Comment**: All products from only one supermarket. Indirect as does not assess effectiveness of "may contain…" statements, only reports on the prevalence.

Key themes/ topics:	Effectiveness of PAL statements
Method:	Examined n = 1355 packed processed goods in a large supermarket for precautionary labelling between May & July 2011
Findings:	Overall, 882 products (65%) had a precautionary statement for one or more allergens. The most common allergens listed on precautionary statements were tree nuts (36.2%) and peanuts (34.1%), followed by sesame (27.5%) and egg(22.6%). Of those that had precautionary statements, 'May contain traces of . . .' was the most common type of precautionary label used on 392 products (29.0%). This was followed by 'May be present' (VITAL) on 172 products (12.7%).
Strengths/ Limitations:	Strengths: Large sample size and detailed assessment of precautionary labelling for both allergens listed and type of precautionary statement used. All brands were examined in equal proportion.
Relevant outcomes:	High used of precautionary labelling for peanut, tree nuts, and eggs. Low uptake of VITAL statement but has increased since 2009.

Study reference:	Food and Drug Administration (2005). Food Labeling; Gluten-Free Labeling of Foods
Study type:	Evaluation study by the FDA on gluten-free labelling
Study population:	USA
Publication date:	2005

Study quality and applicability:	Very Low **Comment**: Not an experimental study and analysis based on secondary data.
Key themes/ topics:	Effective communication of allergen information requires educating the consumer
Method:	Used cost/benefit analysis and regulatory analysis to evaluate gluten dose threshold on gluten-free labelling
Findings:	No exceptions should be made in terms of excluding products that contain gluten with more than 20 ppm produced by the small entities from the shelves as this would jeopardise trust in "gluten-free" labels.
Strengths/ Limitations:	None reported
Relevant outcomes:	Labelling legislation and recommendations for gluten-free labelling

Study reference:	Thompson, T., Lyons, T. B., & Jones, A. (2016). Allergen advisory statements for wheat: do they help US consumers with celiac disease make safe food choices?. European journal of clinical nutrition, 70(12), pp. 1341–1347.
Study type:	Retrospective database study to build upon research by reviewing the labelling claims and testing data of products not labelled gluten-free but appearing to be free of gluten-containing ingredients.
Study population:	U.S.

Publication date:	2016
Study quality and applicability:	Very Low **Comment**: There is risk of sampling bias and lack of understanding where contamination happens. Small sample size of products tested.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Labelling information was compiled for 101 products tested for gluten content was retrospectively reviewed for an allergen advisory statement for wheat, gluten or both. Products reviewed for this analysis were not labelled gluten-free but appeared to be free of gluten containing ingredients based on a review of the ingredients list (that is, no wheat, barley, rye, malt, brewers yeast).
Findings:	Overall, 87/101 (86%) products tested for gluten did not include an allergen advisory statement for wheat or gluten on product packaging. Of the 87 products that did not include an advisory statement, 13 (15%) contained quantifiable gluten at or above 5 p.p.m., including 4 (5%) products that tested at or above 20 p.p.m. of gluten. Of the 14 products that did include an advisory statement, only 1 (7%) contained quantifiable gluten at or above 5 p.p.m. (this product contained at or above 20 p.p.m. of gluten).
Strengths/ Limitations:	Limitations: Only tested on 101 food products, small sample size. It is not possible to determine from this study where in the food production line products became contaminated.
Relevant outcomes:	Precautionary statements should be regulated and standardized so that they are helpful to the consumer.

Study reference:	Voordouw J., Cornelisse-Vermaat J.R., Pfaff S., Antonides G., Niemietz D., Linardakis M., Kehagia O., Frewer L.J. / 2011 / Preferred information strategies for food allergic consumers. A study in Germany, Greece, and The Netherlands.
Study type:	Cross-sectional study aiming to examine the preferences of food labelling among allergic consumers.
Study population:	Europe
Publication date:	2011
Study quality and applicability:	Very low **Comments**: self-reported allergy.
Key themes/ topics:	Symbols as an effective way to communicate allergens on food labelling;
Method:	Questionnaire; linear model; conjoint analysis **Sample size:** n=287
Findings:	Most respondents prefer: 1) a label containing a box with standardised food allergy information; 2) universally recognised symbol at the back and front of the package that would indicate the allergens; 3) labels should indicate percentages of the allergens present in the food; details regarding allergy management in the food chain; 4) eye-catching box located in a standard place on the label; 5) a hotline (phone number) over website address on the label. 6) if only front or back labelling needs to be chosen, prioritise the front allergy labelling. Recommendations for improvement:

	1) mandatory safety warning for allergy ingredients with no exceptions for the size of the product or secondary packaging; 2) adoption of ICT approach can solve the problem of languages. However, pan-European application will incur significant costs to the food industry as standardisation of traceability would be requires across the retail industry.
Strengths/ Limitations:	**Limitations:** 1) demographic data did not allow to separate self and physician diagnosed food allergy or to identify families with multiple members who suffer from food allergies; 2) samplings are not nationally representative; 3) participant selection bias; 4) relatively small sample.
Relevant outcomes:	Universally recognised symbols can be used to indicate allergens. ICT methods can only serve as supplementary information to support food labelling. Food labelling needs to be improved according to the recommendations provided.

Study reference:	Sheth S.S., Waserman S., Kagan R., Alizadehfar R., Primeau M.-N., Elliot S., St. Pierre Y., Wickett R., Joseph L., Harada L., Dufresne C., Allen M., Allen M., Godefroy S.B., Clarke A.E. / 2010 / Role of food labels in accidental exposures in food-allergic individuals in Canada
Study type:	Retrospective survey study aiming to examine risk factors of accidental allergen exposures (including inappropriate labelling by manufacturer, ignoring precautionary statements, etc.)
Study population:	Canada
Publication date:	2010

Study quality and applicability:	Very low **Comments**: this retrospective study has potential recall and attribution bias; participants are more educated about allergen labelling than general population.
Key themes/ topics:	Effective communication of allergen information requires educating the consumer
Method:	Questionnaire; multivariate logistic regression models. **Sample size:** n=1454
Findings:	1. 47% of consumers with food allergies attributed at least one allergen exposure due to manufacturer error.
Strengths/ Limitations:	**Limitations**: no verification of manufacturer error.
Relevant outcomes:	As a significant proportion of allergen exposures is due to manufacturer error there is a need for improved labelling practices across the world. Clear and consistent labelling in pre-packaged foods should increase consumers' confidence and food choices and decrease risk of accidental exposure, which, however, can not be avoided solely by enhancing labelling practices. Consumers should also be educated regarding labelling and how to read allergen information correctly.

Study reference:	Dostálek P., Gabrovská D., Rysová J., Mena M.C., Hernando A., Méndez E., Chmelík J., Šalplachta J. / 2009 / Determination of gluten in glucose syrups

Study type:	Food sampling study evaluating whether glycose syrup is dangerous for consumers with celiac disease.
Study population:	Europe
Publication date:	2009
Study quality and applicability:	Low **Comments**: ELISA methods were used in conjunction with MALDI-TOF mass spectrometer and SDS-PAGE to double check the results; selection bias of products.
Key themes/ topics:	Specific allergens and their effective communication
Method:	Food sampling (20 syrup samples); using ELISA kits do determine gluten.
Findings:	Patients with celiac disease do not have to avoid foods that contain glycose syrups.
Strengths/ Limitations:	None reported
Relevant outcomes:	Some food producers state the presence of wheat on the food label whenever glycose syrup based on wheat is present. However, according to Directive 2005/26/EC, wheat starch-based glycose syrups are exempted from labelling requirement. As a result, consumers with celiac disease may be needlessly avoiding such foods as glycose syrup does not pose any health risks if produced according to food and safety norms.

Study reference:	Verrill L., Choiniere C.J. / 2009 / Are food allergen advisory statements really warnings? Variation in consumer preferences and consumption decisions
Study type:	Control-case study determining consumer preferences for allergy statements; comparing these statements and their efficacy by measuring its impact on consumers' decision-making.
Study population:	USA
Publication date:	2009
Study quality and applicability:	Low **Comments:** recall bias; some participants had to be excluded later in the process of study.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Food experiment (2 foods with 4 different statements on allergy). Questionnaire to assess these statements. **Sample size:** n = 1,243 (survey); n = 4,049 (experiment).
Findings:	Food allergic individuals, including caregivers to food allergic individuals, and a control group of nonallergic people preferred “Allergen Information: May Contain …” over three other statements tested. Wording of the allergy statements will be perceived by consumers in a certain way which will affect their consumption decisions.

Strengths/ Limitations:	**Limitations:** focus on peanut allergy which can be perceived as high risk by more people than any other allergy; individuals with severe anaphylaxis may be underrepresented; some participants had to be excluded later in the process of study.
Relevant outcomes:	Consumers prefer "Allergy Information: may contain peanut" over the other options such as "may contain peanuts"; "manufactured on the same equipment as food that contain peanut"; "produced in a facility with an allergy control plan. May still contain trace amounts of peanuts".

Study reference:	Cornelisse-Vermaat J.R., Voordouw J., Yiakoumaki V., Theodoridis G., Frewer L.J. / 2008 / Food-allergic consumers' labelling preferences: A cross-cultural comparison
Study type:	Observational study evaluating whether labelling practices are perceived as adequate by consumers with allergies and whether any policy changes are required to increase safety.
Study population:	Europe
Publication date:	2008
Study quality and applicability:	Very low **Comments**: study provides indirect findings and the sample is very low; self-reported allergy.
Key themes/ topics:	Improving existing allergen labelling practices for more effective communication Using ICT’s in allergen labelling

Method:	Observation of participants during food selection, then qualitative interviews. Study design developed in conjunction with food dietician. **Sample size**: n=40
Findings:	1) Greek participants would welcome more allergen labelling. 2) Dutch participants indicated problems associated with ever-changing recipes. 3) The constant assortments on Greek shelves reduce shopping time for Greek participants with food allergies relative to that spent by the Dutch. In turn, Dutch consumers with food allergies may be more risk averse.
Strengths/ Limitations:	None reported
Relevant outcomes:	There's a need for: 1) Threshold for minimal font sizes and minimal contrasts of information presented on the packaging. New ICT technologies, like barcoding. 2) Standard location for allergen information is needed (i.e. above the ingredient list). 3) There is a need for universally recognisable symbols that will indicate inclusion/exclusion of certain problematic ingredients. 4) This study indicates that differences in labelling preferences between Greece and Netherlands are minimal, as such, pan-European labelling policies are feasible.

Study reference:	Cochrane S.A., Gowland M.H., Sheffield D., Crevel R.W.R. / 2013 / Characteristics and purchasing behaviours of food-allergic consumers and those who buy food for them in Great Britain
Study type:	Cross-sectional study aiming to explore characteristics and buying behaviour of customers with food allergies in the UK.
Study population:	UK
Publication date:	2013
Study quality and applicability:	Low **Comments:** self-reported allergies; indirectness; recall bias (chances of incorrect attribution of accidental exposure to an external factor (i.e. manufacturer) rather than incorrect reading of the label by the customers themselves); selection bias (most participants are educated regarding food allergen labelling as they're members of food organisations. This limits representation of wider population with general or no knowledge)
Key themes/ topics:	Improving existing allergen labelling practices for more effective communication
Method:	Survey and statistical analysis (chi-squared tests) **Sample size:** n=1000
Findings:	One third of the respondents read allergen labelling on every occasion.

Strengths/ Limitations:	None reported
Relevant outcomes:	As customers with food allergies fail to read labels on every occasion, there is a need to flag up a new allergen ingredient on the front of the packaging to alert customers.

Study reference:	**Zurzolo G.A., Koplin J.J., Mathai M.L., Tang M.K.L., Allen K.J. / 2013 / Perceptions of precautionary labelling among parents of children with food allergy and anaphylaxis**
Study type:	Cross-sectional study aiming to understand consumers' perception of precautionary labelling (parents of children with allergies)
Study population:	Australia
Publication date:	2013
Study quality and applicability:	Low **Comments**: selection bias: results may not be representative as all participants were recruited from the same hospital; around a half of the respondents didn't have a formally recognised allergy. Recall bias – retrospective data collection.
Key themes/ topics:	Effectiveness of PAL statements

Method:	Questionnaire (93% response rate). Pearson test for comparing answers of parents of children with past history of anaphylaxis and without. **Sample size:** n=535
Findings:	1. Statement 'made in the same factory' is more likely tt be ignored (65%) than 'may be present' (22%). 2. One third of parents of children with anaphylaxis history read labelling every time they shop, 30% only the first time they buy the product and 31% most of the times they buy a product. 3. More than two-thirds of parents didn't find the precautionary labelling useful irrespective of wording.
Strengths/ Limitations:	**Limitations**: relying on parents reporting of medically diagnosed allergies.
Relevant outcomes:	The VITAL statement “may be present” was seen as most useful, and was taken more seriously. Customers wrongly assume different levels of risk for different wording on allergy labelling

Study reference:	**Turner, P. J., Allen, K. J., Mehr, S., & Campbell, D. E. (2016). Knowledge, practice, and views on precautionary allergen labeling for the management of patients with IgE-mediated food allergy--a survey of Australasian and UK health care professionals. The journal of allergy and clinical immunology. In practice, 4(1), pp. 165–7**
Study type:	Cross-sectional study to understand how health care professionals (HCP) integrate PAL into patient management and assess the value of current approaches (ie. The VITAL initiative).

Study population:	Australasia & UK
Publication date:	2016
Study quality and applicability:	Very Low **Comments**: Study is based on self-reported opinions, which is subject to several different biases. Sample sizes are also small.
Key themes/ topics:	Effectiveness of PAL statements
Method:	An online survey was distributed to members of the Australasian Society for Clinical Immunology and Allergy (ASCIA), British Society for Allergy and Clinical Immunology (BSACI), and Allergy Academy (UK). Only participants involved in clinical management of patients with IgE-mediated food allergy were asked to respond (n=161).
Findings:	• "Only 51% believed PAL is voluntary and unregulated, while 32% thought PAL was subkected to standardised risk assessment and 13% believed PAL was subject to government regulation. 56% never heard of VITAL. • 43% thought PAL as generally helpful while 40% believed PAL was harmful. 82% believed that PAL "increased anxiety or abnormal food behaviorus" and 80% believed litigation minimization as the most common reason for PAL use by manufacturers. • 89% and 65% discussed PAL during patient consultations, where patient had been assessed as being at high/low risk of anaphylaxis, respectively. Only 14% consistently advised patients to avoid foods with PAL. • 55% believed that presence/absence of PAL is unindicative of allergen cross-contamination. • 89% wanted a single universal phrase for PAL, although no clear consensus on wording to use.

	• 70% thought that PAL should be regulated by legislation with risk assessment. 90% believed this system will improve patient safety."
Strengths/ Limitations:	None reported
Relevant outcomes:	There is a lack of confidence & knowledge in the current voluntary PAL system among HCPs, and there is a need for standardised wordings in legislation

Study reference:	**Voordouw J., Antonides G., Cornelisse-Vermaat J.R., Pfaff S., Niemietz D., Frewer L.J. / 2012 / Optimising the delivery of food allergy information. An assessment of food allergic consumer preferences for different information delivery formats**
Study type:	Cross-sectional study of consumer preferences for different information delivery formats.
Study population:	Europe
Publication date:	2012
Study quality and applicability:	Low **Comments:** limited generalisability due to small sample, self-reported allergy, potential recall and attributions bias
Key themes/ topics:	Using ICT's in allergen labelling

	Symbols as an effective way to communicate allergens on food labelling
Method:	Questionnaire; Latin Square Design **Sample size:** n=62
Findings:	1) Food allergic consumers in this study preferred clear and unambiguous labelling on product packaging, although the functionality of the electronic scanner was appreciated. 2) Additional information provision through the application of novel ICT technologies seems highly relevant. 3) Need for developing and implementing a harmonised international symbolic allergen strategy.
Strengths/ Limitations:	**Limitations**: small sample
Relevant outcomes:	There is a need to standardise allergen labelling, introduce ICT technologies and symbols for allergens.

Study reference:	**Zurzolo G.A., Peters R.L., Koplin J.J., de Courten M., Mathai M.L., Allen K.J. / 2017 / Are food allergic consumers ready for informative precautionary allergen labelling?**
Study type:	Cross-sectional study analysing informative precautionary allergen labelling.
Study population:	Australia

Publication date:	2017
Study quality and applicability:	Very low **Comments**: 76% of participants do not have allergies at all, 6.4% have a self-reported allergy, not a balanced sample; comparing data between self-diagnosed and doctor-diagnosed allergy consumers
Key themes/ topics:	Effectiveness of PAL statements Effective communication of allergen information requires educating the consumer
Method:	Questionnaire from earlier study: Zurzolo et al (2013). **Sample size:** n=535
Findings:	1) The majority of responders would find symbol, mobile app and a toll-free number very useful if they were placed on package goods. 2) If these methods of labelling were delivered to consumers with appropriate education regarding the VITAL process consumers would be able to consume foods without the added stress, anxiety and uncertainty that currently exist around packaged goods.
Strengths/ Limitations:	**Strengths**: response rate 93%; unlikely bias towards VITAL process as participants are not educated about it. **Limitations**: self-reported allergies, no verification of anaphylaxis history

Relevant outcomes:	1) Consumers would benefit from utilising methods of labelling such as symbol, mobile phone application and a toll-free number. 2) More education about VITAL process is needed.

Study reference:	**Marra C.A., Harvard S., Grubisic M., Galo J., Clarke A., Elliott S., Lynd L.D. / 2017 Consumer preferences for food allergen labeling**
Study type:	Discrete choice experiment questionnaire study. This study examines consumer preferences in food labelling for allergy avoidance and anaphylaxis prevention.
Study population:	Canada
Publication date:	2017
Study quality and applicability:	Very low **Comments**: Indirectness of findings and conclusions (examines theoretical behaviour of participants); unclear how observations took place; selection process is not explained well;
Key themes/ topics:	Symbols as an effective way to communicate allergens on food labelling
Method:	Questionnaire **Sample size:** n=1100

Findings:	The use of symbols was the most important food allergen-labelling attribute for those in class 1 (44%) and the use of symbols and a safety statement were equally important to those in class 2 (38%) of respondents, with respondents in both classes preferring both precautionary and safety symbols. Those in class 3 (18%) were essentially indifferent to allergen labelling.
Strengths/ Limitations:	**Limitations**: while the questionnaire was only administered in English, we do not anticipate that this would have biased the results in any way; it is also important to consider that the responses are based on a stated choice experiment and not on actual choices; only included respondents who had computer access.
Relevant outcomes:	Current Canadian food allergen labelling regulation can be improved by enforcing the use of standardized precautionary and safety symbols and educating the public on the use of these symbols.

Study reference:	**Marchisotto M.J., Harada L., Kamdar O., Smith B.M., Waserman S., Sicherer S., Allen K., Muraro A., Taylor S., Gupta R.S. / 2017 / Food Allergen Labeling and Purchasing Habits in the United States and Canada (No full text available)**
Study type:	Cross-sectional study assessing consumer perception of PAL labelling in North America.
Study population:	North America
Publication date:	2017
Study quality and applicability:	Low **Comments**: recall bias

Key themes/ topics:	Effectiveness of PAL statements
Method:	Survey; multiple logistic regression **Sample size**: n=6684
Findings:	11% of respondents purchased food with "may contain" labeling, 40% - "manufactured in a facility that also processes." 37% of respondents thought PAL was based on the amount of allergen present. Individuals who suffered from severe allergic reactions in the past were unlikely to buy foods with PAL.
Strengths/ Limitations:	None reported
Relevant outcomes:	Understanding of PAL is poor, and improved awareness and guidelines are needed to help food-allergic consumers purchase food safely.

Study reference:	**Mesquita J., Silva A., Giesteira B. / 2016 / Identification of food allergens by using relief pictograms in food packaging**
Study type:	Field observation to create (using inclusive design) a universal sign of food allergens that would account for needs of individuals with sight impairment.
Study population:	Portugal

Publication date:	2016
Study quality and applicability:	Very low **Comments**: This study focuses on 14 main allergens recognised by the EU in an attempt to create more inclusive allergen labelling. However, methodology is very poor.
Key themes/ topics:	Improving existing allergen labelling practices for more effective communication
Method:	User-Centered Design of a pictogram based on the preferences of user collected from structured and unstructured interviews, focus-groups, and questionnaires. **Sample size:** unclear
Findings:	Organic shapes (tree, egg, apple) are to complex to understand through tactile experience. Rectangle, ellipsis and hexagon also do not work for individuals with sight impairment as they're confsued with other forms. The dots (like in braille) are impractical as tehy might utrn into lines in the final printing.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Triangle, circle and square are easy forms to recognise for individuals with impaired sight.

Study reference:	**Ju S.-Y., Park J.-H., Kwak T.-K., Kim K.-E. / 2015 / Attitudes and preferences of consumers toward food allergy labeling practices by diagnosis of food allergies**

Study type:	Cross-sectional study exploring consumer preferences in food allergy labelling practices.
Study population:	South Korea
Publication date:	2015
Study quality and applicability:	Low **Comments**: self-reported allergy.
Key themes/ topics:	Improving existing allergen labelling practices for more effective communication
Method:	Questionnaire, SPSS **Sample size:** n=543
Findings:	All participants indicated that bold font, font colour, box frame, warning statement, front label, and addition of potential allergens - all necessary to improve food allergen labelling.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Readability and visibility of allergen information on labels need to be improved.

Study reference:	**Gupta R., Kanaley M., Negris O., Roach A., Bilaver L. / 2020 / Understanding Precautionary Allergen Labeling (PAL) Preferences Among Food Allergy Stakeholders (No full text available)**
Study type:	Cross-sectional study aimed to understand PAL preferences among food allergy stakeholders.
Study population:	USA
Publication date:	2020
Study quality and applicability:	Low **Comments**: recall bias
Key themes/ topics:	Effectiveness of PAL statements
Method:	Survey; logistic regression **Sample size:** n=3008
Findings:	Majority of respondents never purchase products with a “May contain traces of allergen” label (85.5%) in comparison with never purchasing products with a “Good manufacturing practices used to segregate ingredients in a facility that also processes allergen” label (35.0%). Their top preferences for a PAL statement were “Not suitable for people with ‘blank’ allergy” (29.3%) and “May contain” (22.1%).
Strengths/ Limitations:	None reported.

Relevant outcomes:	Consumers are not aware of PAL policies and make decisions based on the words in the PAL. They prefer having clearer, more specific, and consistent labelling on products, indicating that explicit PAL policies are needed to allow customers to easily identify safe foods.

Study reference:	**DunnGalvin A., Roberts G., Regent L., Austin M., Kenna F., Schnadt S., Sanchez-Sanz A., Hernandez P., Hjorth B., Fernandez-Rivas M., Taylor S., Baumert J., Sheikh A., Astley S., Crevel R., Mills C. / 2019 / Understanding how consumers with food allergies make decisions based on precautionary labelling**
Study type:	Cross-sectional study examining how consumers make decisions based on PAL.
Study population:	Europe
Publication date:	2019
Study quality and applicability:	Low
Key themes/ topics:	Symbols as an effective way to communicate allergens on food labelling
Method:	Survey with convenience sampling; statistical analysis **Sample size:** n=1560

Findings:	The value of PAL has been devalued through overuse and inconsistent application; it can act as a barrier to informed decision-making and increases risk to consumers with FA" "Participants were also unsure whether a product is safe to eat if it has no PAL indicating uncertainty, a central theme in food allergy that has a negative impact on quality of life" "verall, consumers strongly welcomed seeing a label that stated clearly that a product had undergone a risk assessment, reporting that it would be both useful and helpful. Furthermore, 32% adults and 44% parents stated that mandatory use would 'considerably improve their trust'. The statement 'This product has undergone a risk assessment and there is risk of an allergic reaction (ie not safe to consume)' was seen as more helpful by a slightly higher proportion (52%) than a similar statement with 'safe to consume' (49%).
Strengths/ Limitations:	**Limitations**: convenience sampling which limits generalisability.
Relevant outcomes:	To avoid overly 'wordy' additions to products, information in the form of one symbol with a corresponding one- or two-word safety statement, would likely also suffice. Also, regulatory approach is needed.

Study reference:	**Hefle S.L., Furlong T.J., Niemann L., Lemon-Mule H., Sicherer S., Taylor S.L. / 2007 / Consumer attitudes and risks associated with packaged foods having advisory labeling regarding the presence of peanuts**
Study type:	Retrospective study which aims to determine whether consumers with food allergies heed advisory labels and whether products with such labelling contain allergens.
Study population:	USA

Publication date:	2007
Study quality and applicability:	Low **Comments**: recall bias due to retrospective data collection.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Surveys (in 2003 and 2006). Food analysis to detect allergen contamination using Neogen Veratox Quantitative Peanut Allergen Test. Statistical analysis: Chi squared test. **Sample size:** n=625 in 2003 and n=645 in 2006
Findings:	Consumers were less likely to heed advisory labelling in 2006 (75%) compared with in 2003 (85%, P < .01); behaviour varied significantly according to the form of the statement.
Strengths/ Limitations:	None reported.
Relevant outcomes:	‘‘May contain’’ statements are apparently more effective deterrents than ‘‘shared facility’’ statements, and ‘‘shared equipment’’ statements are intermediate in effectiveness.

Study reference:	**Pele M., Brohée M., Anklam E., van Hengel A.J. / 2007 / Peanut and hazelnut traces in cookies and chocolates: Relationship between analytical results and declaration of food allergens on product labels.**
Study type:	Food sampling study of cookies and chocolates determining peanut and hazelnut content to compare analytical results with information provided on the product label.
Study population:	Europe
Publication date:	2007
Study quality and applicability:	Low **Comments**: Robustness of ELISA method is low.
Key themes/ topics:	Effectiveness of PAL statements
Method:	315 different types of cookies and 254 different types of chocolates (Austria, Belgium, Bulgaria, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and The Netherlands). RIDASCREEN FAST and ELISA test kits to analyse foods content.
Findings:	Based on the frequency of precautionary labelling, the majority of chocolates and almost half the cookies, which do not declare peanut or hazelnut as an ingredient, pose a risk to allergic consumers.
Strengths/ Limitations:	None reported.

Relevant outcomes:	Precautionary labelling can be a deterrent provided it is recognised its overuse can result in an unduly restricted choice for allergic consumers and an erosion of the message. Furthermore, it can only be an effective deterrent if precautionary labelling identifies an increased chance of allergen contamination. Our study confirmed that food products carrying a precautionary warning showed a higher frequency of contamination with hazelnut or peanut. Ideally, the absence of a precautionary warning guarantees that peanut or hazelnut traces were not detected in a cookie or chocolate.

Study reference:	**Vierk K.A., Koehler K.M., Fein S.B., Street D.A. / 2007 / Prevalence of self-reported food allergy in American adults and use of food labels**
Study type:	Retrospective study analysis to describe the use of labels among consumers with food allergies.
Study population:	US
Publication date:	2007
Study quality and applicability:	Low **Comments**: major problem - self-reported allergy.
Key themes/ topics:	Specific allergens and their effective communication

Method:	Survey analysis (the US Food and Drug Administration’s 2001 Food Safety Survey). Statistical analysis: Chi squared test. **Sample size:** n=4482
Findings:	Several label characteristics were rated as serious problems by about 40% of respondents. Issues such as 'too technical wording', 'hard to understand', 'not always alerting new ingredients' were reported as obstacles that hinder managing an allergy.
Strengths/ Limitations:	**Limitations**: self-reported food allergy; recall bias. **Strengths**: questions on food allergy and questions on label use were asked of the same individual.
Relevant outcomes:	There is a need to address problems such as ingredient lists that give a general name for an ingredient without specifying the source (eg, spices and flavors), use of different words for the allergenic food on different food products, and the use of words on ingredient lists that are too technical or hard to understand.

Study reference:	**Joshi P., Mofidi S., Sicherer S.H. / 2002 / Interpretation of commercial food ingredient labels by parents of food-allergic children**
Study type:	Review exercise aimed to determine the accuracy of label reading among parents of food-allergic children.
Study population:	USA

Publication date:	2002
Study quality and applicability:	Very low **Comments**: self-administered questionnaire, small sample
Key themes/ topics:	Effective communication of allergen information requires educating the consumer
Method:	Review of 23 food labels taken from widely available commercial products. Questionnaire completed by parent during the visit. **Sample size:** n=91
Findings:	Correct label identification was associated with prior instruction by a dietitian. With current labelling practices, most parents are unable to identify common allergenic food ingredients.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Need for improved labelling with plain-English terminology and allergen warnings as well as the need for diligent education of patients about reading labels.

Study reference:	**Ruchi S. Gupta, Steve L. Taylor, Joseph L. Baumert, Lauren M. Kao, Erik Schuster, and Bridget M. Smith / 2017 / Economic Factors Impacting Food Allergen Management: Perspectives from the Food Industry**

Study type:	Mixed methods study to characterize the factors that contribute to the economic impact of food allergen control practices on the food industry.
Study population:	USA
Publication date:	2017
Study quality and applicability:	Very low **Comments**: convenience sampling for survey - selection bias; small sample; potential confounders not accounted for.
Key themes/ topics:	Effectiveness of PAL statements
Method:	Focus group (n=100), survey (n=50). Statistical analysis: Chi-squared and Fischer's exact tests
Findings:	Current PAL usage was reported by 34% of the respondents, with ‘‘may contain’’ (30%) being the labeling used most frequently, followed by ‘‘manufactured in’’ (16%), ‘‘manufactured on’’ (10%), and ‘‘other’’ (4%) (Table 4). These results indicate that manufacturers use multiple allergen labels on their products. However, 78% of the respondents reported that having only a single option for PAL (e.g., ‘‘may contain’’) would improve their industry.
Strengths/ Limitations:	**Limitations**: small sample.
Relevant outcomes:	PAL phrasing should be consolidated and standardized to improve its effectiveness.

Study reference:	**Pieretti MM, Chung D, Pacenza R, Slotkin T, Sicherer SH. / 2009 / Audit of manufactured products: use of allergen advisory labels and identification of labeling ambiguities**
Study type:	Cross-sectional study to determine the frequency and language used in voluntary advisory labels among commercially available products and to identify labelling ambiguities affecting consumers with allergy.
Study population:	USA
Publication date:	2009
Study quality and applicability:	Low **Comments**: indirectness
Key themes/ topics:	Specific allergens and their effective communication
Method:	1st survey: 20,241 unique manufactured food products were evaluated for use of advisory labels; 2nd survey: 744 unique products were evaluated for additional labelling practices.
Findings:	Categorically, advisory warnings included ‘‘may contain’’ (38%), ‘‘shared equipment’’ (33%), and ‘‘within plant’’ (29%). The sub survey disclosed 25 different types of advisory terminology. Nonspecific terms, such as ‘‘natural flavours’’ and ‘‘spices,’’ were found on 65% of products and were not linked to a specific ingredient for 83% of them. Additional ambiguities included unclear sources of soy (lecithin vs protein), nondisclosure of sources of gelatine and lecithin, and simultaneous disclosure of ‘‘contains’’ and ‘‘may contain’’ for the same allergen, among others."

Strengths/ Limitations:	None reported.
Relevant outcomes:	Further regulations regarding soy, such as specifying ‘‘this product contains soy as lecithin only’’ or not including ‘‘contains soy’’ if soy oil is the only soy ingredient, could expand the products available to the individual with soy allergy. Unregulated use of allergen advisory labelling presents the consumer with food allergy with frequent but unclear warnings.

6. INFORMING THE FSA AS TO INCIDENTS INVOLVING FH

Study reference:	**Munro, C., Semic-Jusufagic, A., Pyrz, K., Couch, P., Dunn-Galvin, A., Peek, N., Themis, M., Mills, C., Buchan, I., Hourihane, J., & Simpson, A. (2015). An eHealth Approach to Reporting Allergic Reactions to Food and Closing the Knowledge Gap. Studies in health technology and informatics, 216, 320–324.**
Study type:	Cross-sectional survey to develop and evaluate eHealth methods on reporting allergic reactions
Study population:	UK
Publication date:	2015
Study quality and applicability:	Low **Comment**: Only 39 participants tested, and all recruited through clinics/charities
Key themes/ topics:	Reporting systems for allergic reactions
Method:	Participants were selected from charities to pilot the system and answer a questionnaire on understanding of questions using a Likert scale. Validation study was conducted. Sample size: n=39
Findings:	Participants complete an enrolment questionnaire once then complete incident questionnaires each time they have a reaction. Participants can also take photos and use the system on a mobile. Clinicians can access history of patient-reported incidents and rate severity of reaction based on photos.

	Limitations of system is that it requires network connectivity and technology with camera to take pictures.
Strengths/ Limitations:	Limitations of study: Gender bias in validation (90% are female), participants recruited through clinics and charities (not representative of population).
Relevant outcomes:	Development of an eHealth system for reporting allergies

Study reference:	**Løvik, M., Namork, E., Fæste, C., & Egaas, E. (2009). The Norwegian National Reporting System and Register of Severe Allergic Reactions to Food. Norsk Epidemiologi, 14(2).**
Study type:	Retrospective review in Norway of 300 cases recorded in the national reporting system and register of severe food allergic reactions
Study population:	Norway
Publication date:	2009
Study quality and applicability:	Very Low **Comment**: Non-primary research, secondary data analysis. Future research can benefit from impact evaluation.
Key themes/ topics:	Reporting systems for allergic reactions
Method:	Review of the cases recorded in the system; feedback analysis.

	Sample size: n=300
Findings:	1) The system has been very well received by the patient organisations and the medical profession. 2) A major challenge with running a reporting system is to maintain a high reporting rate.
Strengths/ Limitations:	None reported
Relevant outcomes:	The Norway study reported on cases in the national system. They found the register food safety problems in relation to allergy that probably could be discovered only with the help of a systematic, nation-wide registration of cases.

7. IMPACT OF CO-FACTORS ON REACTION SEVERITY

Study reference:	**Tye-Din, J.A., Daveson, A.J.M., Goldstein, K.E. et al. Patient factors influencing acute gluten reactions and cytokine release in treated coeliac disease. BMC Med 18, 362 (2020). https://doi.org/10.1186/s12916-020-01828-y**
Study type:	Cohort study to examine factors influencing severe gluten reactions.
Study population:	USA, Australia, New Zealand
Publication date:	2020
Study quality and applicability:	Low

	Comments: Uses food challenge to measure food allergy but severity of symptoms were self-reported. Participation voluntary, only those with severe symptoms may volunteer for study. Confounders not taken into account.
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Data collected on participants from a separate study. Participants undertook an open-label gluten food challenge. **Sample size:** n=295
Findings:	1. No patient characteristics (age, gender, height, weight, age at diagnosis) were associated with clinical severity of reaction. 2. Patient age & age of diagnosis associated with elevation in serum IL-2.
Strengths/ Limitations:	**Limitations**: may not be applicable to children & adolescents, patients regularly consuming gluten or those without CD who strictly avoid gluten. Participants volunteered to be in study (not representative), food challenge used standardised format with fixed gluten amount.
Relevant outcomes:	Severity of food allergic reaction

Study reference:	**Dua, S., Ruiz-Garcia, M., Bond, S., Durham, S. R., Kimber, I., Mills, C., Roberts, G., Skypala, I., Wason, J., Ewan, P., Boyle, R., & Clark, A. (2019). Effect of sleep deprivation and exercise on reaction threshold in adults with peanut allergy: A randomized controlled study. The Journal of allergy and clinical immunology, 144(6), 1584–1594.e2. https://doi.org/10.1016/j.jaci.2019.06.038**

Study type:	RCT estimating peanut threshold doses and the effect of exercise and sleep on this threshold.
Study population:	UK
Publication date:	2019
Study quality and applicability:	Moderate **Comments:** RCT. Randomised food challenges to measure food allergic reaction.
Key themes/ topics:	Association between exercise and food allergies (FDEIA)
Method:	Crossover study, where peanut-allergy participants did three blinded peanut challenges in random order: with exercise, with sleep deprivation, and no intervention. Difference in % change of 'threshold dose triggering symptoms' between non-intervention challenge and each intervention was measured. **Sample size:**
Findings:	1. Mean (SD) threshold was 214 mg (330mg) for non-intervention challenges and this was reduced by 45% (95% confidence interval 21,61 p=0.001) and 45% (22,62 p=0.001) for exercise and sleep deprivation, respectively. 2. Exercise and sleep deprivation each significantly reduce the threshold of reactivity in people with peanut allergy, putting them at greater risk of a reaction.
Strengths/ Limitations:	**Limitations**: eliciting dose estimate is based on a volunteer peanut-allergic population thus those with most severe reactions may be under-represented. Use of open challenges following blinded baseline food challenges.

Relevant outcomes:	Severity of food allergic reaction

Study reference:	**McWilliam, V. L., Koplin, J. J., Field, M. J., Sasaki, M., Dharmage, S. C., Tang, M., Sawyer, S. M., Peters, R. L., Allen, K. J., & SchoolNuts investigators (2018). Self-reported adverse food reactions and anaphylaxis in the SchoolNuts study: A population-based study of adolescents. The Journal of allergy and clinical immunology, 141(3), 982–990. https://doi.org/10.1016/j.jaci.2017.09.012**
Study type:	Population-based study to understand the frequency, prevalence, and risk factors of severe reaction among 10-14 year olds.
Study population:	Australia
Publication date:	2018
Study quality and applicability:	Very low **Comments**: self-reported study, diagnosis is not robust.
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Participants recruited from a stratified, random, population-based sample of schools. Self-reported food allergy and reaction details obtained by student questionnaire. **Sample size:** n=9663
Findings:	1) those with nut allergy were most at risk of severe reactions (aOR, 2.9 [95% CI, 1.1-4.4]).

	2) did not show that those with asthma were at significantly increased risk for severe reactions (aOR, 0.8 [95% CI, 0.3-2.2].
Strengths/ Limitations:	**Strengths**: Population based, highly detailed, not limited to clinical samples (those that seek treatment). **Limitations**: Anaphylaxis defined according to self-reported symptoms, only urban/suburban areas, underpowered.
Relevant outcomes:	Severity of food allergic reaction

Study reference:	**Clark, A. T., Anagnostou, K., & Ewan, P. W. (2007). Cashew nut causes more severe reactions than peanut: case-matched comparison in 141 children. Allergy, 62(8), 913–916. https://doi.org/10.1111/j.1398-9995.2007.01447.x**
Study type:	Retrospective Case-Matching study to compare reaction severity between cashew and peanut in children
Study population:	UK
Publication date:	2017
Study quality and applicability:	Low **Comments:** Uses sensitisation as proxy for determining allergy (and Skin Prick Test is used to confirm this, not a food challenge). Matches-case so confounding factors considered but cannot discount some residual confounding. Small sample size and is retrospective.
Key themes/ topics:	Impact of type of nut on reaction severity

Method:	Children with worst reactions to peanuts were matched 2:1 for those with cashews and severity of reactions were compared (47 in cashew vs 94 in peanut). Evidence of sensitisation diagnosed by Skin Prick Test. **Sample size:**
Findings:	Wheezing and cardiovascular symptoms were reported more frequently during cashew reactions than peanut (odds ratios (OR) 8.4(95% CI: 3.2–22.0) and 13.6 (95% CI: 5.6–32.8), respectively. Cashew group received adrenaline more frequently. Severe reactions reported more frequently in cashew (22%) compared to peanut (1%).
Strengths/ Limitations:	None reported
Relevant outcomes:	Severity of reaction

Study reference:	**Aihara, M., Miyazawa, M., Osuna, H., Tsubaki, K., Ikebe, T., Aihara, Y., & Ikezawa, Z. (2002). Food-dependent exercise-induced anaphylaxis: influence of concurrent aspirin administration on skin testing and provocation. The British journal of dermatology, 146(3), 466–472. https://doi.org/10.1046/j.1365-2133.2002.04601.x**
Study type:	Cross-sectional study to understand effect of aspirin on FDEIA
Study population:	Japan
Publication date:	2002

Study quality and applicability:	Low **Comments:** Incredibly small sample size. Two types of tests used, SPT an open food challenges - more robust measurement of reaction. Unclear selection criteria of participants.
Key themes/ topics:	Association between exercise and food allergies (FDEIA)
Method:	Administered SPT and provocation tests on patients with history of FDEIA. Tests performed with combinations of foods, exercise and aspirin. **Sample size:** n=12
Findings:	1) SPT reaction was enhanced by oral aspirin pre-treatment in 62.5% of patients. 2) Aspirin provoked symptoms in 71% of patients.
Strengths/ Limitations:	None reported
Relevant outcomes:	Symptoms of FDEIA from aspirin ingestion

Study reference:	**Negoro, T., Orihara, K., Irahara, T., Nishiyama, H., Hagiwara, K., Nishida, R., Takagi, H., Satoh, K., Yamamoto, Y., Shimizu, S., Hagiwara, T., Ishii, M., Tanioka, T., Nakano, Y., Takeda, K., Yoshimura, I., Iikura, Y., & Tobe, T. (2006). Influence of SNPs in cytokine-related genes on the severity of food allergy and atopic eczema in children. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology, 17(8), 583–590. https://doi.org/10.1111/j.1399-3038.2006.00463.x**

Study type:	Retrospective study to understand effect of single nucleotide polymorphism (SNP) and environmental factors on severity of food allergy in children.
Study population:	Japan
Publication date:	2006
Study quality and applicability:	Very low **Comments:** Small sample size. No controls used for comparison. 220 children were recruited for study but 33 participants were excluded without explaining why. Severity of symptoms assessed by drugs used and diet, which may not be robust as opposed to a validated index or clinical data.
Key themes/ topics:	Genetic and environmental factors on severity of food allergy
Method:	Reviewed clinical records and questionnaires on genetic information, allergy symptoms, and environmental factors for children. Severity of FA based on drugs and diet used. **Sample size:** n=187
Findings:	No single SNP determined severity, but combination of SNP & environmental factors influenced severity.
Strengths/ Limitations:	**Limitations**: Small sample size, no controls used.
Relevant outcomes:	Severity of food allergy symptoms

Study reference:	**Murray, J. A., Moore, S. B., Van Dyke, C. T., Lahr, B. D., Dierkhising, R. A., Zinsmeister, A. R., Melton, L. J., 3rd, Kroning, C. M., El-Youssef, M., & Czaja, A. J. (2007). HLA DQ gene dosage and risk and severity of celiac disease. Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association, 5(12), 1406–1412. https://doi.org/10.1016/j.cgh.2007.08.013**
Study type:	Population-based study to understand contribution of DQA & DQB alleles to risk & severity of CD.
Study population:	USA
Publication date:	2007
Study quality and applicability:	Very low **Comments:** Not a RCT so start with low. Classification of severity is binomial (only severe vs not severe) and based on weight loss and diarrhoea. Difficult to generalise beyond geographical area and those clinically diagnosed with CD. However, control group used, and biopsy-proven CD used.
Key themes/ topics:	Genetic and environmental factors on severity of food allergy
Method:	Performed HLA genotyping on a population-based sample of participants with CD (n=84) and a comparable control group (n=102). Severity of CD gauged by at least 10-pound weight loss followed by diarrhoea.
Findings:	No relation between HLA DQ gene dosage and severity of CD.
Strengths/ Limitations:	**Strengths**: Used geographically restricted cases and control groups. **Limitations**: Based on clinically diagnosed CD only (exclude those undiagnosed), use of blood donors as controls who are healthy by definition.

Relevant outcomes:	Severity of reaction gauged by presentation of symptoms.

Study reference:	**Karinen, H., Kärkkäinen, P., Pihlajamäki, J., Janatuinen, E., Heikkinen, M., Julkunen, R., Kosma, V. M., Naukkarinen, A., & Laakso, M. (2006). Gene dose effect of the DQB1*0201 allele contributes to severity of coeliac disease. Scandinavian journal of gastroenterology, 41(2), 191–199. https://doi.org/10.1080/00365520500206277**
Study type:	Population-based study to understand impact of DQB gene dosage on severity of CD.
Study population:	Finland
Publication date:	2006
Study quality and applicability:	Low **Comments**: Large sample size but all patients from one medical centre. Used villous atrophy rather than just symptoms.
Key themes/ topics:	Genetic and environmental factors on severity of food allergy
Method:	Performed HLA genotyping on patients with biopsy-proven CD. Other data was collected by biopsies and questionnaires, with severity of CD gauged by villous atrophy. **Sample size:** n=144
Findings:	DQB allele associated with a more severe form of CD and slows down rate of recovery of villous atrophy after a year of GFD.

Strengths/ Limitations:	None reported
Relevant outcomes:	Severity of reaction gauged by villous atrophy

Study reference:	**Cardona, V., Luengo, O., Garriga, T., Labrador-Horrillo, M., Sala-Cunill, A., Izquierdo, A., Soto, L., & Guilarte, M. (2012). Co-factor-enhanced food allergy. Allergy, 67(10), 1316–1318. https://doi.org/10.1111/j.1398-9995.2012.02877.x.**
Study type:	Descriptive Study examining role of co-factors on increasing the severity of food allergy reaction.
Study population:	Spain
Publication date:	2012
Study quality and applicability:	Very low **Comments:** No confounders taken into account, different ways of assessing food allergic reaction. No combined test of food challenges and co-factors.
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Retrospective case study of 74 cases that experienced co-factor enhanced food allergy. These were assessed by skin-prick tests, specific IgE and oral challenges. **Sample size:** n=74
Findings:	Non-steroidal anti-inflammatory drugs (NSAID) were involved in 58% of cases, exercise in 52.7% and alcohol in 12.2%.

Strengths/ Limitations:	**Limitations**: retrospective study, no combination test of food challenge and co-factors.
Relevant outcomes:	Severity of food allergic reaction

Study reference:	**Versluis, A., van Os-Medendorp, H., Kruizinga, A. G., Blom, W. M., Houben, G. F., & Knulst, A. C. (2016). Cofactors in allergic reactions to food: physical exercise and alcohol are the most important. Immunity, inflammation and disease, 4(4), 392–400. https://doi.org/10.1002/iid3.120**
Study type:	Retrospective database study to understand frequency of exposure to cofactors and how often cofactors are associated with more severe symptoms.
Study population:	Netherlands
Publication date:	2016
Study quality and applicability:	Very low **Comments:** Diagnosis of food allergy inconsistent (mixture of SPT, ImmunoCAP, and food challenges). Patients all from one medical centre. Self-reported data. No combined test of food challenges and co-factors.
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Patients in a referral centre were asked to fill in questionnaire about lifestyle habits and diagnosis of food allergy.

	Sample size: n=496
Findings:	1) 13% of patients reported more severe symptoms after participating in one or more of the cofactors: physical exercise (10%), alcohol consumption (5%), and use of analgesics (0.6%). 2) Physical exercise and alcohol consumption were the most frequently reported cofactors, but occurring still in only 10% or less.
Strengths/ Limitations:	**Limitations**: Self-reported data (recall bias)
Relevant outcomes:	Severity of food allergic reaction

Study reference:	**Versluis, A., van Os-Medendorp, H., Blom, W. M., Michelsen-Huisman, A. D., Castenmiller, J., Noteborn, H., Houben, G. F., & Knulst, A. C. (2019). Potential cofactors in accidental food allergic reactions are frequently present but may not influence severity and occurrence. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology, 49(2), 207–215. https://doi.org/10.1111/cea.13282**
Study type:	Prospective cohort study to understand frequency of presence of potential cofactors in accidental food allergic reactions in adults and their influence on severity and occurrence.
Study population:	Netherlands
Publication date:	2019

Study quality and applicability:	Very low **Comments:** Diagnosis of food allergy inconsistent (mixture of SPT, ImmunoCAP, and food challenges). Patients all from one medical centre. Self-reported data. No combined test of food challenges and co-factors.
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Data collected from questionnaires filled in by patients on accidental food allergic reactions over a 1-year period. **Sample size:** n=147
Findings:	No significant difference in the presence of these factors (tiredness, alcohol intake, stress, symptoms of pollinosis , symptoms of asthma, sickness/flu, physical exercise and use of analgesics) between mild, moderate and severe reactions.
Strengths/ Limitations:	**Limitations**: accidental allergic reaction and severity of symptoms are self-reported.
Relevant outcomes:	Severity of food allergic reactions

Study reference:	**Pettersson, M. E., Koppelman, G. H., Flokstra-de Blok, B., Kollen, B. J., & Dubois, A. (2018). Prediction of the severity of allergic reactions to foods. Allergy, 73(7), pp. 1532–1540.**
Study type:	Retrospective database study to identify predictors for severity of food allergic reactions and quantify their impact

Study population:	Netherlands
Publication date:	2018
Study quality and applicability:	Low **Comment**: Uses DBPCDC as confirmatory testing, which is the gold standard. However, it is a retrospective database review and not an RCT. Thus, it's automatically graded as low but not graded down because there is low risk of bias (eg. DBPCFC, large sample size etc.)
Key themes/ topics:	Co-factors which increase severity of reaction
Method:	Study population consisted of children (n=734) with DBPCFC- conformed FA to milk, egg, peanut, cashew and/or hazelnut. 2 scoring systems used to determine severity of reactions.
Findings:	Independent predictors for the severity of the DBPCFC reaction were age (B = 0.04, P = .001), skin prick test ratio (B = 0.30, P < .001), eliciting dose (B = -0.09, P < .001), level of specific immunoglobulin E (B = 0.15, P < .001), reaction time during the DBPCFC (B =-0.01, P = .004), and severity of accidental reaction (B = 0.08, P = .015). The total explained variance of this model was 23.5%, and the eliciting dose only contributed 4.4% to the model. Independent predictors for more severe accidental reactions with an explained variance of 7.3% were age (B = 0.03, P = .014), milk as causative food (B = 0.77, P < .001), cashew as causative food (B = 0.54, P < .001), history of atopic dermatitis (B = 0.47, P = .006), and severity of DBPCFC reaction (B = 0.12, P = .003)
Strengths/ Limitations:	Strengths: Allergy confirmed by DBPCDC and children with history of anaphylaxis included, gives statistically underpinned evidence for the identified factors independently of the other determinants.

	Limitations: Generalisability needs to be externally validated in other studies, severe reactions can be halted with prompt treatment so using food challenges could have masked severity of reaction
Relevant outcomes:	The severity of DBPCFCs and accidental reactions to food remains largely unpredictable

8. IMPACT OF SOCIOECONOMIC FACTORS (INCLUDING RACE/ETHNICITY) ON FHS

Study reference:	**Ji, J., Ludvigsson, J. F., Sundquist, K., Sundquist, J., & Hemminki, K. (2011). Incidence of celiac disease among second-generation immigrants and adoptees from abroad in Sweden: evidence for ethnic differences in susceptibility. Scandinavian journal of gastroenterology, 46(7-8), 844–848. https://doi.org/10.3109/00365521.2011.579999**
Study type:	Retrospective cohort study to examine influence of genetic versus ethnicity factors on incidence of childhood CD.
Study population:	Sweden
Publication date:	2011
Study quality and applicability:	Very low **Comments:** Does not take into account confounders or risk factors among patients. Only includes hospitalized patients (overrepresentation of severe cases). Does not report SIR of native swedes**.** Confounders not dealt with: no info on risk factors and perinatal factors.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in adults

Method:	Second-generation immigrants and adoptees from abroad were identified and followed until diagnosis of CD, death, or the end of study. Standard Incidence Ratios (SIR) were calculated for them, using native Swedes as a control group. **Sample size:**
Findings:	Decreased incidence of CD (SIR = 0.89, 95% CI 0.84-0.94) among second generation immigrations and adoptees from Eastern Asia.
Strengths/ Limitations:	**Strengths**: prospective design, comprehensive follow-up, reliable data (from nationwide databases). **Limitations**: no information on individual risk factors among patients, no info on perinatal factors.
Relevant outcomes:	Ethnic differences in genes may contribute to the worldwide variation of CD.

Study reference:	**Kumar, R., Tsai, H. J., Hong, X., Liu, X., Wang, G., Pearson, C., Ortiz, K., Fu, M., Pongracic, J. A., Bauchner, H., & Wang, X. (2011). Race, ancestry, and development of food-allergen sensitization in early childhood. Pediatrics, 128(4), e821–e829. https://doi.org/10.1542/peds.2011-0691**
Study type:	Cohort study to examine variation of risk of food-allergen sensitization between self-identified race in childhood.
Study population:	USA
Publication date:	2011

Study quality and applicability:	Very low **Comments:** Subtle socioeconomic differences and some perinatal factors not taken into account, not balanced ethnic groups, but other potential confounders taken into account. Voluntary participants may cause selection bias. <400 panel of AIMS used may not be large enough to determine ancestry.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in children
Method:	Studying a cohort from patients at the Boston Medical Centre, by extracting medical records and following up with a post-natal questionnaire. **Sample size:** n=1104
Findings:	1. Self-reported black race (OR: 2.34 [95% CI: 1.24 – 4.44]) and African ancestry (OR: 1.07 [95% CI: 1.02–1.14]) were associated with food sensitization. 2. Self-reported black race (OR: 3.76 [95% CI: 1.09 – 12.97]) and African ancestry (OR: 1.19 [95% CI: 1.07–1.32]) were associated with a high number of food sensitizations.
Strengths/ Limitations:	**Limitations**: Confounding from subtle socioeconomic factors and perinatal factors, young cohort, ancestry derived from only 150 panels of Ancestry Information Markers.
Relevant outcomes:	Black children were more likely to be sensitized to food allergens and were sensitized to more foods. African ancestry was associated with peanut sensitization.

Study reference:	**Liu, A. H., Jaramillo, R., Sicherer, S. H., Wood, R. A., Bock, S. A., Burks, A. W., Massing, M., Cohn, R. D., & Zeldin, D. C. (2010). National prevalence and risk factors for food allergy and relationship to asthma: results from the National Health and Nutrition Examination Survey 2005-2006. The Journal of allergy and clinical immunology, 126(4), 798–806.e13. https://doi.org/10.1016/j.jaci.2010.07.026**
Study type:	Retrospective Cohort Study to understand prevalence and demographic risk factors for FA.
Study population:	USA
Publication date:	2010
Study quality and applicability:	Low **Comments:** Only used IgE levels to determine clinical Food Allergy. No confounders taken into account.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in adults
Method:	Use serologic data from a National Survey to derive population-based estimates of FA and identify high risk populations. **Sample size:** n=8203
Findings:	Risk of Possible/Likely Food Allergy was increased in non-Hispanic blacks ((OR) 3.06; 95% (CI) 2.14-4.36), males (1.87; 1.32-2.66), and children (2.04; 1.42-2.93).

Strengths/ Limitations:	**Strengths**: nationally representative cohort, consistent methodologies of the National Survey, using standardized food-specific serum IgE. **Limitations**: relied solely on IgE levels for determination of clinical FA estimates, over/under estimation of FA prevalence, only includes 4 food allergens.
Relevant outcomes:	Non-Hispanic Blacks and males as risk factors for FA.

Study reference:	**Dias, R. P., Summerfield, A., & Khakoo, G. A. (2008). Food hypersensitivity among Caucasian and non-Caucasian children. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology, 19(1), 86–89. https://doi.org/10.1111/j.1399-3038.2007.00582.x**
Study type:	Cohort study to determine whether socioeconomic deprivation increases or reduces coeliac disease development.
Study population:	Wales
Publication date:	2008
Study quality and applicability:	Very low **Comments:** Potential confounders like ethnicity/race not taken into account. Small sample size. Using current postcode to determine socioeconomic status.

Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in children
Method:	Data collected from a cross-sectional study (of children < 16 years old) diagnosed with coeliac disease from a particular medical centre and linked with Welsh Index of Multiple Deprivation score 2008. **Sample size:** n=232
Findings:	Higher prevalence of CD in low deprivation area (rate = 1.16) than high deprivation area (0.49)
Strengths/ Limitations:	**Limitations**: relatively small sample size limited by number of patients in geographical area.
Relevant outcomes:	Higher CD prevalence among children living in affluent areas.

Study reference:	**Taylor-Black, S., & Wang, J. (2012). The prevalence and characteristics of food allergy in urban minority children. Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology, 109(6), 431–437.**
Study type:	The Retrospective chart review aims to determine prevalence and characteristics of food allergy in a low-income minority population of children.
Study population:	USA
Publication date:	2012

Study quality and applicability:	Very low **Comments:** No control group (high-income non minority population) to compare the characteristics with. Significant black and Hispanic population, lack of Caucasian and Asian patients to compare with within the low-income population. Only one clinic.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in children
Method:	Examined allergy related and demographic detail of medical records for ages 0 to 21 and categorised patient records by testing and history of symptoms. Statistical analysis was conducted with comparison of categorical data. **Sample size:** n=9184
Findings:	1. Overall prevalence of food allergy was significantly higher in Black patients than in patients of other races (4.7% vs 2.7%, $p<0.0001$). 2. Black children had significantly higher rates of peanut, shellfish, and tree nut allergy; as well as higher rates of multiple allergies.
Strengths/ Limitations:	**Strengths**: Large subject population (c.9000), uses physician documentation (which is more accurate than food-specific Ig-E or self-reported allergy) **Limitations**: Retrospective nature, documentation errors, lack of documented clinical reactivity in all patients, 32% had race documented as 'other' (doesn't fully capture full number of patients of African & Hispanic ancestry).

Relevant outcomes:	Prevalence & characteristics of food allergy of low-income minority children & by race

Study reference:	**Olén, O., Bihagen, E., Rasmussen, F., & Ludvigsson, J. F. (2012). Socioeconomic position and education in patients with coeliac disease. Digestive and liver disease : official journal of the Italian Society of Gastroenterology and the Italian Association for the Study of the Liver, 44(6), 471–476. https://doi.org/10.1016/j.dld.2012.01.006**
Study type:	Matched case control study to examine relation of socioeconomic status and education to coeliac disease.
Study population:	Sweden
Publication date:	2012
Study quality and applicability:	Low **Comments:** Post-diagnosis socioeconomic data may be confounded by presence of CD. Used matched controls however still have residual confounding from ethnicity, smoking, & alcohol. Used biopsy to confirm CD - which is robust.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in adults
Method:	Linked data on CD from biopsy reports with socioeconomic and education variables data from government agency. Odds ratios for the risk of having coeliac disease were calculated for these variables. **Sample size:** n=29,096

Findings:	Diagnosed coeliac disease was slightly less common in individuals with low socioeconomic position (adjusted OR = 0.89; 95% CI = 0.84–0.94) but not associated with educational level.
Strengths/ Limitations:	**Strengths**: used nationwide data from biopsy reports. **Limitations**: uses post-diagnosis socioeconomic data which may be impacted by CD, validity of education and occupation data for younger individuals, lack of smoking and alcohol data.
Relevant outcomes:	Low socioeconomic position is less associated with CD as compared to high socioeconomic position.

Study reference:	**Muhammad, H., Reeves, S., Ishaq, S., Mayberry, J., & Jeanes, Y. M. (2017). Adherence to a Gluten Free Diet Is Associated with Receiving Gluten Free Foods on Prescription and Understanding Food Labelling. Nutrients, 9(7), 705. https://doi.org/10.3390/nu9070705**
Study type:	Cross-sectional survey examining difference in adherence to a GF diet between Caucasian and South Asian adults.
Study population:	UK
Publication date:	2017
Study quality and applicability:	Very low

	Comments: Low response rate to survey (unrepresentative of population). Voluntary participants - selection bias. Confounders not taken into account, unbalanced ethnicity. Self-reported data - subject to recall bias.
Key themes/ topics:	Adherence to gluten free (GF) diet
Method:	CD confirmed participants selected from a hospital database and sent survey on diet, allergy details, and adherence to GF diet. **Sample size:** n=375
Findings:	1. Adherence to GF diet the same for both groups (53%). 2. Higher proportion of South Asian patients, compared with Caucasians, reported difficulties understanding what they can eat (76% versus 5%; $p < 0.001$) and understanding of food labels (53% versus 4%; $p < 0.001$).
Strengths/ Limitations:	**Limitations**: Low response rate (39%), selection bias since voluntary response, unbalanced ethnicity of respondents, recall bias.
Relevant outcomes:	Variation in adherence to GF diet between Caucasian & South Asian patients.

Study reference:	**Jansen, M., Beth, S. A., van den Heuvel, D., Kiefte-de Jong, J. C., Raat, H., Jaddoe, V., van Zelm, M. C., & Moll, H. A. (2017). Ethnic differences in coeliac disease autoimmunity in childhood: the Generation R Study. Archives of disease in childhood, 102(6), 529–534. https://doi.org/10.1136/archdischild-2016-311343**

Study type:	Prospective population-based cohort study to identify ethnic differences in Coeliac Disease Autoimmunity (CDA) in 6 year olds and explain the socioeconomic factors behind them.
Study population:	Netherlands
Publication date:	2017
Study quality and applicability:	Very low **Comments:** Age & gender considered but may have residual confounding. Not oral food challenge being used, observing serologic data.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in children.
Method:	Obtained serum from children and ethnicity and socioeconomic data were assessed by questionnaires. **Sample size:** n=4442
Findings:	1. Western ethnicity was positively associated with TG2A - proxy for CDA - positivity (adjusted odds ratio (aOR) 1.94; 95% CI 1.02 to 3.70). 2. High socioeconomic position and day-care attendance partly explained this result.
Strengths/ Limitations:	**Strengths**: large screened population based multi-ethnic cohort, participants unaware of serum screening. **Limitations**: Residual confounding from other environmental factors.
Relevant outcomes:	Positive association between Western children and CDA, explained by high SEP and day-care attendance.

Study reference:	**Mahdavinia, M., Fox, S. R., Smith, B. M., James, C., Palmisano, E. L., Mohammed, A., Zahid, Z., Assa'ad, A. H., Tobin, M. C., & Gupta, R. S. (2017). Racial Differences in Food Allergy Phenotype and Health Care Utilization among US Children. The journal of allergy and clinical immunology. In practice, 5(2), 352–357.e1. https://doi.org/10.1016/j.jaip.2016.10.006 (No full text available)**
Study type:	Retrospective cohort study to identify racial differences in FA and health care utilization among children.
Study population:	USA
Publication date:	2017
Study quality and applicability:	Low **Comments:** observational study
Key themes/ topics:	Racial differences in prevalence of FHs in children
Method:	Study of children aged 0-17 years with FA seen in allergy/immunology clinics at 2 urban tertiary care centres. Used multiple logistic regression analyses adjusted for age, gender, and insurance. **Sample size:** n=817
Findings:	Compared with non-Hispanic white children, 1. African American and Hispanic children had significantly higher odds of allergy to wheat, soy, corn, fish, and shellfish ($P < .01$) and significantly higher odds of having eczema.

	2. African American children also had significantly higher odds of having asthma. 3. African American and Hispanic children had a shorter duration of follow-up for FA with an allergy specialist and higher rates of FA-related anaphylaxis and emergency department visits (P < .01).
Strengths/ Limitations:	n/a
Relevant outcomes:	Higher odds of FA and higher rates of FA related anaphylaxis and emergency visits for African American and Hispanic children.

Study reference:	**McGowan, E. C., Matsui, E. C., Peng, R., Salo, P. M., Zeldin, D. C., & Keet, C. A. (2016). Racial/ethnic and socioeconomic differences in self-reported food allergy among food-sensitized children in National Health and Nutrition Examination Survey III. Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology, 117(5), 570–572.e3. https://doi.org/10.1016/j.anai.2016.08.034**
Study type:	Retrospective study to determine whether there were racial/ethnic and socioeconomic differences in the relationship between sensitization to common foods and self-reported food allergy.
Study population:	USA
Publication date:	2016

Study quality and applicability:	Very low **Comments:** Food sensitization and self-reported food allergy used to confirm food allergy.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in children
Method:	Data on food allergies, socioeconomic status and race were analysed from the National Health and Nutrition Examination Survey (NHANES) **Sample size:** n=2673
Findings:	1. Sensitization to foods was significantly higher among black than white or Mexican American children. 2. Self-reported food allergy was significantly less common among black and Mexican American children than white children.
Strengths/ Limitations:	**Strengths**: large sample, rigorous NHANES methodology, participants not selected (reduced selection bias). **Limitations**: Food allergy self-reported, only measured 4 allergens, historical data.
Relevant outcomes:	Uneven recognition of food allergy in the past, with more recognition among higher income and non-minority groups.

Study reference:	**Roy, A., Mehra, S., Kelly, C. P., Tariq, S., Pallav, K., Dennis, M., Peer, A., Lebwohl, B., Green, P. H., & Leffler, D. A. (2016). The association between socioeconomic status and the symptoms at**

	diagnosis of celiac disease: a retrospective cohort study. Therapeutic advances in gastroenterology, 9(4), 495–502. https://doi.org/10.1177/1756283X16637532
Study type:	Retrospective Cohort Study to examine association between socioeconomic status and symptoms at diagnosis of CD.
Study population:	USA
Publication date:	2016
Study quality and applicability:	Very low **Comments:** Biopsy proven CD. Socioeconomic status based on place of residence (not income, occupation etc). Small sample size. Confounders not taken into account.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in adults
Method:	Patients with biopsy-proven CD were categorized based on the presence or absence of (1) diarrhoea and (2) any gastrointestinal symptoms at diagnosis. **Sample size:** n=872
Findings:	1. Patients without diarrhoea and gastrointestinal symptoms at presentation had a higher mean capita income. 2. After adjusting for confounders, per capita income remained a significant predictor of diagnosis without gastrointestinal symptoms and diarrhoea.

Strengths/ Limitations:	**Limitations**: all patients from one tertiary centre, race/ethnicity not taken into account, socioeconomic status based on place of residence, small sample size, measured symptoms rather than rates of diagnosis.
Relevant outcomes:	Patients with nonclassical symptoms of celiac disease are less likely to be diagnosed if they are of lower socioeconomic status.

Study reference:	**Bilaver, L. A., Kester, K. M., Smith, B. M., & Gupta, R. S. (2016). Socioeconomic Disparities in the Economic Impact of Childhood Food Allergy. Pediatrics, 137(5), e20153678. https://doi.org/10.1542/peds.2015-3678**
Study type:	Cross-sectional survey to compare costs borne by families of food-allergic children by socioeconomic groups.
Study population:	USA
Publication date:	2016
Study quality and applicability:	Low **Comments:** Affordability of special foods is only a minor focus of the topic. Costs are self-reported. Wide variation in costs - measurement error. Selection bias - some participants recruited through organisations helping these groups.

Key themes/ topics:	Impact of socioeconomic differences on affordability/ accessibility/ availability to appropriate foods for those with FHS
Method:	Cross-sectional survey data collected between November 2011 and January 2012 from US caregivers with a food-allergic child. Differences in mean cost were identified by levels of household income and race or ethnicity. **Sample size:** n=1643
Findings:	1) African American ($177) and Asian American ($148) caregivers spend the least on food costs.
Strengths/ Limitations:	**Limitations:** Measurement error (wide variation in self-reported out-of-pocket costs), some families recruited through advocacy organisations.
Relevant outcomes:	African American caregivers spent the least on out-of-pocket costs, which includes accessing specialty foods.

Study reference:	**Joseph, C. L., Zoratti, E. M., Ownby, D. R., Havstad, S., Nicholas, C., Nageotte, C., Misiak, R., Enberg, R., Ezell, J., & Johnson, C. C. (2016). Exploring racial differences in IgE-mediated food allergy in the WHEALS birth cohort. Annals of allergy, asthma & immunology : official publication of the American College of Allergy, Asthma, & Immunology, 116(3), 219–224.e1. https://doi.org/10.1016/j.anai.2015.12.019**
Study type:	Birth cohort study to understand racial differences in IgE-mediated food allergy.

Study population:	USA
Publication date:	2016
Study quality and applicability:	Very low **Comments:** Used questionnaires and serologic data to determine food allergy, although aided by panel of certified allergists diagnosis. Distinguished between sensitisation and food allergy but outcome also only focuses on IgE-mediated FA.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in children
Method:	Used serologic and demographic data from the Wayne County Health, Environment, Allergy, and Asthma Longitudinal Study (WHEALS) study. **Sample size:** n=590
Findings:	1. No statistically significant racial/ethnic differences in IgE-FA were observed. 2. Sensitization (serum specific IgE >0.35 IU/mL) to the food allergens was significantly higher for African American children compared with non-African American children.
Strengths/ Limitations:	**Limitations**: Recall bias, participants cannot distinguish severity of reactions.
Relevant outcomes:	No elevated risk of IgE-FA for African American children, although established differences in sensitization were observed.

Study reference:	**Oza, S. S., Akbari, M., Kelly, C. P., Hansen, J., Theethira, T., Tariq, S., Dennis, M., & Leffler, D. A. (2016). Socioeconomic Risk Factors for Celiac Disease Burden and Symptoms. Journal of clinical gastroenterology, 50(4), 307–312. https://doi.org/10.1097/MCG.0000000000000366**
Study type:	Prospective survey study to assess the relationships between income, symptoms, and perceived burden of CD.
Study population:	n/a
Publication date:	2016
Study quality and applicability:	Low **Comments:** Used biopsy to confirm CD, which is robust. Although used validated indexes and scales as a guide for respondents, symptoms still self-reported.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in adults
Method:	Patients with biopsy confirmed CD were eligible to participate and provided socioeconomic data, and GF lifestyle. **Sample size:** n=341
Findings:	1. Higher income predicted better overall health, better CD related health, and fewer symptoms. 2. Low income was associated with greater CD symptoms (odds ratio=6.04, P=0.002).

Strengths/ Limitations:	None reported.
Relevant outcomes:	Those with low income had 6 times the odds of greater symptoms compared with those with high income.

Study reference:	**Burden, M., Mooney, P. D., Blanshard, R. J., White, W. L., Cambray-Deakin, D. R., & Sanders, D. S. (2015). Cost and availability of gluten-free food in the UK: in store and online. Postgraduate medical journal, 91(1081), 622–626. https://doi.org/10.1136/postgradmedj-2015-133395**
Study type:	Survey to understand cost and availability of GF food in UK
Study population:	UK
Publication date:	2015
Study quality and applicability:	Very low **Comments:** Poor availability in budget supermarkets to imply harder availability for lower socioeconomic status (indirect). Only done in Sheffield, not representative.
Key themes/ topics:	Impact of socioeconomic differences on affordability/ accessibility/ availability to appropriate foods for those with FHS
Method:	Supermarkets in UK surveyed and price difference with non-GF alternatives analysed.

Findings:	1. No budget supermarkets stocked GF food. 2. All GF foods were at least four times more expensive than non-GF alternatives ($p<0.0001$).
Strengths/ Limitations:	None reported.
Relevant outcomes:	Poor availability in budget supermarkets and added cost is likely to impact on adherence in deprived groups.

Study reference:	**Mardini, H. E., Westgate, P., & Grigorian, A. Y. (2015). Racial Differences in the Prevalence of Celiac Disease in the US Population: National Health and Nutrition Examination Survey (NHANES) 2009-2012. Digestive diseases and sciences, 60(6), 1738–1742. https://doi.org/10.1007/s10620-014-3514-7**
Study type:	Retrospective study to estimate of the prevalence of celiac disease by race/ethnic origin.
Study population:	US
Publication date:	2015
Study quality and applicability:	Very low **Comments:** Using serologic data (but not including IgA data). CDA used as proxy for CD. No potential confounders taken into account. Historical data.

Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in adults
Method:	Data on food allergies and race were analysed from the National Health and Nutrition Examination Survey (NHANES). **Sample size:** n=19,591
Findings:	Non-Hispanic white were more likely to be positive for tissue transglutaminase (tTG) and endomysial (EMA) IgA antibodies compared to other races.
Strengths/ Limitations:	**Limitations**: CD assessed by Coeliac Disease Autoimmunity, serology tests did not include IgA level testing, might be a dose– effect relationship between the amount of gluten-containing food consumed and the degree of serology and biopsy ‘‘positivity’’ among celiac disease patients.
Relevant outcomes:	Prevalence is 4–8 times higher among non-Hispanic white compared with other races.

Study reference:	**Ben-Shoshan, M., Soller, L., Harrington, D. W., Knoll, M., La Vieille, S., Fragapane, J., Joseph, L., St Pierre, Y., Wilson, K., Elliott, S. J., & Clarke, A. E. (2015). Eczema in early childhood, sociodemographic factors and lifestyle habits are associated with food allergy: a nested case-control study. International archives of allergy and immunology, 166(3), 199–207. https://doi.org/10.1159/000381829**
Study type:	Case-control study to evaluate the association between the most common food allergies and sociodemographic characteristics and lifestyle habits.
Study population:	Canada

Publication date:	2015
Study quality and applicability:	Very low **Comments:** Food allergy is self-reported. Survey so income/education is self-reported as well. Matched controls used and potential confounders taken into account.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in adults
Method:	Random national telephone survey asking about food allergies, sociodemographic factors & lifestyle habits. Matched controls were chosen **Sample size:** n= 480 cases and 4,950 controls
Findings:	1. For all 9 allergens, factor associated with a higher risk of probable allergy: high household income (top 20%; OR 1.5, 95% CI 1.2-2.0). 2. Males and older individuals were less likely to have food allergy (OR 0.7, 95% CI 0.6-0.9, and OR 0.99, 95% CI 0.99-1.00).
Strengths/ Limitations:	**Limitations**: self-report of probable food allergy, differential recall bias by individuals with food allergy
Relevant outcomes:	High household income associated with higher risk of probable allergy.

Study reference:	**Soller, L., Ben-Shoshan, M., Harrington, D. W., Knoll, M., Fragapane, J., Joseph, L., St Pierre, Y., La Vieille, S., Wilson, K., Elliott, S. J., & Clarke, A. E. (2015). Prevalence and predictors of food allergy in Canada: a focus on vulnerable populations. The journal of allergy and clinical immunology. In practice, 3(1), 42–49. https://doi.org/10.1016/j.jaip.2014.06.009**
Study type:	Cross-sectional survey to estimate prevalence of food allergy among vulnerable populations.
Study population:	Canada
Publication date:	2015
Study quality and applicability:	Very low **Comments:** Self-reported data - subject to different biases. Area with high proportion of vulnerable individuals were chosen - sampling bias.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in adults
Method:	Information on food allergies and demographics were collected by randomly selecting households (in high proportion vulnerable areas) to complete a survey. **Sample size:** n=5734
Findings:	1. Food allergy was less common among adults without postsecondary education versus those with postsecondary education (6.4% [95% CI, 5.5%-7.3%] vs 8.9% [95% CI, 7.7%-10%]) and new Canadians versus those born in Canada (3.2% [95% CI, 2.2%-4.3%] vs 8.2% [95% CI, 7.4%-9.1%]).

	2. No difference for income and Aboriginal identity.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Individuals of low education and new Canadians self-report fewer allergies. Could be due to genetics, environment, lack of appropriate health care, or lack of awareness of allergies, which reduces self-report.

Study reference:	**Leia M. Minaker, Susan J. Elliott & Ann Clarke (2015) Low income, high risk: the overlapping stigmas of food allergy and poverty, Critical Public Health, 25:5, 599-614, DOI: 10.1080/09581596.2014.926309**
Study type:	Cross-sectional surveys to understand intersectional stigma between food allergies and poverty.
Study population:	Canada
Publication date:	2015
Study quality and applicability:	Low **Comments:** Small sample size. Financial incentives given. All data self-reported and subjective.
Key themes/ topics:	Impact of socioeconomic differences on affordability/ accessibility/ availability to appropriate foods for those with FHS

Method:	Semi-structured interviews were conducted with low-income families affected by food allergies (n=13) & key informants from agencies working closely with them on FA (n=10).
Findings:	1. Low-income participants reported difficulty in procuring safe foods and felt particularly unsafe at food banks and hard-discount supermarkets (food banks provide food containing allergens and cross-contamination). But they felt they had no choice. 2. Unused EAIs expire after 12–18 months, which represented a major financial barrier for several participants. 3. Over half of the low-income participants reported being insufficiently trained or educated about allergy management and treatment by their health care provider.
Strengths/ Limitations:	**Strengths**: in-depth interviews, inclusion of key informant. **Limitations**: limited geographical area, no data on how long they were low-income and no verification of low-income.
Relevant outcomes:	Low-income participants perceived difficulty in procuring safe foods and felt insufficiently trained/education on FHS management.

Study reference:	**Coulson, E., Rifas-Shiman, S. L., Sordillo, J., Bunyavanich, S., Camargo, C. A., Jr, Platts-Mills, T., Coull, B. A., Luttmann-Gibson, H., Oken, E., Gold, D. R., & Rice, M. B. (2020). Racial, ethnic, and socioeconomic differences in adolescent food allergy. The journal of allergy and clinical immunology. In practice, 8(1), 336–338.e3. https://doi.org/10.1016/j.jaip.2019.06.006**

Study type:	Prospective pre-birth cohort study to examine racial, ethnic and socioeconomic differences in adolescent FA.
Study population:	USA
Publication date:	2020
Study quality and applicability:	Very low **Comments:** Uses food sensitisation as indicator for food allergy. Also used serologic data. No limitations reported in study. Confounders not taken into account.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in adults
Method:	Serologic data and data on race and socioeconomic factors of participants were collected from a different study. **Sample size:** n=1114
Findings:	Higher rates of food sensitisation among non-Hispanic Blacks and lower socioeconomic homes.
Strengths/ Limitations:	None reported.
Relevant outcomes:	There are racial and socioeconomic disparities in food sensitisation among adolescents.

Study reference:	**Adam, U. U., Melgies, M., Kadir, S., Henriksen, L., & Lynch, D. (2019). Coeliac disease in Caucasian and South Asian patients in the North West of England. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association, 32(4), 525–530. https://doi.org/10.1111/jhn.12622**
Study type:	Cohort study to examine adherence to gluten-free diet in Caucasian and South Asian celiac patients.
Study population:	UK
Publication date:	2019
Study quality and applicability:	Very low **Comments:** All self-reported data and is retrospective, subject to recall bias. Assessment of notes is subjective. Not using food challenges to determine food allergy. Confounders not taken into account. Small sample.
Key themes/ topics:	Adherence to GF diet
Method:	Data collected from dietetic coeliac disease database in an NHS trust. Follow-up visits to determine adherence were made 1 year within appointment. **Sample size:** n=146
Findings:	Larger proportion of Caucasian patients being fully adherent to gluten-free diet compared to South Asian patients (64.6% versus 12.1%, $P < 0.001$).

Strengths/ Limitations:	**Limitations**: Food diaries and 24-hours recall may be subject to different biases, serology data not available for review, subjective assessment of notes, confounding.
Relevant outcomes:	Adherence to gluten-free diets

Study reference:	**Hanci O, Jeanes YM Are gluten-free food staples accessible to all patients with coeliac disease? Frontline Gastroenterology 2019;10:222-228.**
Study type:	Cross-sectional survey of GF foods to understand costs and availability of GF foods.
Study population:	UK
Publication date:	2019
Study quality and applicability:	Very low **Comments:** Only surveyed supermarkets in one geographic area, not representative. Unclear on how comparison between cost of staple and non-staple foods were made.
Key themes/ topics:	Impact of socioeconomic differences on affordability/ accessibility/ availability to appropriate foods for those with FHS
Method:	Surveyed physical and online stores. Compared costs of GF to their GC counterparts.

Findings:	1. There's scarcity of manufactured GF foods within budget and convenience stores, more choices online. 2. Majority (82%) of GF food categories were significantly more expensive online compared with regular supermarkets. 3. This could exclude those with lower SES, poorer literacy, rural communities.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Accessibility of GF foods is lower in budget and convenience stores.

Study reference:	**Alayna P Tackett, Caroline M Roberts, Michael Farrow, Elizabeth L McQuaid, Food insecurity and caregiver perceptions of food allergen risk by food purchase location in children with food allergies, Translational Behavioral Medicine, Volume 9, Issue 3, June 2019, Pages 404–412, https://doi.org/10.1093/tbm/ibz059**
Study type:	Cross-sectional survey to understand relation between food purchase location and food allergen related risks and food-induced anaphylaxis from caregivers' perspective.
Study population:	USA
Publication date:	2019

Study quality and applicability:	Very low **Comments:** Self-reported data - subject to different biases. High proportion of minority were in survey - sampling bias.
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in children
Method:	Participants were recruited for a survey. **Sample size:** n=172
Findings:	1. Compared to caregivers who purchased food items at supermarkets/grocery stores, caregivers who purchased food items from gas stations, convenience marts, or bodegas reported greater perceived risk of accidental ingestion and greater frequency of food-induced anaphylaxis. 2. Caregivers in the latter group reported more food insecurity.
Strengths/ Limitations:	**Limitations**: cross-sectional, all data self-reported (no verification), oversampling of minority residents.
Relevant outcomes:	Those who report higher food insecurity also have higher perceived risk of food allergen risk and anaphylaxis.

Study reference:	**Frost, D. W., & Chalin, C. G. (2005). The effect of income on anaphylaxis preparation and management plans in Toronto primary schools. Canadian journal of public health = Revue canadienne de sante publique, 96(4), 250–253. https://doi.org/10.1007/BF03405156**

Study type:	Cross-sectional survey to understand relationship between the proportion of low-income households in Toronto neighbourhoods and the adequacy of anaphylaxis management plans in primary schools.
Study population:	Canada
Publication date:	2005
Study quality and applicability:	Very low **Comments:** Survey so all data self-reported by principal (subject to different biases). Low response rate (underrepresentation of those with suboptimal plans). No confounders taken into account.
Key themes/ topics:	Socioeconomic differences and management of FHS
Method:	Survey was distributed to principals of primary schools, asking about prevalence of food allergy and management plans. **Sample size:** n=50
Findings:	1. For children with severe reported food allergies attending schools in area with >20% low-income families, there is less likely to be medication in school than those in areas with <20% low-income households. 2. Staff EpiPen training and parental provision of information to the school not correlated with income.
Strengths/ Limitations:	**Limitations**: Data on prevalence and management reported by principal (could be in accurate), low response rate (underrepresentation of those with suboptimal plans).

Relevant outcomes:	Adequacy of management plans in low-income vs high-income schools.

Study reference:	**Almqvist, C., Pershagen, G., & Wickman, M. (2005). Low socioeconomic status as a risk factor for asthma, rhinitis and sensitization at 4 years in a birth cohort. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology, 35(5), 612–618. https://doi.org/10.1111/j.1365-2222.2005.02243.x**
Study type:	Prospective birth cohort study to understand relation between socioeconomic status and allergic diseases in children.
Study population:	Sweden
Publication date:	2005
Study quality and applicability:	Low **Comments:** No food challenges used (serologic data used to confirm allergies). Only used occupation to determine socioeconomic status. However, large sample size and confounders taken into account (but cannot discount residual confounding especially ethnicity).
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in children
Method:	Questionnaire answer by families in predefined areas about environmental and socioeconomic factors, and allergy symptoms.

	Blood samples of children were taken at 4 years and tested for specific IgE to common airborne and food allergens. **Sample size:** n=4089
Findings:	1. Risk of sensitization to food allergens also decreased with increasing socioeconomic status. 2. OR 0.65 (0.41-1.02) in the highest socioeconomic group & OR 0.78 (0.57-1.03) for second lowest socioeconomic group.
Strengths/ Limitations:	**Limitations**: Residual confounding, no information on household income and ethnicity.
Relevant outcomes:	Socioeconomic status (i.e occupation) and risk of sensitisation to food allergens.

Study reference:	**Brar, P., Lee, A. R., Lewis, S. K., Bhagat, G., & Green, P. H. (2006). Celiac disease in African Americans. Digestive diseases and sciences, 51(5), 1012–1015. https://doi.org/10.1007/s10620-005-9000-5**
Study type:	Case Series describing celiac disease in African Americans
Study population:	US
Publication date:	2006

Study quality and applicability:	Very low **Comments:** Small sample size, only 9 patients and database is from one specialist centre. No control group to compare to. Residual confounding. However, biopsy proven CD - which is robust.
Key themes/ topics:	Adherence to GF diet
Method:	African American patients with biopsy-proven celiac were identified from a prospectively generated database of 700. All relevant data were prospectively recorded **Sample size:** n=9
Findings:	1. Diarrhoea was present in only 2 patients, while 3 presented with iron deficiency anaemia. 3 had at least one autoimmune disease. 2. Adherence to a gluten-free diet was poor, with only 4/9 adhering.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Celiac disease symptoms and GF adherence in African-americans

Study reference:	**Freeman H. J. (2003). Biopsy-defined adult celiac disease in Asian-Canadians. Canadian journal of gastroenterology = Journal canadien de gastroenterologie, 17(7), 433–436. https://doi.org/10.1155/2003/789139**

Study type:	Retrospective record review describing celiac disease in Asian-Canadians.
Study population:	Canada
Publication date:	2003
Study quality and applicability:	Very low **Comments:** Small sample size (n=14) and all from one hospital. No control group to compare with. No report on compliance to GF diet even though it was assessed. Residual confounding. However, biopsy-proven CD is used - robust diagnosis.
Key themes/ topics:	Racial differences in prevalence of food hypersensitivities in adults
Method:	Asian patients with biopsy-proven celiac were identified from a prospectively generated database of 214. Medical records were reviewed and compliance to GF diet was repeatedly assessed. **Sample size:** n=14
Findings:	1. 10/14 are of Punjabi descent 2. Abdominal pain is the most frequent symptom.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Celiac disease prevalence and symptoms in Asian-Canadians.

Study reference:	**Butterworth, J. R., Banfield, L. M., Iqbal, T. H., & Cooper, B. T. (2004). Factors relating to compliance with a gluten-free diet in patients with coeliac disease: comparison of white Caucasian and South Asian patients. Clinical nutrition (Edinburgh, Scotland), 23(5), 1127–1134. https://doi.org/10.1016/j.clnu.2004.02.009**
Study type:	Cross-sectional study to identify factors of compliance with a GF diet among Caucasian & South Asian patients.
Study population:	UK
Publication date:	2004
Study quality and applicability:	Very low **Comments:** Self-reported data on adherence to GFD and related factors (recall bias). All patients from one specialist centre. Higher response rate among Caucasian than Asian patients (selection bias).
Key themes/ topics:	Adherence to GF diet
Method:	Survey distributed to 130 patients with biopsy-proven CD. Responses received with 9:4 Caucasian to Asian patients. Questionnaire included symptoms, advice given, adherence to GF diet **Sample size:** n=87
Findings:	1. Higher proportions of Caucasian patients reported never ingesting gluten or did so less than once a month. (P=0:04 and 0.03, respectively).

	2. All 7 factors were correlated with perceived strictness of GFD of Caucasian patients: Coeliac Society membership, obtaining GF foods on prescription, obtaining sufficient GF foods on prescription, understanding food labelling, affordability of GF foods, explanation by the physician about coeliac disease and the need for the GFD and regular dietetic follow-up. 3. None were correlated for South Asian patients.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Factors explaining difference in adherence to GFD among Caucasian and South Asian patients.

Study reference:	**Ludvigsson, J. F., & ABIS Study Group (2005). Socio-economic characteristics in children with coeliac disease. Acta paediatrica (Oslo, Norway : 1992), 94(1), 107–113. https://doi.org/10.1111/j.1651-2227.2005.tb01796.x**
Study type:	Prospective Cohort Study to understand the relationship between socioeconomic factors and coeliac disease among children.
Study population:	Sweden
Publication date:	2005
Study quality and applicability:	Low

	Comments: Large sample size - robust. However, only small proportion are positive CD cases (under sampling). Biopsy Proven CD - robust diagnosis. Confounders taken into account but could have residual confounding. Also, socioeconomic data self-reported (bias) and reported at birth but CD diagnosis was done at later time (socioeconomic data might have changed).
Key themes/ topics:	Socioeconomic differences in prevalence of food hypersensitivities in children
Method:	Mothers of children born in Southwest Sweden from 1997-1999 were invited to participated and answered questionnaires on socioeconomic factors. CD confirmed by biopsy. **Sample size:** n=16,286
Findings:	1. Coeliac disease less common among children with mothers who worked < 3 months during pregnancy, adjusted for confounders (R = 0.28; 95% CI: 0.09-0.92). 2. No other socioeconomic factor related to CD.
Strengths/ Limitations:	**Limitations**: Residual confounding (observational study), Socioeconomic data and CD diagnosis data collected at different times, Positive CD cases are low in proportion to sample.
Relevant outcomes:	Relationship of socioeconomic factors and CD in children.

Study reference:	**Lee, A. R., Ng, D. L., Zivin, J., & Green, P. H. (2007). Economic burden of a gluten-free diet. Journal of human nutrition and dietetics: the official journal of the British Dietetic Association, 20(5), 423–430. https://doi.org/10.1111/j.1365-277X.2007.00763.x**

Study type:	Observational Study to examine availability and cost differentials of GF food in the public.
Study population:	USA
Publication date:	2007
Study quality and applicability:	Low **Comments**: Observational study so graded as low. No reason to grade down as methods to compare cost differentials were defined clearly and study was conducted in various locations.
Key themes/ topics:	Impact of socioeconomic differences on affordability/ accessibility/ availability to appropriate foods for those with FHS
Method:	Analysed price differences of a market basket of goods between location and type of stores.
Findings:	1. Every gluten-free product was more expensive than their wheat-based counterpart (P = 0.05). 2. Regular grocery stores carried 36%, while upscale markets carried 41%, and health food stores 94%, compared with 100% availability on the internet.
Strengths/ Limitations:	None reported.
Relevant outcomes:	GF foods are less readily available and more expensive.

Study reference:	**Whyte, L. A., Kotecha, S., Watkins, W. J., & Jenkins, H. R. (2014). Coeliac disease is more common in children with high socio-economic status. Acta paediatrica, 103(3), pp. 289–294.**
Study type:	Cohort Study to determine whether socioeconomic deprivation increases or reduces Coeliac disease development
Study population:	Wales
Publication date:	2014
Study quality and applicability:	Very Low **Comment**: Potential confounders like ethnicity not taken into account in analysis. The study also has small sample sizes and uses current postcode to determine socioeconomic status, which may not be accurate.
Key themes/ topics:	Socioeconomic differences in prevalence of FH in children
Method:	Data collected from a cross-sectional study (of children < 16 years old) diagnosed with coeliac disease from a particular medical centre, and linked with Welsh Index of Multiple Deprivation score 2008 (n=232)
Findings:	Higher prevalence of CD in low deprivation area (rate = 1.16) than high deprivation area (0.49)
Strengths/ Limitations:	Limitations: Relatively small sample size limited by number of patients in geographical area
Relevant outcomes:	Higher CD prevalence among children living in affluent areas

Study reference:	**Mullins, R.J., Clark, S. & Camargo, C.A., Jr. (2010). Socio-economic status, geographic remoteness and childhood food allergy and anaphylaxis in Australia. Clinical & Experimental Allergy, 40, pp. 1523-1532.**
Study type:	Retrospective review study of association between socio-economic status (SES), geographic remoteness and childhood FA and anaphylaxis in Australia
Study population:	Australia
Publication date:	2010
Study quality and applicability:	Very Low **Comment**: Indirect - Uses sales of IHF and EpiPens, and hospital admissions rate as proxy for FA. Also. There are no confirmatory allergy tests done to ensure robustness of clinical diagnosis
Key themes/ topics:	Socioeconomic differences in prevalence of FH in children
Method:	Sales of infant hypoallergenic formulae (IHF) and EpiPens for children ages 0-4 and hospital anaphylaxis admission rates for children and adults were used as proxies for food allergy and anaphylaxis. Used government and commercial data to obtain SES and geographic data. Age-specific rates for IHF and EpiPen sales and anaphylaxis admissions were expressed per 100 000 population/year.
Findings:	Annual IHF sales rates are higher for those with greater socio-economic advantages (47 830 vs. 21 384 tins/100 000 population; $P < 0.001$). EpiPen sales were also higher in those with greatest socio-economic advantages most marked in those aged 0–4 (1713 vs. 669/100 000; $P = 0.002$) and 5–14 years(1628 vs.

	600/100 000; P = 0.001). While anaphylaxis admission rates were higher in those with the greatest compared with the least socio-economic advantage in children aged 0–4 years (129 vs. 92/100 000 population/year; P = 0.03), the opposite was observed in older age groups (e.g. aged 25–64 years: 43 vs. 76, P = 0.01). There was no association between geographic remoteness and anaphylaxis admissions
Strengths/ Limitations:	Limitations: Using hospital admissions as proxy has inherent limitations such as underrepresenting the true incidence of anaphylaxis in communities where medical attention is not sought and dependence on accuracy of clinical diagnosis without confirmatory testing.
Relevant outcomes:	Socio-economic advantage and residence in major cities may be risk factors for developing childhood FA and anaphylaxis

Study reference:	**Sverker, A., Östlund, G., Hallert, C., & Hensing, G. (2009). 'I lose all these hours…'– exploring gender and consequences of dilemmas experienced in everyday life with coeliac disease. Scandinavian Journal of Caring Sciences, 23, pp. 342-352.**
Study type:	Mixed methods study to understand gender and household activities of those with CD or has a close relative with CD
Study population:	Sweden
Publication date:	2009
Study quality and applicability:	Very Low

	Comment: Findings mainly based on qualitative data which is seld-reported, thus subject to several biases. The study also has a small sample size and unbalanced gender grouping, with more proportion of females in people with CD but signifiantly lower proportion of females in close relatives.
Key themes/ topics:	Gender and experiences of CD
Method:	The qualitative section was done through semi-structured interviews on impact of CD on their everyday life. The quantitative section was through a questionnaire on food preparation, purchasing, cooking habits, and meal behaviour. (n=76)
Findings:	Women and men experienced similar consequences of dilemma of CD on everyday life (e.g. daily concerns of gluten and constant preparation of gluten-free food, social exclusion, and emotional pressure). However, men and women reported having different responsibilities in relation to food preparation etc as that burden mainly falls on women.
Strengths/ Limitations:	Strengths: 2 researchers were involved in identification and categorisation of the consequences which increases reliability of analysis Limitations: Only focused on consequences of problematic situations, irrespective of degree of difficulty and frequency. Low number of female close relatives interviewed.
Relevant outcomes:	Women and men with CD experience similar consequences of dilemma in everyday life but differ in food preparation responsibilities

Study reference:	**Sampson, M. A., Muñoz-Furlong, A., & Sicherer, S. H. (2006). Risk-taking and coping strategies of adolescents and young adults with food allergy. The Journal of allergy and clinical immunology, 117(6), pp. 1440–1445.**
Study type:	Cross-sectional study to understand food allergen management behaviours of adolescents and young adults
Study population:	USA
Publication date:	2006
Study quality and applicability:	Very Low **Comment**: Small sample size. All self-reported data and diagnosis of food allergy is not confirmed. Could have selection bias as participants all recruited through an allergy website.
Key themes/ topics:	Management of FA among adolescents
Method:	Distributed an anonymous questionnaire to participants aged 13-21 (n=174). Open call was promoted via advertisements on Food Allergy & Anaphylaxis Network (FAAN) newsletter and websites. Participants out of the age range or did not have food allergies were excluded.
Findings:	Regarding risk taking, 61% reported that they ‘‘always’’ carry self-injectable epinephrine, but frequencies varied according to activities: traveling (94%), restaurants (81%), friends’ homes (67%), school dance (61%), wearing tight clothes (53%), and sports (43%). 54 % indicated purposefully ingesting a potentially unsafe food. Willingness to eat a food labelled ‘‘may contain’’ an allergen was reported by 42%. Twenty-nine participants were designated at high risk because they did not always carry epinephrine and ate foods

	that ‘‘may contain’’ allergens. The high-risk group, compared with the rest of the participants (P < .05), felt less ‘‘concern’’ about and ‘‘different’’ because of their allergy and had more recent reactions.
Strengths/ Limitations:	Limitations: Self-reported data, which could be subject to recall bias or social desirability bias. Participants are recruited from food allergy sites thus might represent more educated group and there is no confirmed diagnosis of food allergy (self-reported).
Relevant outcomes:	Significant number of adolescents and young adults with FA admit taking risks that vary by social circumstances. Education could reduce this risk taking behaviour.

Study reference:	**Acker, W. W., Plasek, J. M., Blumenthal, K. G., Lai, K. H., Topaz, M., Seger, D. L., Goss, F. R., Slight, S. P., Bates, D. W., & Zhou, L. (2017). Prevalence of food allergies and intolerances documented in electronic health records. The Journal of allergy and clinical immunology, 140(6), pp. 1587–1591.**
Study type:	Retrospective population study determining the prevalence of food allergy and intolerance documented in the electronic health records allergy module.
Study population:	USA
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Reliance on secondary data and unverified allergy data (self-reporting of allergy without diagnosis)

Key themes/ topics:	Racial differences in prevalence of FH in adults
Method:	Electronic health records were analysed for food allergy prevalence (2000-2013) n=97,482. Data were validated using radioallergosorbent test and ImmunoCAP results, when available, for patients with reported peanut allergy.
Findings:	The prevalence of food allergy and intolerance was higher in females (4.2% vs 2.9%; P < .001) and Asians (4.3% vs 3.6%; P < .001).
Strengths/ Limitations:	Limitations: Unverified allergy data. Inaccurate records due to self-reporting and food preferences that may not be allergies. EHR format was not suitable to capture food allergies details. Potential Overestimation due to method of data generation.
Relevant outcomes:	Females and Asians are more likely to have food allergies and intolerance

Study reference:	**Gupta, R. S., Rivkina, V., DeSantiago-Cardenas, L., Smith, B., Harvey-Gintoft, B., & Whyte, S. A. (2014). Asthma and food allergy management in Chicago Public Schools. Pediatrics, 134(4), pp. 729–736.**
Study type:	Population based study aimed to characterize asthma and food allergy reporting and management in Chicago Public Schools.
Study population:	USA
Publication date:	2014

Study quality and applicability:	Very Low **Comment**: An accurate chronic disease reporting and management system could help better reporting. Study is based on self-reported data, which may not be robust
Key themes/ topics:	Racial differences in prevalence of FHs in children
Method:	Population based study (2012/2013): Demographic and health data for students who have asthma and food allergy were extracted from the Chicago Public Schools database. 18 000 asthmatic and 4000 food allergic students were identified.
Findings:	In children only in Chicago schools • Of asthmatic students, 9.3% had a food allergy; of food allergic students, 40.1% had asthma. • Asthma odds were significantly higher among black and Hispanic students • Food allergy odds were significantly higher among black students and significantly lower among Hispanic students.
Strengths/ Limitations:	Limitations: Causal inferences are limited by the cross-sectional design, which restricts analysis to descriptive statistics and associations. Parent-reported asthma and/or food allergy were not included in analysis.
Relevant outcomes:	Black students have higher chances of having food allergies while Hispanic students are less likely to have food allergies

Study reference:	**Natcen for FSA (2017). Profiles and practices of people with food hypersensitivities**
Study type:	Secondary analysis study in the UK based on FDA's Food and You survey (n=12,965) on demographics of those with food allergies versus those without.
Study population:	UK
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Based on self-reported data and secondary data analysis
Key themes/ topics:	Socioeconomic differences in prevalence of FH in adults
Method:	Performed secondary analysis on data collected by FSA's Food and You Survey
Findings:	UK secondary analysis study found socioeconomic factors such as household size, presence of children, working status, educational level and country of residence are not related with impact on health or risks associated with FHs.
Strengths/ Limitations:	None reported
Relevant outcomes:	Association between socioeconomic factors and health or risks of FHs

9. IMPACT OF ENVIRONMENTAL EXPOSURES ON THE RISK OF DEVELOPING FHS

Study reference:	**Kim, J., Chang, E., Han, Y., Ahn, K., & Lee, S. I. (2011). The incidence and risk factors of immediate type food allergy during the first year of life in Korean infants: a birth cohort study. Pediatric allergy and immunology, 22(7), pp. 715–719.**
Study type:	Prospective birth-cohort study examining the incidence of food allergy in Korean infants and identifying risk factors associated with this
Study population:	Korea
Publication date:	2011
Study quality and applicability:	Low **Comment**: oral food challenge was not used
Key themes/ topics:	Birth season as a risk factor for developing FHs
Method:	Questionnaire and telephone interviews. Medical data was collected through biological samples and medical records. Statistical analysis includes the Chi-squared test and the Fisher exact test; univariate and multivariate logistic regression. Sample size: n=1177 infants
Findings:	1) Children with a history of maternal AD showed a significantly higher prevalence of FA (P = 0.012)

	2) Children who were born during autumn had a higher prevalence than those born during spring (p = 0.005)
Strengths/ Limitations:	Limitations: no oral food challenge was used due to age of children.
Relevant outcomes:	Maternal history of atopic dermatitis is associated with the development of food allergies in the offspring. Children who are born in autumn are more likely to have food allergies than those born in spring.

Study reference:	**Liu, X., Wang, G., Hong, X., Wang, D., Tsai, H. J., Zhang, S., Arguelles, L., Kumar, R., Wang, H., Liu, R., Zhou, Y., Pearson, C., Ortiz, K., Schleimer, R., Holt, P. G., Pongracic, J., Price, H. E., Langman, C., & Wang, X. (2011). Gene-vitamin D interactions on food sensitization: a prospective birth cohort study. Allergy, 66(11), pp. 1442–1448.**
Study type:	Cohort study aimed to examine whether deficiency in Vitamin D contributes to the development of food allergies
Study population:	USA
Publication date:	2011
Study quality and applicability:	Very Low Comment: low generalisability as a small and very specific sample from Boston Birth Cohort - selection bias

Key themes/ topics:	Vitamin D status and intake as risk factors for developing FHs
Method:	Assessing Vitamin D levels; Logistic regression Sample size: n=649
Findings:	Low cord blood vitamin D levels significantly increase the risk of food sensitisation among children with certain genotypes.
Strengths/ Limitations:	Limitations: confounding effect of population stratification; variability in Vitamin D deficiency cut-offs
Relevant outcomes:	Vitamin D deficiency may increase the risk of food sensitisation among individuals with certain genotypes.

Study reference:	**Grimshaw, K., Roberts, G., Selby, A., Reich, A., Butiene, I., Clausen, M., Dubakiene, R., Fiandor, A., Fiocchi, A., Grabenhenrich, L. B., Larco, J. I., Kowalski, M. L., Rudzeviciene, O., Papadopoulos, N. G., Rosenfeld, L., Sigurdardottir, S. T., Sprikkelman, A. B., Schoemaker, A. A., Xepapadaki, P., Mills, E., Keil., T., & Beyer, K. (2020). Risk Factors for Hen's Egg Allergy in Europe: EuroPrevall Birth Cohort. The journal of allergy and clinical immunology. In practice, 8(4), pp. 1341–1348.**
Study type:	Birth cohort study assessing the risk factors, particularly eczema, for hen's egg allergy
Study population:	Europe
Publication date:	2020

Study quality and applicability:	Low Comment: DBPCFC is a strength of this study, however, very small sample which limits generalisability
Key themes/ topics:	Other (multiple factors)
Method:	Questionnaire. Allergy diagnosis: skin prick testing, specific IgE assessment, and double-blind, placebo-controlled food challenge. Sample size: n=86 (84 DBPCFC) and 140 controls
Findings:	Independently associated with egg allergy were past/current eczema (adjusted odds ratio, 9.21; 95% CI, 2.65-32.04), Scoring Atopic Dermatitis (1.54 per 5 units; 1.28-1.86), antibiotics in the first week of life (6.17; 1.42-26.89), and current rhinitis (3.02; 1.04-8.78). Increasing eczema severity was associated with an increasing likelihood of egg allergy. Eczema was reported to have started 3.6 (SE, 0.5) months before egg allergy. Age of introduction of egg into the diet was not associated with egg allergy.
Strengths/ Limitations:	n/a
Relevant outcomes:	Eczema was strongly associated with egg allergy development and the association increased with increasing eczema severity. The age of introduction of dietary egg was not a risk factor. The potential role of antibiotics in early life as a risk factor for egg allergy needs further examination.

Study reference:	**Venter, C., Palumbo, M.P., Sauder, K.A., Glueck, D.H., Liu, A.H., Yang, I., Abdullah, M.B., Fleischer, D., & Dabelea, D. (2020) Incidence and timing of offspring asthma, wheeze, allergic rhinitis, atopic dermatitis and food allergy and association with maternal history of asthma and allergic rhinitis. World Allergy Organization Journal [Unpublished paper]**
Study type:	Pre-birth cohort study assessing the associations between maternal history of asthma and the development of respiratory and allergic diseases in offspring.
Study population:	USA
Publication date:	2020
Study quality and applicability:	Very Low Comment: Self-reported mother's atopy, also unpublished so results are subject to change.
Key themes/ topics:	Maternal atopy as a risk factor for developing FHs
Method:	Maternal history of asthma and allergic rhinitis - self-reported during early pregnancy. Offspring respiratory and allergy information - electronic medical records. Adjusted Cox proportional hazard models assessed the associations between maternal history of asthma and development of respiratory and allergic diseases in the offspring up to 8 years. Sample size: n=1410
Findings:	Children born to women with a history of asthma had an 77% greater risk of developing asthma, a 45% greater risk of atopic dermatitis/eczema, and a 65% greater risk of wheeze (all $p<0.01$), but no significantly

	increased risk of allergic rhinitis or food allergies, compared to children born to women with no history of asthma.
Strengths/ Limitations:	Limitations: No data on maternal history of atopic dermatitis/eczema or food allergy. Not able to separate mothers with a history of allergic asthma from those with non-allergic asthma. No specific IgE tests or skin prick test to confirm atopic status in the pregnant women or their offspring. Only used sensitization information from the electronic medical record to confirm the food allergy diagnosis.
Relevant outcomes:	There's no association between maternal asthma and child food allergies

Study reference:	**Mullins, R. J., Clark, S., Katelaris, C., Smith, V., Solley, G., & Camargo, C. A., Jr (2011). Season of birth and childhood food allergy in Australia. Pediatric allergy and immunology, 22(6), pp. 583–589.**
Study type:	Cohort study aiming to examine the relationship between low Vitamin D and food allergies pathogenesis
Study population:	Australia
Publication date:	2011
Study quality and applicability:	Very Low Comment: FA diagnosis is unclear, no tests were used to verify it, relied on the parents' concern of possible FA.
Key themes/ topics:	Birth season as a risk factor for developing FHs

	Vitamin D status and intake as risk factors for developing FHs
Method:	Compared IgE-mediated food allergy rates by season of birth in children aged 0–4yr assessed 1995–2009 in a specialist referral clinic, using population births as controls. Statistical analysis included chi-squared tests and linear regression. Sample size: n=835
Findings:	1) Autumn/winter births were more common than spring/summer births among food allergy patients (57% vs. 43%; $p < 0.001$). The same seasonal pattern was observed with peanut (60% vs. 40%; $p < 0.001$) and egg (58% vs. 42%; $p = 0.003$). 2) Regional UVR intensity was correlated with relative rate of overall food allergy (β, −1.83; $p = 0.05$) and peanut allergy (β, −3.27; $p = 0.01$).
Strengths/ Limitations:	Limitations: Birth month pattern was only examined by location of residence, no adjustment for other factors - possibility of confounding. Referral bias
Relevant outcomes:	Ultraviolet light exposure/Vitamin D status maybe one of the factors that contribute to the development of food allergies. People who are born in autumn/winter are more likely to have food allergies compared to those born in spring/summer.

Study reference:	**Lannerö, E., Wickman, M., van Hage, M., Bergström, A., Pershagen, G., & Nordvall, L. (2008). Exposure to environmental tobacco smoke and sensitisation in children. Thorax, 63(2), pp. 172–176.**
Study type:	Retrospective cohort study examining whether exposure to smoking prenatally/post-natally is associated with IgE sensitisation in children of 4 years old.
Study population:	Sweden
Publication date:	2008
Study quality and applicability:	Very Low Comment: retrospective data collection, confounding bias
Key themes/ topics:	Exposure to smoking as a risk factor for developing FHs
Method:	Questionnaire. Blood collected at age 4 years from 2614 children was analysed for IgE antibodies to common inhalant and food allergens. Odds ratios (OR) and 95% confidence intervals (CI) were calculated using logistic regression with adjustments for potential confounders. Sample size: n=4089 families
Findings:	No evidence to suggest that maternal smoking increases risk of IgE sensitisation. There was an increased risk of sensitisation to inhalant and/or food allergens (OR(adj) 1.28 (95% CI 1.01 to 1.62)) among children exposed to ETS at 2 months of age.

Strengths/ Limitations:	Limitations: lack of objective assessment of smoke exposure (as surveys were filled in by parents); a risk of recall bias; potential for selection bias (non-participation by smoker parents)
Relevant outcomes:	Smoking exposure in infancy increases the risk of sensitisation to food allergens.

Study reference:	**Wingren, C. J., Agardh, D., & Merlo, J. (2012). Acculturation and celiac disease risk in second-generation immigrants: a nationwide cohort study in Sweden. Scandinavian journal of gastroenterology, 47(10), 1174–1180.**
Study type:	Cohort study examining environmental factors that can increase risk of celiac disease.
Study population:	Sweden
Publication date:	2012
Study quality and applicability:	Very Low **Comment**: Confounding bias is of high risk
Key themes/ topics:	Other (multiple factors)
Method:	Collecting clinical data from national registry; Cox regression models

Findings:	1) In children whose mothers immigrated to Sweden from a country outside of Europe, a maternal length of stay in Sweden of more than 5 years increased the hazard ratio (HR) of CD (1.73, 95% confidence interval (CI) 1.06–2.81). 2) Observed a similar result among children born to mothers from a Nordic country outside of Sweden (HR 1.57, 95% CI 0.89–2.75), but a non-conclusive protective effect was observed in second-generation immigrant children from a non-Nordic European country (HR 0.65, 95% CI 0.39–1.09).
Strengths/ Limitations:	Limitations: lack of clinical information on breastfeeding length and timeframes of gluten introduction into child's nutrition; no data on countries of origin for both parents.
Relevant outcomes:	The risk of developing celiac disease may be conditioned by maternal length of stay in Sweden prior to the birth of a child. This suggests that environmental factors contribute to the risk variation of CD.

Study reference:	**Dubakiene, R., Rudzeviciene, O., Butiene, I., Sezaite, I., Petronyte, M., Vaicekauskaite, D., & Zvirbliene, A. (2012). Studies on early allergic sensitization in the Lithuanian birth cohort. TheScientificWorldJournal, 2012, 909524.**
Study type:	Cohort study examining environmental factors that increase the risk of FHs
Study population:	Lithuania
Publication date:	2012

Study quality and applicability:	Low **Comment**: parental questionnaires filled at the day of the recruitment, 12 months questionnaires and physical examination form, results of performed skin prick tests (SPT) and specific Ig-E (sIgE) analysis. All infants with suspected food allergy were clinically evaluated including DBPCFC.
Key themes/ topics:	Antibiotics intake as a risk factor for developing FHs Maternal atopy as a risk factor for developing FHs
Method:	EuropPrevall cohort. Data collected on the maternal factors antenatally and at months 6 and 12. The questionnaires included data on pre-existing diseases, intake of foods, nutritional supplements, medications, tobacco, sociodemographic data, pet ownership, and family history. In addition to three telephone interviews during the first months, parents were asked to immediately inform the allergology centre about possible allergic reactions to food at any time during the follow-up period. Sample size: n=12,049
Findings:	No significant impact of following factors on early food sensitisation: antibiotics ($P>0.05$); avoidance of milk and eggs or consumption of these in elevated amounts ($P>0.05$); parental allergic diseases. But, children of atopic mothers are more likely to be sensitized to egg (37.5%) compared to children of non-atopic mothers (17.3%)
Strengths/ Limitations:	None reported

Relevant outcomes:	Such factors as diseases, maternal dies, antibiotics and tobacco smoke during pregnancy are not identified as significant factors that can impact on the early sensitisation to food allergens.

Study reference:	**Mårild, K., Stephansson, O., Montgomery, S., Murray, J. A., & Ludvigsson, J. F. (2012). Pregnancy outcome and risk of celiac disease in offspring: a nationwide case-control study. Gastroenterology, 142(1), pp. 39–45.**
Study type:	Case-control study examining caesarean delivery as risk factor for the development of celiac disease
Study population:	Sweden
Publication date:	2012
Study quality and applicability:	Low **Comment**: possible confounding bias
Key themes/ topics:	Caesarean delivery as a risk factor for developing FHs
Method:	Biopsy-verified celiac disease. Statistical analysis icnludes odds ratios, confidence intervals, logistic regression, multivariate analysis Sample size: n=11,749 individuals with CD and 53,887 controls.

Findings:	1) Positive association between elective caesarean delivery and later celiac disease (adjusted OR 1.15; 95 CI; 1.04 –1.26), but no increased risk of celiac disease after emergency (adjusted OR, 1.02; 95% CI, 0.92–1.13) or any caesarean delivery (adjusted OR, 1.06; 95% CI, 0.99 –1.13). 2) Infants born small for gestational age were at a 21% increased risk of celiac disease (95% CI, 1.09 – 1.35).
Strengths/ Limitations:	Strengths: prospectively recorded exposure and outcome data - no recall bias; large population sample - highly representative. Limitations: didn't account for breastfeeding as potential confounder.
Relevant outcomes:	Bacterial flora of the Newborn plays a role in the development of celiac disease. Elective caesarean delivery is positively associated with later celiac disease

Study reference:	**Namatovu, F., Lindkvist, M., Olsson, C., Ivarsson, A., & Sandström, O. (2016). Season and region of birth as risk factors for coeliac disease a key to the aetiology?. Archives of disease in childhood, 101(12), pp. 1114–1118.**
Study type:	Prospective cohort longitudinal study examining season of birth and risk for the development of celiac disease
Study population:	Sweden
Publication date:	2016

Study quality and applicability:	Low **Comment**: Large study sample: 1 912 204 children were identified of which n=6596 were diagnosed with CD. Potential confounders (infections and Vitamin D).
Key themes/ topics:	Birth season as a risk factor for developing FHs
Method:	Medical data collected from medical records and celiac disease was biopsy verified. Statistical analysis included Cox regression.
Findings:	CD risk was higher for children born during spring, summer and autumn as compared with children born during winter: adjusted HR for spring 1.08 (95% CI 1.01 to 1.16), summer 1.10 (95% CI 1.03 to 1.18) and autumn 1.10 (95% CI 1.02 to 1.18). Increased CD risk was highest if born in the south, followed by central Sweden when compared with children born in northern Sweden.
Strengths/ Limitations:	Limitations: lack of data on infections and vitamin D level.
Relevant outcomes:	Season of birth and region of birth are associated with increased risk of developing CD during the first 15 years of life. Seasonal variation in infectious load is the likely explanation

Study reference:	**Stelmach, I., Majak, P., Jerzynska, J., Podlecka, D., Stelmach, W., Polańska, K., Ligocka, D., & Hanke, W. (2015). The effect of prenatal exposure to phthalates on food allergy and early eczema in inner-city children. Allergy and asthma proceedings, 36(4), pp. 72–78.**
Study type:	Prospective cohort study examining whether maternal prenatal and children urine metabolite concentration of phthalates would be associated with food allergy and early eczema among inner-city children.
Study population:	n/a
Publication date:	2015
Study quality and applicability:	Very Low **Comment**: small sample size
Key themes/ topics:	Prenatal phthalate exposure as a risk factor for developing FHs
Method:	Medical data collected includes urinal samples. Statistical analysis includes logistic regression. Sample size: n=147
Findings:	Higher urine concentrations of monobenzyl phthalate in mothers during pregnancy increased the risk of food allergy in children during the first 2 years of life (odds ratio 4.17 [95% confidence interval, 1.17–17.89]).
Strengths/ Limitations:	Limitations: white population only.

	Strengths: use of a urinary biomarker of phthalate exposures in mothers and offspring
Relevant outcomes:	Promoting the ecological model of living seems to be helpful in minimizing human's exposure to phthalates. As high levels of phthalate during pregnancy are a risk factor for developing food allergy in the offspring.

Study reference:	**Gaylord, A., Trasande, L., Kannan, K., Thomas, K. M., Lee, S., Liu, M., & Levine, J. (2020). Persistent organic pollutant exposure and celiac disease: A pilot study. Environmental research, 186, 109439.**
Study type:	Pilot study which aims to elucidate the association between persistent organic polluters and celiac disease.
Study population:	US
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Very small sample; prevalence of female participants problematises comparing female and male odds of celiac disease due to POP. Low generalisability as mostly non-Hispanic white participants
Key themes/ topics:	Exposure to pollutants as a risk factor for developing FHs
Method:	PBDE, DDE, and PFAS measurements. Upper intestinal endoscopy to determine CD. Genetic susceptibility score. Statistical analysis includes odds ratios, Chi-square test and the Fischer Exact Test.

Findings:	Statistically significant association of DDE with celiac disease (95% CI = 1.08, 3.84).
Strengths/ Limitations:	Limitations: small sample size, lack of racial variance; limited sample size limits the power for sub-analyses and statistical interaction.
Relevant outcomes:	Increased odds of celiac disease associated with specific persistent organic pollutants, and in particular p,p'-dichlorodiphenyldichloroethylene, although these estimates lacked precision.

Study reference:	**Hicke-Roberts, A., Wennergren, G., & Hesselmar, B. (2020). Late introduction of solids into infants' diets may increase the risk of food allergy development. BMC pediatrics, 20(1), pp. 273.**
Study type:	Retrospective survey study examining introduction of solid foods into a child's diet as a risk factor of developing FHs
Study population:	Sweden
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Self-reported allergies
Key themes/ topics:	Postnatal dietary patterns as risk factors for developing FHs
Method:	Questionnaire

	Sample size: n=1029
Findings:	Introduction of solids into a child's diet from the age of 7 months or later, and maternal history of allergic disease, were both risk factors associated with a higher risk of food allergy or intolerance.
Strengths/ Limitations:	Limitations: low response rate. Strengths: the uniform methods used in both towns with the same validated questions for asthma, ARC and eczema, targeting the same age groups and similar populations, as well as the overall number of participants in the study and the broad data collection that allowed to do comparisons between allergies in the index child with allergies in the siblings.
Relevant outcomes:	Late introduction of solids into an infant's diet may be one risk factor for developing food allergy or intolerance.

Study reference:	**Tsuang, A., Grishin, A., Grishina, G., Do, A. N., Sordillo, J., Chew, G. L., & Bunyavanich, S. (2020). Endotoxin, food allergen sensitization, and food allergy: A complementary epidemiologic and experimental study. Allergy, 75(3), pp. 625–635.**
Study type:	Retrospective cohort study examining household endotoxin levels and risk for food sensitisation
Study population:	US
Publication date:	2020

Study quality and applicability:	Low **Comment**: highly representative sample
Key themes/ topics:	Household factors and risk for developing FHs
Method:	Secondary medical data; logistic regression models; peripheral blood mononuclear cell collected; peripheral blood mononuclear cell. Household endotoxin level measurement. Sample size: n=6963
Findings:	Household endotoxin level was associated with sensitization to milk (OR 1.7, 95% CI 1.2-2.1) and egg (OR 1.4, 95% CI 1.01-1.9), but not peanut (OR 0.98, 95% CI 0.8-1.2)
Strengths/ Limitations:	Limitations: challenging to determine causal connections. Strengths: large representative sample
Relevant outcomes:	Higher household endotoxin is associated with increased odds of milk and egg sensitization.

Study reference:	**Aversa, Z., Atkinson, E. J., Schafer, M. J., Theiler, R. N., Rocca, W. A., Blaser, M. J., & LeBrasseur, N. K. (2021). Association of Infant Antibiotic Exposure With Childhood Health Outcomes. Mayo Clinic proceedings, 96(1), pp. 66–77.**

Study type:	Retrospective cohort study investigating the extent to which antibiotic exposure in the first 2 years of life is associated with the risk of immunological health conditions with childhood onset.
Study population:	US
Publication date:	2021
Study quality and applicability:	Very Low Comment:
Key themes/ topics:	Antibiotics intake as a risk factor for developing FHs
Method:	Time-to-event analysis; medical records Sample size: n=18,160
Findings:	Early antibiotic exposure was associated with an increased risk of celiac disease ($P<0.05$)
Strengths/ Limitations:	Strengths: well characterized population-based cohort, the long follow-up duration, and the capture and confirmation of antibiotic prescriptions and of a broad set of medical diagnoses through the records-linkage system - eliminates recall bias. Limitations: could not disentangle the effects of antibiotics from those of the underlying conditions, which may have resulted in confounding by indication; could not verify adherence to antibiotic prescriptions on record nor account for prescriptions issued outside the records-linkage system, which may have affected

	our estimates of absolute exposure; did not account for breastfeeding, lifestyle behaviors (eg, diet, physical activity, and sleep), other medications, or familial factors (eg, siblings).
Relevant outcomes:	Significant association between early life antibiotic exposure and celiac disease

Study reference:	**Thorisdottir, B., Gunnarsdottir, I., Vidarsdottir, A. G., Sigurdardottir, S., Birgisdottir, B. E., & Thorsdottir, I. (2019). Infant Feeding, Vitamin D and IgE Sensitization to Food Allergens at 6 Years in a Longitudinal Icelandic Cohort. Nutrients, 11(7), pp. 1690.**
Study type:	Prospective population study examining dietary patterns and vitamin D levels in infants and their risk of sensitisation to food allergens
Study population:	Nordic countries
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: small sample
Key themes/ topics:	Vitamin D status and intake as risk factors for developing FHs Postnatal dietary patterns as risk factors for developing FHs
Method:	Dietary recall, blood sampling, biochemical analysis

	Sample size: n=144
Findings:	Introduction of solid foods prior to 4 months increased the odds of IgE-sensitization, OR = 4.9 (95%, CI = 1.4–16.6) and vitamin D supplement at 6 years decreased the odds of IgE-sensitization, OR = 0.2 (95%, CI = 0.1–0.98), adjusting for maternal smoking.
Strengths/ Limitations:	Strength: detailed longitudinal data on infant feeding, vitamin D supplement use and growth from birth to 6 years in a population-based sample. Limitations: small sample, wide confidence intervals
Relevant outcomes:	The results support the NNR on not introducing complementary solid food before the age of 4 months and encouraging vitamin D intake from diet and supplements for Nordic infants and children.

Study reference:	**Sander, D.S., Nybo Andersen, A. M., Murray, J. A., Karlstad, Ø., Husby, S., & Størdal, K. (2019). Association Between Antibiotics in the First Year of Life and Celiac Disease. Gastroenterology, 156(8), pp. 2217–2229.**
Study type:	Retrospective observational cohort study exploring the association between exposure to a systemic antibiotic in the first year of life and risk of diagnosed celiac disease.
Study population:	Denmark & Norway
Publication date:	2019
Study quality and applicability:	Low

	Comment: The outcome was diagnosed celiac disease and it cannot be excluded that these associations were attributable to factors related to celiac disease.
Key themes/ topics:	Antibiotics intake as a risk factor for developing FHs
Method:	Secondary data from administrative and health administrative registers. Statistical analysis: logistic regression model. Sample size: n=3346
Findings:	Exposure to systemic antibiotics in the first year of life was positively associated with diagnosed celiac disease in the Danish and Norwegian cohorts (pooled odds ratio 1.26, 95% confidence interval 1.16–1.36)
Strengths/ Limitations:	None reported
Relevant outcomes:	Childhood exposure to systemic antibiotics could be a risk factor for celiac disease.

Study reference:	**Davisse-Paturet, C., Raherison, C., Adel-Patient, K., Divaret-Chauveau, A., Bois, C., Dufourg, M. N., Lioret, S., Charles, M. A., & de Lauzon-Guillain, B. (2019). Use of partially hydrolysed formula in infancy and incidence of eczema, respiratory symptoms or food allergies in toddlers from the ELFE cohort. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology, 30(6), pp. 614–623.**

Study type:	Birth cohort study that assesses the links between 2-month infant formula use and the incidence of eczema, respiratory symptoms, or food allergies (FA) up to 2 years of age.
Study population:	France
Publication date:	2019
Study quality and applicability:	Low **Comment**: high risk of confounding bias
Key themes/ topics:	Postnatal dietary patterns as risk factors for developing FHs
Method:	Telephone interviews. Secondary data from data from the ELFE study. Descriptive statistical analyses (allowing rates and prevalence estimations); multinomial logistic regressions, sensitivity analyses. Sample size: n=10 407
Findings:	The use of pHF-HA, compared with nHF, at 2 months was related to higher risk of wheezing at 1 year in at-risk infants (1.68[1.24-2.28]) and higher risk of FA at 2 years both in non-at-risk infants (3.78[1.52-9.41]) and in at-risk infants (2.31[1.36-3.94]).
Strengths/ Limitations:	None reported
Relevant outcomes:	Partially hydrolysed formulas area associated with higher risk of food allergies.

Study reference:	**Kårhus, L. L., Gunnes, N., Størdal, K., Bakken, I. J., Tapia, G., Stene, L. C., Håberg, S. E., & Mårild, K. (2018). Influenza and risk of later celiac disease: a cohort study of 2.6 million people. Scandinavian journal of gastroenterology, 53(1), pp. 15–23.**
Study type:	Retrospective cohort study determining the risk of CD after influenza
Study population:	Norway
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Findings are confined to individuals with medically attended influenza and may represent associations with more clinically severe influenza.
Key themes/ topics:	Influenza as a risk factor for developing FHs
Method:	Secondary data from medical records. Statistical analysis: Cox regression. Register-based cohort study included 2,637,746 Norwegians Sample size: n=7321 individuals with CD
Findings:	Influenza and pandemic influenza diagnosis were associated with increased risks of later CD.
Strengths/ Limitations:	Limitations: didn't study the association between influenza and undiagnosed CD; didn't study whether treatment for influenza mediated the association with CD; unable to account for a potential influence of

	seasonal influenza vaccinations; no medical records to verify the influenza diagnoses; lack of data on subclinical influenza.
Relevant outcomes:	Positive association with influenza diagnosis is consistent with the hypothesis that infections may play a role in CD development.

Study reference:	**Eggesbø, M., Botten, G., Stigum, H., Nafstad, P., & Magnus, P. (2003). Is delivery by cesarean section a risk factor for food allergy?. The Journal of allergy and clinical immunology, 112(2), pp. 420–426.**
Study type:	Prospective birth cohort study examining whether caesarean delivery and the use of antibiotics were associated with subsequent food allergy
Study population:	Norway
Publication date:	2003
Study quality and applicability:	Low
Key themes/ topics:	Caesarean delivery as a risk factor for developing FHs
Method:	Double-blind, placebo-controlled food challenge. Skin prick test. Odds ratio. Questionnaires Sample size: n=2803

Findings:	Among children whose mothers were allergic, caesarean section was associated with a 7-fold increased risk of parentally perceived reactions to egg, fish, or nuts (odds ratio, 7.0; CI, 1.8-28; P = .005) and a 4-fold increased risk of confirmed egg allergy (odds ratio, 4.1; CI, 0.9-19; P = .08)
Strengths/ Limitations:	Limitations: potential confounding bias and small number of cases. Strengths: prospective design
Relevant outcomes:	Children who are genetically predisposed to food allergies have a higher risk of development of food allergies if they were delivered by caesarean section. This supports that factors interfering with the colonization process might play a role in the development of food allergy.

Study reference:	**Dioun, A. F., Harris, S. K., & Hibberd, P. L. (2003). Is maternal age at delivery related to childhood food allergy? Pediatric allergy and immunology: official publication of the European Society of Pediatric Allergy and Immunology, 14(4), pp. 307–311.**
Study type:	Case-control study evaluate whether maternal age at the time of delivery is associated with a food allergy in children.
Study population:	US
Publication date:	2003
Study quality and applicability:	Very Low

	Comment: it's a preliminary study, small sample
Key themes/ topics:	Maternal age at the time of delivery as a risk factor for developing FHs
Method:	Case patients - evidence of clinical sensitivity and IgE to one or more food allergens (n = 58); control patients (n = 96)
Findings:	The proportion of children whose mother was aged 30 and over at their birth was significantly higher in children with a food allergy than control patients (78% vs. 55% p = 0.005) and higher than all births in Massachusetts (78% vs. 53% p = 0.0002).
Strengths/ Limitations:	None reported
Relevant outcomes:	Mothers of children with a food allergy had about three times greater odds of being aged 30 or over at the time of delivery than mothers in either of the comparison groups.

Study reference:	**Bakos, N., Schöll, I., Szalai, K., Kundi, M., Untersmayr, E., & Jensen-Jarolim, E. (2006). Risk assessment in elderly for sensitization to food and respiratory allergens. Immunology letters, 107(1), pp. 15–21.**
Study type:	Cross-sectional study examining the prevalence and risk factors for sensitizations in people with a mean age of 77 years, who are living in a geriatric nursing home.
Study population:	Hungary

Publication date:	
Study quality and applicability:	Very Low Comment: small sample size, confounding bias
Key themes/ topics:	Alcohol consumption among elderly as a risk factor for developing FHs
Method:	In-depth interviews; IgE measurement; skin prick test; cytokine assays; statistical analysis: descriptive statistics, t-tests, Mann–Whitney U-test. Sample size: n=109
Findings:	Positive skin prick tests with food allergens could be correlated with chronic alcohol consumption (P = 0.036)
Strengths/ Limitations:	None reported
Relevant outcomes:	The risk factor for sensitisation to food allergen across elderly population is chronic alcohol consumption

Study reference:	**Kull, I., Bergström, A., Melén, E., Lilja, G., van Hage, M., Pershagen, G., & Wickman, M. (2006). Early-life supplementation of vitamins A and D, in water-soluble form or in peanut oil, and allergic diseases during childhood. The Journal of allergy and clinical immunology, 118(6), pp. 1299–1304.**

Study type:	Prospective birth cohort study that explored the association between early life supplementation of vitamins A and D in water-soluble form or in peanut oil and allergic diseases up to 4 years of age
Study population:	Sweden
Publication date:	2006
Study quality and applicability:	Low Comment: prospective data collection during 4 years
Key themes/ topics:	Vitamin D status and intake as risk factors for developing FHs
Method:	Parental questionnaires; clinical data and blood samples collection. Statistical analysis: Chi square test, odds ratios, 95% confidence intervals; the Wald test Sample size: n=4089
Findings:	Children supplemented with vitamins A and D in water-soluble form during the first year of life had an increased risk of food hypersensitivity (adjusted OR, 1.89; 95% CI, 1.33-2.65), and sensitization to common food and airborne allergens (adjusted OR, 1.88; 95% CI, 1.34-2.64) at age 4 years compared with those receiving vitamins in peanut oil.
Strengths/ Limitations:	Strengths: high response rate for all questionnaires during the 4-year follow-up period, reliable measurements of exposure, and well-defined outcome measures.

	Limitations: lack of information about vitamin supplementation after the first year of life, and therefore exposure misclassification related to later exposure cannot be entirely ruled out.
Relevant outcomes:	Supplementation of vitamins A and D in water-soluble form seems to increase the risk of allergic disease up to the age of 4 years compared with supplementation with the same vitamins given in peanut oil.

Study reference:	**Ivarsson, A., Hernell, O., Nyström, L., & Persson, L. A. (2003). Children born in the summer have increased risk for coeliac disease. Journal of epidemiology and community health, 57(1), pp. 36–39.**
Study type:	Retrospective cohort based study that aimed to analyse if the risk for coeliac disease varies with month of birth as a proxy for a seasonal pattern for possible causal environmental exposure(s).
Study population:	Sweden
Publication date:	2003
Study quality and applicability:	Low **Comment**: used secondary data only
Key themes/ topics:	Birth season as a risk factor for developing FHs
Method:	Secondary population data from Statistics Sweden. Statistical analysis: Poisson regression; confidence intervals

	Sample size: n=2151
Findings:	The risk for coeliac disease was significantly higher if born during the summer as compared with the winter (RR=1.4, 95% CI 1.2 to 1.7), but only in children below 2 years of age at diagnosis.
Strengths/ Limitations:	None reported
Relevant outcomes:	Children born in the summer have a higher risk of developing celiac disease compared to those born in the winter.

Study reference:	**Sandberg-Bennich, S., Dahlquist, G., & Källén, B. (2002). Coeliac disease is associated with intrauterine growth and neonatal infections. Acta paediatrica (Oslo, Norway : 1992), 91(1), pp. 30–33.**
Study type:	Retrospective cohort study which aims to investigate whether factors in the fetal or neonatal period influence the risk of later development of coeliac disease
Study population:	Sweden
Publication date:	2002
Study quality and applicability:	Low **Comment**: used secondary data only

Key themes/ topics:	Intrauterine environment as a risk factor for developing FHs Low birthweight as a risk factor for developing FHs
Method:	Statistical analysis: odds ratios and test-based confidence intervals. Sample size: n=3482
Findings:	The most evident risk factors for developing celiac disease: 1) being exposed to neonatal infections (OR = 1.52, confidence limits 1.19; 1.95); 2) being small for gestational age (OR = 1.45, confidence limits 1.20; 1.75). Maternal smoking and low birthweight - weak risk factors.
Strengths/ Limitations:	None reported
Relevant outcomes:	The intrauterine environment, low birthweight for gestational age and neonatal infection diagnosis, is associated with the risk of developing coeliac disease.

Study reference:	**Gern, J. E., Reardon, C. L., Hoffjan, S., Nicolae, D., Li, Z., Roberg, K. A., Neaville, W. A., Carlson-Dakes, K., Adler, K., Hamilton, R., Anderson, E., Gilbertson-White, S., Tisler, C., Dasilva, D., Anklam, K., Mikus, L. D., Rosenthal, L. A., Ober, C., Gangnon, R., & Lemanske, R. F., Jr (2004). Effects of dog ownership and genotype on immune development and atopy in infancy. The Journal of allergy and clinical immunology, 113(2), pp. 307–314.**

Study type:	Cohort study determine the effects of pet exposure and genotype on immunologic development and the incidence of atopic markers and diseases in the first year of life.
Study population:	US
Publication date:	2004
Study quality and applicability:	Very Low **Comment**: small sample, confounding bias
Key themes/ topics:	Household factors and risk for developing FHs
Method:	Pet exposure in the home was compared with cytokine secretion patterns (mitogen-stimulated mononuclear cells at birth and age 1 year) and indicators of atopy (allergen-specific and total IgE, eosinophilia, food allergy, atopic dermatitis) in infants. Interactions with genotype at the CD14 locus were also evaluated in the data analyses. Sample size: n=285
Findings:	Exposure to dogs was associated with reduced allergen sensitization (19% vs 33%, P =.020) and atopic dermatitis (30% vs 51%, P <.001).
Strengths/ Limitations:	None reported
Relevant outcomes:	Having a dog in infancy is associated with reduced allergic sensitization

Study reference:	**Laubereau, B., Filipiak-Pittroff, B., von Berg, A., Grübl, A., Reinhardt, D., Wichmann, H. E., Koletzko, S., & GINI Study Group (2004). Caesarean section and gastrointestinal symptoms, atopic dermatitis, and sensitisation during the first year of life. Archives of disease in childhood, 89(11), pp. 993–997.**
Study type:	Cohort study investigating the effect of caesarean section on gastrointestinal symptoms, atopic dermatitis, and sensitisation to nutritional allergens in infants.
Study population:	Germany
Publication date:	2004
Study quality and applicability:	Low
Key themes/ topics:	Caesarean delivery as a risk factor for developing FHs
Method:	Full term neonates with parental history of allergy participating in the prospective German Infant Nutritional Intervention Program (GINI) were exclusively breast fed during the first four months of life and had a one year follow up. Data were obtained by follow up visits at age 1, 4, 8, and 12 months, weekly diaries for the first six months, and measurement of total and specific IgE at birth and 12 months. Sample size: n=865
Findings:	Infants born by caesarean section (147/865, 17%) had a greater risk of sensitisation to food allergens, adjusted (OR(adj) 2.06, 95% CI 1.123 to 3.80)

Strengths/ Limitations:	None reported
Relevant outcomes:	Caesarean delivery might be a risk factor for sensitisation in infants with family history of allergy.

Study reference:	**Logan, K., Perkin, M. R., Marrs, T., Radulovic, S., Craven, J., Flohr, C., Bahnson, H. T., & Lack, G. (2020). Early Gluten Introduction and Celiac Disease in the EAT Study: A Prespecified Analysis of the EAT Randomized Clinical Trial. JAMA paediatrics, 174(11), pp. 1–7.**
Study type:	Randomised control study determining whether early introduction of high-dose gluten lowers the prevalence of CD at age 3 years
Study population:	England & Wales
Publication date:	2020
Study quality and applicability:	Moderate
Key themes/ topics:	Gluten intake as a risk factor for developing CD
Method:	The EAT study is an open label randomized clinical trial. Sample size: n=1004

Findings:	In this analysis of infants in the EAT Study, the introduction of gluten from age 4 months was associated with reduced CD prevalence
Strengths/ Limitations:	None reported
Relevant outcomes:	Early introduction of gluten is associated with reduced CD prevalence.

Study reference:	**Marrs, T., Logan, K., Craven, J., Radulovic, S., McLean, W., Lack, G., Flohr, C., Perkin, M. R., & EAT Study Team (2019). Dog ownership at three months of age is associated with protection against food allergy. Allergy, 74(11), pp. 2212–2219.**
Study type:	Secondary cohort study in the Enquiring About Tolerance (EAT) study (using RCT)
Study population:	England & Wales
Publication date:	
Study quality and applicability:	Low
Key themes/ topics:	Gluten intake as a risk factor for developing CD Household factors and risk for developing FHs

Method:	Survey. Skin and serum testing at 3, 12 and 36 months. Food allergy status was determined by double-blind placebo-controlled food challenges between 1 and 3 years. Sample size: n=1303
Findings:	None of the 49 infants living with at least two dogs developed food allergy, suggesting a dose-response relationship (each dog owned aOR 0.12 (CI 0.02-0.81), P = 0.03)
Strengths/ Limitations:	None reported
Relevant outcomes:	Dog ownership in infancy may prevent food allergy

Study reference:	**Li, M., Lu, Z. K., Amrol, D. J., Mann, J. R., Hardin, J. W., Yuan, J., Cox, C. L., & Love, B. L. (2019). Antibiotic Exposure and the Risk of Food Allergy: Evidence in the US Medicaid Pediatric Population. The journal of allergy and clinical immunology. In practice, 7(2), pp. 492–499.**
Study type:	Cohort study examining the impact of exposure to antibiotics early in life on time to development of food allergy.
Study population:	US
Publication date:	2019

Study quality and applicability:	Low
Key themes/ topics:	Antibiotics intake as a risk factor for developing FHs
Method:	Cox proportional hazards regression model; sensitivity analyses
Findings:	Antibiotic exposure was significantly associated with faster development of food allergy (hazard ratio, 1.40; 95% CI, 1.34-1.45).
Strengths/ Limitations:	None reported
Relevant outcomes:	Compared with antibiotic nonusers, children with antibiotic prescription had an increased risk of food allergy.

Study reference:	**Bittker, S. S., & Bell, K. R. (2019). Potential risk factors for celiac disease in childhood: a case-control epidemiological survey. Clinical and experimental gastroenterology, 12, pp. 303–319.**
Study type:	Case-control epidemiological survey determining whether nine variables are associated with CD in children
Study population:	Canada
Publication date:	2019

Study quality and applicability:	Very Low **Comment**: selection bias: social media, websites, electronic newsletters, and advertisements; demographic differences between cases and controls
Key themes/ topics:	Antibiotics intake as a risk factor for developing FHs
Method:	Internet-based survey Sample size: n=322 with CD and n=240 controls
Findings:	Skim milk as the primary form of liquid cow's milk consumed between 2–3 years old (adjusted odds ratio [aOR]=3.556, CI=1.430–10.22, P=0.010), vitamin D drops administered for more than 3 months (aOR=1.749, CI=1.079–2.872, P=0.025), courses of antibiotics (aOR=1.133, CI=1.037–1.244, P=0.007), and incidence of ear infection (aOR=1.183, CI=1.041–1.348, P=0.010) are all associated with CD in children.
Strengths/ Limitations:	Limitations: retrospectively collected data set derived from an Internet survey; no data verification, no formal test for CD; demographic differences between case and control groups
Relevant outcomes:	Positive association between skim milk consumption and CD and vitamin D drop use for greater than 3 months and CD. Early life exposure to antibiotics and early life infection, specifically ear infection, are associated with CD.

Study reference:	**Sasaki, M., Peters, R. L., Koplin, J. J., Field, M. J., McWilliam, V., Sawyer, S. M., Vuillermin, P. J., Pezic, A., Gurrin, L. C., Douglass, J. A., Tang, M., Dharmage, S. C., & Allen, K. J. (2018). Risk**

	Factors for Food Allergy in Early Adolescence: The SchoolNuts Study. The journal of allergy and clinical immunology. In practice, 6(2), pp. 496–505.
Study type:	Retrospective survey study investigating the risk factors for current adolescent food allergy using a population-based sample
Study population:	Australia
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Bias in data collection, self-reported allergies.
Key themes/ topics:	Household factors and risk for developing FHs
Method:	Multiple logistic regression Sample size: n=4,991
Findings:	Males and those with early-onset eczema had a higher risk of current food allergy in adolescence (adjusted odds ratio [aOR], 1.55; 95% confidence interval [CI], 1.12-2.15 and aOR, 14.08; 95% CI, 10.25-19.33). Those with Asian parents had increased risk compared with those with Caucasian parents (aOR, 2.82; 95% CI, 1.91-4.16), whereas being born in Asia compared with being born in Australia had decreased risk (aOR, 0.16; 95% CI, 0.04-0.67). Dog exposure during the first 5 years of life was associated with a decreased risk (aOR, 0.58; 95% CI, 0.38-0.91).

Strengths/ Limitations:	None reported
Relevant outcomes:	Early-onset eczema, Asian background, and family history of allergic disease were associated with an increased risk of food allergy, whereas dog exposure in early life reduced the risk in 10- to14-year-old adolescents.

10. CURRENT KNOWLEDGE OF FHS AMONGST THE GENERAL PUBLIC

Study reference:	**Soon J. M. (2019). Food allergen knowledge, attitude and practices among UK consumers: A structural modelling approach. Food research international (Ottawa, Ont.), 120, pp. 375–381.**
Study type:	Cross-sectional study to investigate the food allergen knowledge, attitude towards food allergens and food allergy management practices among food allergic and intolerant consumers and/or their family members and carers.
Study population:	U.K.
Publication date:	2019
Study quality and applicability:	Very Low **Comments**: Potential bias in participant selection as all recruited at Free From events in the UK, also limiting generalisability. Questionnaires were all completed face to face. Sample size is limited, and results

	are based on self-reported data. However, a pilot study was conducted among 20 participants (excluded from the actual study) to ensure the clarity and suitability of wordings.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Questionnaires were distributed at three major Free From events in the UK. Structural Equation Modelling (SEM) was used as a confirmatory technique to determine the model's validity. Consumers experiencing food allergies or intolerance, or those who are carers to individuals with food allergies/intolerance and those interested in Free From food products were invited to participate in the study. **Sample Size**: n = 252
Findings:	Consumers demonstrate relatively good knowledge of food allergens. Food allergen knowledge and attitude did not directly affect food allergen handling practices. More than 90% of the respondents were aware of the danger of food allergens and the best way to avoid an allergic reaction is to avoid the causative agent. A third of the respondents knew that high temperature cooking does not destroy food allergen and more than half recognised that rinsing cooking utensils with water only is insufficient. Up to 89% of the respondents are aware of potential hidden egg ingredients in food products.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Consumers demonstrated good knowledge and attitudes to reaction severity and avoidance of allergens. However, both knowledge and attitude did not translate into food allergy management practices.

Study reference:	**Laheri, Z., & Soon, J. M. (2018) Awareness of alternative gluten-free grains for individuals with coealiac disease. British Food Journal, 120 (12). pp. 2793¬2803.**
Study type:	Cross-sectional study to determine the current knowledge of the gluten-free diet (GFD), consumption rates and awareness of alternative grains for individuals diagnosed with Coeliac Disease
Study population:	U.K.
Publication date:	2018
Study quality and applicability:	Very Low **Comments**: Potential selection bias as participants recruited via a gluten-free event and coeliac support groups. Majority of participants were also females which might have a gender bias on results. Sample size is limited, and results are based on self-reported data. However, a pilot study was conducted to ensure the clarity and suitability of wordings.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Participants were recruited via local coeliac support groups as well as an “Allergy and Free From Show”, to participate in a survey about their knowledge of gluten-free food (GFF) and AG and consumption rate of AG. **Sample Size**: n = 100

Findings:	Overall, participants possessed good knowledge of the GFD. Yogurt, vinegar and oats resulted in the highest incorrect responses. Additionally, those more recently diagnosed had poorer knowledge of the GFD, reduced consumption rates of and poor awareness of alternative grains.
Strengths/ Limitations:	None reported.
Relevant outcomes:	Knowledge among Coeliac Disease sufferers on GFD and alternative grains

Study reference:	**Gruenfeldova J., Domijan K. & Walsh C. (2019). A study of food safety knowledge, practice and training among food handlers in Ireland. Food Control, 105, pp. 131-140.**
Study type:	Cross-sectional study which aims to investigate and assess the current levels of food safety knowledge, practice and training among food handlers working in the Irish food service sector.
Study population:	Ireland
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Limited information is given on recruitment decisions and procedure.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs

Method:	A 39-question survey was designed to examine food handler's knowledge on cross-contamination, cleaning, cooking, cooling, reheating, food allergens and food pathogens. The questionnaire was distributed among the food service sector in Ireland between October and November of 2017; of which 689 (99 electronic and 590 hardcopies) were completed. Responses from 689 questionnaires were analysed using R statistical software.
Findings:	28% of all respondents claimed ‘never’ to have received food safety training. Absence of training only accounted for 1% of all canteen workers surveyed. In addition, individuals working in canteens were found to have the highest knowledge score (81%) and the highest %age of level 3 training (60%). While 79% of respondents identified milk as an allergen, only 57% included crustacean and 66% egg.
Strengths/ Limitations:	None reported
Relevant outcomes:	Only 16% of respondents could list each of the 14 named allergens. 28% of all respondents claimed ‘never’ to have received any food safety training. High levels of knowledge & training were reported among staff working in canteens.

Study reference:	**Soon J. M. (2019). Food allergen knowledge, attitude and practices among UK consumers: A structural modelling approach. Food research international (Ottawa, Ont.), 120, pp. 375–381.**
Study type:	Questionnaire and structural equation modelling to investigate the food allergen knowledge, attitude towards food allergens and food allergy management practices among food allergic and intolerant consumers and/or their family members and carers.

Study population:	UK
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Small sample size. Potential bias in participant selection as all recruited at Free From events in the UK, also limiting generalisability.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Questionnaires were distributed at three major Free From events in the UK in 2017 and 2018. Structural Equation Modelling (SEM) was used as a confirmatory technique to determine the model's validity. Consumers experiencing food allergies or intolerance, or those who are carers to individuals with food allergies/intolerance and those interested in Free From food products were invited to participate in the study. Descriptive and Exploratory Factor Analysis (EFA) was conducted using SPSS 24.0. EFA was performed to extract items from knowledge, attitude and practices based on factor loadings >0.4 (Baser et al., 2017; Soon, 2018b). Based on the extracted items, SEM was conducted using Analysis of Moment Structures (AMOS) and confidence level was set at 95%. (n=252)
Findings:	More than 90% of the respondents were aware of the danger of food allergens and the best way to avoid an allergic reaction is to avoid the causative agent. 38.1% believed that tree nuts are similar to peanuts while 48% were uncertain about this statement. A third of the respondents knew that high temperature cooking does not destroy food allergen, and more than half recognised that rinsing cooking utensils with water only is insufficient. Most of the respondents have good understanding of hidden allergenic

	ingredients in food products and knew that consuming even a small amount of food allergen will cause an allergic reaction and in severe cases, it can be fatal.
Strengths/ Limitations:	None reported
Relevant outcomes:	Consumers demonstrate relatively good knowledge of food allergens. Food allergen knowledge and attitude did not directly affect food allergen handling practices.

Study reference:	**Jamieson, J. A., & Gougeon, L. (2019). Adults following a gluten-free diet report little dietary guidance in a pilot survey exploring relationships between dietary knowledge, management, and adherence in Nova Scotia, Canada. Nutrition research (New York, N.Y.), 66, pp. 107–114.**
Study type:	Mixed methods explanatory pilot study (paper describes online questionnaire) to investigate relationships between personal, social, and health care factors and dietary adherence.
Study population:	Canada
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. There is a relatively small sample size all drawn from one location, limiting generalisability. There could also have selection bias as participants were self-selected and recruited through dietitian networks.

Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Participants were a convenience sample of community-dwelling adults (over 19 years) following a GFD for the past for months and were recruited through networking (dietitian professional electronic mailing lists and grocery store dietitian contacts), social media advertising, and strategically-placed flyers. From December 2016 - October 2017 68 participants completed a self-administered, 41-item online questionnaire. This included measurements of adherence, food label and ingredient knowledge and demographic information.
Findings:	Self-reported data combined for both CD and “non-celiac reasons for wheat restriction” respondents showed 76% perceived their health status as good to excellent. Most (62%) reported not receiving GFD advice from a health professional. Respondents with higher frequency of intentional consumption of gluten were more likely to have fewer correct answers to a food label quiz ($\rho = -0.44$; $P = .0002$). Most participants (75%) made at least one error in identifying gluten-free and gluten-containing foods.
Strengths/ Limitations:	Limitations: Relies on self-reported information, which could have social desirability bias and result in under reporting of gluten consumption. Sample may have included respondents who are more “health-conscious” or health and computer literate than the general population following a GFD, as participants were self-selected (via convenience sampling), and recruitment included health food store advertising (reflected in a relatively high household income for the sample).
Relevant outcomes:	Although knowledge was not the main focus of this paper, findings highlight gaps in knowledge.

Study reference:	**Loerbroks, A., Tolksdorf, S. J., Wagenmann, M., & Smith, H. (2019). Food allergy knowledge, attitudes and their determinants among restaurant staff: A cross-sectional study. PloS one, 14(4).**
Study type:	Cross-sectional survey to assess restaurant staffs' food allergy knowledge and attitudes
Study population:	Germany
Publication date:	2019
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. The sample sizes are also small, limited generalisability. The findings may not be generalisable beyond the region of Germany from which the sample were recruited.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Data was collected from staff members (n=295) in restaurants from 15 randomly selected districts from the city of Düsseldorf, Germany. Data were collected during personal visits and by self-administered questionnaires or–in case of language problems–by personal interviews. Knowledge was assessed by asking participants to name three common food allergens and to answer five true/false-statements. Seven items assessed attitudes. A total of 16 potential determinants were examined using logistic regression models with backward selection.
Findings:	A total of 54 participants (18.3%) were unable to name any correct food allergen. One, two and three correct food allergens were reported by 14.9% (n = 44), 36.6% (n = 108), and 30.2% (n = 89) of the participants, respectively. At least 80% of the participants provided correct answers to four of the five

	questions assessing general food allergy knowledge. The most frequent misbelief entailed that customers should be served water in case of an allergic reaction (correctly identified as false by 65.4% or n = 193). The total knowledge score, based on five questions, was skewed towards an elevated number of correct responses but only 40.7% (n = 120) of the participants attained the perfect score.
Strengths/ Limitations:	Strengths: Cognitive interviews were conducted to ensure that all instruments used were adequately understood and were reasonably complete. The knowledge tests were completed on site in the presence of the interviewer, which rules out the possibility that respondents searched external sources, such as the internet for correct responses. Limitations: There could be social desirability bias from self-reporting of attitudes. Due to data being collected in a single city, results are likely representative for the recruitment area, but not necessarily for other regions.
Relevant outcomes:	There are knowledge gaps on food allergies among restaurant staff

Study reference:	**Lefèvre, S., Abitan, L., Goetz, C., Frey, M., Ott, M., & de Blay, F. (2019(Multicenter survey of restaurant staff's knowledge of food allergy in eastern France. Allergo Journal International, 28, pp. 57–62.**
Study type:	Cross-sectional study to investigate restaurant staff's knowledge about food allergies.
Study population:	France
Publication date:	2019

Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. The sample sizes are also small, limited generalisability. There could also be selection bias as respondents are self-selected (convenience sampling).
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	A standardized 26 item telephone questionnaire was administered to one member of staff at 100 restaurants in Metz and Strasbourg, France. The list of restaurants was randomly selected and subsequently contacted for inclusion in the survey until 100 inclusions were obtained. The interviewer was a medical student in Strasbourg and a dietetic student in Metz. Both were trained to have the same standard frame of discussion.
Findings:	79% knew about the European regulation. In all, 32% reported to be very confident in in providing a safe meal to a food-allergic customer, 30% somewhat confident, 34% confident and 4% not confident. Answers to true-false questions indicated some frequent misunderstandings: 25% believed an individual experiencing a reaction should drink water to dilute the allergen; 22% thought consuming a small amount of an allergen is safe; 39% reported allergen removal from a finished meal would render it safe; 32% agreed cooking food prevents it causing allergy and 8% were unaware allergy could cause death. Chefs and waiters seemed to have greater knowledge of food allergies compared to owners or managers for the four aforementioned questions ($p = 0.02$).
Strengths/ Limitations:	Limitations: Self-selecting participants so they may represent those with a better knowledge or interest on food allergy. The results cannot be extrapolated to other cities, given the observed differences between the two cities in this study. Response rate is also low

Relevant outcomes:	There are knowledge gaps on food allergies among restaurant staff

Study reference:	**Drabińska, N., Bączek, N., & Krupa-Kozak, U. (2017). Knowledge about coeliac disease: Results of survey conducted among persons screened using a self-administered transglutaminase-based test, Acta Alimentaria Acta Alimentaria, 46(3), pp. 283-289.**
Study type:	Cross-sectional study to evaluate the knowledge on CD among individuals, who conducted a self-administered coeliac disease test.
Study population:	Poland
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Limited information is given on the design of the survey and its validity. Questionnaires were not included in analysis if responders did not declare their socio-demographic status or provided incomplete information. Majority of responders came from one city in Oslo and sample sizes are small, limiting generalisability. Study based on self-reported data, which could have recall bias and social desirability bias. Potential selection bias as participants self-select.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	An advertisement concerning CD testing was published in the local media. All CD screening participants received a free test to perform individually in accordance with the instructions provided by the

	manufacturer. Among the 300 people who took part in the small-scale tTG population screening, a survey concerning their knowledge on CD was carried out (n=276). Survey participants were asked to fill out the authors' original questionnaire containing seven multiple-choice questions. Questions concerned mainly the definition, aetiology, symptoms, and treatment of CD. Additionally, the sociodemographic structure of respondents was recorded.
Findings:	94% of respondents correctly defined CD as gluten intolerance; among them, 26 individuals described CD as both gluten intolerance and the chronic inflammation of the small intestine. In the question concerning the age of persons suffering from CD, most respondents (nearly 90%) answered that children, adolescents, and adults alike may suffer from the disease. Gluten was correctly identified as the factor responsible for CD development by the majority of responders. Only 4% of those interviewed pointed to other triggers. Most correctly selected a GFD as the method of treating CD but 5% gave other treatments indicating a diet of easily digestible foods, surgical intervention, or vitamin C as methods of treating the disease.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight gaps in in the knowledge of participants with CD

Study reference:	**Wen, H., & Kwon, J. (2017). Restaurant servers' risk perceptions and risk communication-related behaviors when serving customers with food allergies in the U.S. International Journal of Hospitality Management, 64, pp. 11-20.**

Study type:	Cross-sectional study aims to explore the perceived risks and risk communication-related behaviours of restaurant servers when serving customers with food allergies in the U.S.
Study population:	U.S.
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Small sample size and only focuses on full-service restaurants which may limit generalisability. Potential selection bias as participants self-select.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	An online survey instrument was developed based on interviews with full-service restaurant managers, pilot-tested, and distributed to staff in these restaurants. Because there were no panels that included only full-service restaurant service staff, filtering questions were used to gather data from only those who met the inclusion criteria. (n=316) responses were received and analysed.
Findings:	Of the 25 points possible, the mean knowledge score was 16.77 ± 3.05, ranging from 3 to 23. Among the eight major food allergens, a significant number of participants failed to identify fish (n = 161, 50.9%), soy (n = 144, 45.6%), and egg (n = 120, 38.0%) as the major food allergens. Only 21 respondents (6.6%) correctly recognized all eight major food allergens. The results indicated that most servers lacked knowledge about food allergies and perceived that initiating communication and preventing allergic reactions were mostly the responsibilities of customers with food allergies.

Strengths/ Limitations:	Limitations: Online survey may exclude those in the population that do not use computers or the Internet. Self-reported data could have social desirability bias. As research is conducted only in full-service restaurants, the results may not be generalized to other types of restaurants.
Relevant outcomes:	Findings highlight knowledge gaps amongst restaurant managers.

Study reference:	**Schultz, M., Shin, S., & Coppell, K. J. (2017). Awareness of coeliac disease among chefs and cooks depends on the level and place of training. Asia Pacific journal of clinical nutrition, 26(4), pp. 719–724**
Study type:	Cross-sectional study to examine knowledge about coeliac disease and gluten-free food preparation among chefs and cooks, and culinary students in Dunedin, New Zealand
Study population:	New Zealand
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Small sample size and only conducted in a single city in New Zealand limits generalisability. Potential selection bias as participants self-select.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs

Method:	Outlets serving gluten-free food were identified. The head chefs and cooks and a class of first year chef trainees completed were invited to complete a questionnaire regarding demographics, education, qualification, experience and knowledge of coeliac disease and gluten-free food preparation. Participants were made up of 90 restaurant chefs and cooks, and 35 first-year culinary students. Participants were also asked to identify which meals had gluten from looking at pictures of food.
Findings:	Half of participating chefs and cooks had received no formal training, but all were aware of the term gluten-free diet. Twelve (13%) were unaware of coeliac disease, all of whom were non-European and worked at an ethnic restaurant which did not have gluten-free policies in place. There was no significant difference in awareness of coeliac disease between chefs and students ($p=0.36$). However, students were significantly more aware of necessary gluten-free food preparation ($p=0.007$) and scored better in the gluten-free quiz ($p=0.01$) than chefs and cooks.
Strengths/ Limitations:	We only sampled restaurants in central Dunedin and therefore our results might not be representative of areas of New Zealand beyond central Dunedin city. We are unaware of the content of other cooking courses within New Zealand, but it is unlikely that gluten-free food preparation is not included given CD is relatively common in New Zealand. A key strength of our study is that, in contrast to the study by Simpson et al,11 we conducted all interviews in person, but did not pre-arrange an appointment, thereby avoiding preparation for the interview.
Relevant outcomes:	Findings highlighted gaps in the knowledge of cooks and culinary students.

Study reference:	**Sogut, A., Kavut, A. B., Kartal, İ., Beyhun, E. N., Çayır, A., Mutlu, M., & Özkan, B. (2015). Food allergy knowledge and attitude of restaurant personnel in Turkey. International forum of allergy & rhinology, 5(2), pp. 157–161.**
Study type:	Cross-sectional study to investigate awareness of restaurant personnel on food allergy
Study population:	Turkey
Publication date:	2015
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Small sample size and only conducted in a single city in Turkey limits generalisability. Potential selection bias as participants self-select.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	The training, knowledge levels on food allergy, and comfort level in providing safe food of 351 restaurant personnel in Erzurum Province, Turkey, were assessed through a face-to-face survey. The restaurant personnel were administered a questionnaire designed to measure their understanding of basic food allergy principles.
Findings:	Among the participants, 81.5% were male (mean age 28.5 ± 8.5 years). Among them, 17.1% were chefs, 11.1% managers, 5.7% owners, and 66.1% waiters. Food allergy training was reported by 17.1% of the participants. The rates of restaurant personnel who gave the correct answers to the 4 questionnaire items, “Customers with food allergies can safely consume a small amount of that food/Food allergic reaction can

	cause death/If a customer is having an allergic reaction, it is appropriate to immediately serve them water to 'dilute' the allergen/Removing an allergen from a finished meal (eg, taking off nuts) may be all that is necessary to provide a safe meal for an allergic customer," which measure food allergy knowledge levels, were 46.4%, 65.7%, 55.0%, and 65.7%, respectively.
Strengths/ Limitations:	Limitations: A declaration-based questionnaire was used in this study, and no real-time monitoring or observation was made. Second, the study was conducted in 1 city only.
Relevant outcomes:	The rates of restaurant personnel who gave the correct answers to the 4 questionnaire items, "Customers with food allergies can safely consume a small amount of that food/Food allergic reaction can cause death/If a customer is having an allergic reaction, it is appropriate to immediately serve them water to 'dilute' the allergen/Removing an allergen from a finished meal (eg, taking off nuts) may be all that is necessary to provide a safe meal for an allergic customer," which measure food allergy knowledge levels, were 46.4%, 65.7%, 55.0%, and 65.7%, respectively. The authors conclude that there are gaps in the food allergy knowledge of restaurant personnel.

Study reference:	**Lee Y.M., Sozen E. (2016). Food allergy knowledge and training among restaurant employees. International Journal of Hospitality Management, 57, pp. 52-59.**
Study type:	Questionnaire. Aim: to assess food allergies knowledge of restaurant employees and training among the employees
Study population:	U.S.
Publication date:	2016

Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size. Potential selection bias from participants being selected from market research company.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	The questionnaire was completed by 229 restaurant employees. The target population included front- and back-of-the house employees working in restaurants in the United States. The online questionnaire included: demographic information about the participants and 12 knowledge questions capturing various aspects of food allergy knowledge, 14 items about restaurant food allergy training, including previous training, intention to participate in future training, and reasons for not having an interest in training.
Findings:	Of the maximum 28 points possible, the mean food allergy knowledge score was 20.8 ± 3.4 (range = 6 to 28). Most of the participants (n = 105; 50.2%) scored between 21 and 25 points. For major allergen identification, almost 40% of the participants were not able to identify soy and fish as major allergens. A total of 167 (72.9%) participants were not able to identify “arachis oil” as an indicator of the presence of peanuts in food items. Close to 29% (n = 65) of the participants believed that removing food allergens could prevent an allergic reaction.
Strengths/ Limitations:	Strengths: Sample size comparable with other studies performed in restaurant setting Limitations: The questionnaire was only administered in English and participants with limited English proficiency or representing ethnic restaurants were not included as part of this study. The study might have selection bias. The participants were recruited by a market research company and therefore included only individuals whose contact information was currently in the company’s database.

Relevant outcomes:	Findings highlight knowledge gap among restaurant staff

Study reference:	**Lee, Y. M., & Xu, H. (2015). Food allergy knowledge, attitudes, and preparedness among restaurant managerial staff. Journal of Foodservice Business Research, 18(5), pp. 454-469.**
Study type:	Cross-sectional study to investigate restaurant managerial staff levels of food allergy knowledge, awareness, and preparedness in serving clients with food allergies.
Study population:	U.S.
Publication date:	2015
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size. Majority of participants worked for independent restaurants, which might limit generalisability. Potential selection bias as participants self-select.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	110 restaurant managerial staff in the United States were surveyed. The questionnaire comprised four sections and the following items: 12 items to define demographic characteristics, 14 items about food allergy training practices, 12 items about food allergy knowledge, 9 items about attitudes toward food allergies, and 7 items about perceived barriers to providing food allergy training.

Findings:	Mean food allergy knowledge score was 19.7 ± 4.6 of max 28. Most participants would modify recipes for clients with allergies (n = 85), but perceived customers should be responsible to request special meals (4.1 ± 0.9). Seventy-six participants have provided employee food allergy training. Participants identified that employee lack of commitment (3.9 ± 0.9) and time constrains (3.7 ± 1.0) were barriers to provide training.
Strengths/ Limitations:	Limitations: There could be selection bias, as the online questionnaires were distributed by a market research company, which reached out only to a limited number of restaurateurs in its database. Second, the participants who responded to this survey might already have more awareness and/or show genuine interest in this topic, thereby demonstrating higher food allergy knowledge scores than non-respondents.
Relevant outcomes:	Findings highlight knowledge gap, attitudes towards allergen risk management and training among restaurant staff

Study reference:	**Laheri, Z., & Soon, J. M. (2018) Awareness of alternative gluten-free grains for individuals with coealiac disease. British Food Journal, 120 (12). pp. 2793¬-2803.**
Study type:	Cross-sectional study to determine the current knowledge of the gluten-free diet (GFD), consumption rates of Alternative Grains (AG) and awareness of AG, for individuals diagnosed with CD
Study population:	UK
Publication date:	2018
Study quality and applicability:	Very Low

	Comment: The authors draw conclusions about gender differences but the majority of participants were female. Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size. Potential selection bias as participants recruited from coeliac groups and coeliac related event, this they may represent a population with more knowledge of GFD.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	A total of 100 participants were recruited via local coeliac support groups as well as an “Allergy and Free From Show”, to participate in a survey. The questionnaire was related to participants’ demographic characteristics, knowledge of gluten-free food (GFF) and AG and consumption rate of AG. Participants were asked to select correct GFF from a checklist. To test the awareness of AG, participants was asked to identify if it was possible for three different GF grains, to be used in the production of six generic food items.
Findings:	Overall, both genders possessed good knowledge of the GFD. It was found that females possessed better knowledge of both GFF and AG. Females reported a higher consumption rate of AG than males. Additionally, those more recently diagnosed had poorer knowledge of the GFD, reduced consumption rates of AG and poor awareness of AG.
Strengths/ Limitations:	Limitations: All participants were recruited via an “Allergy and Free From Show” and coeliac support groups and thus may already possess a heightened awareness of the GFD and AG. Moreover, participants’ place of recruitment increases the likelihood of individuals having an interest in the study and being more positively motivated. All data based on self-reporting.
Relevant outcomes:	Findings may indicate a knowledge gap regarding the use of AG

Study reference:	**Dupuis, R., Meisel, Z., Grande, D., Strupp, E., Kounaves, S., Graves, A., Frasso, R., & Cannuscio, C. C. (2016). Food allergy management among restaurant workers in a large U.S. city. Food control, 63, pp. 147-157.**
Study type:	Cross-sectional study to identify knowledge gaps in the food service industry in a large northeastern U.S. city.
Study population:	U.S.
Publication date:	2016
Study quality and applicability:	Very Low **Comment:** Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size, only focuses on one U.S. city and limited-service restaurants, which might limit generalisability. Potential selection bias as each participant was remunerated with a $5 gift card, which may have undue influence.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Recruited food service workers from all eligible limited-service restaurant establishments within a designated area of Philadelphia and 80.3% (n = 187) participated. Surveys were conducted in person at the restaurant counter by a research assistant. Questions focused on views regarding food allergies and food allergy management practices.
Findings:	No restaurant employee was able to name all seven “best practices” to reduce the risk of food allergy adverse events in restaurants. Most participants could name only zero or one preventive measure. Few

	participants knew to respond to anaphylaxis by administering epinephrine and calling 9-1-1. 24.1% thought water would dilute an allergic reaction and 11.7% thought customers with food allergies can safely consume a small amount of that food.
Strengths/ Limitations:	Limitations: Study included only English-speaking restaurant workers, in an industry that employs many new immigrants with primary languages other than English.
Relevant outcomes:	Findings highlight knowledge gap and attitudes towards allergen risk management among restaurant staff

Study reference:	**Silvester, J. A., Weiten, D., Graff, L. A., Walker, J. R., & Duerksen, D. R. (2016). Is it gluten-free? Relationship between self-reported gluten-free diet adherence and knowledge of gluten content of foods. Nutrition (Burbank, Los Angeles County, Calif.), 32(7-8), pp. 777–783.**
Study type:	Cross-sectional study to assess the relationship between self-reported GFD adherence and the ability to determine correctly the appropriateness of particular foods in a GFD
Study population:	U.S.
Publication date:	2016
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size. Potential selection bias as participants recruited from coeliac support groups and clinics. Unbalanced gender groups, with majority of respondents identifying as female.

Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Persons with CD were recruited through clinics and support groups. Participants (n=82) completed a questionnaire with items related to GFD information sources, gluten content of 17 common foods (food to avoid, food allowed, and food to question), GFD adherence, and demographic characteristics. Diagnosis was self-reported.
Findings:	Most (55%) reported strict adherence, 18% reported intentional gluten consumption and 21% acknowledged rare unintentional gluten consumption. No participant identified correctly the gluten content of all 17 foods; only 30% identified at least 14 foods correctly. The median score on the Gluten-Free Diet Knowledge Scale (GFD-KS) was 11.5 (interquartile ratio, 10–13). One in five incorrect responses put the respondent at risk of consuming gluten.
Strengths/ Limitations:	Limitations: GFD adherence reliant on self-reported adherence. Also, the study cohort included patients who had been adherent to a GFD for a prolonged period of time, which may not be representative of the GFD knowledge among an unselected group of celiac patients.
Relevant outcomes:	There is generally reasonable adherence to a GFD but there are gaps in knowledge of GFD

Study reference:	**McAdams, B., Deng, A. and MacLaurin, T. (2018), "Food allergy knowledge, attitudes, and resources of restaurant employees". British Food Journal, 120(11), pp. 2681-2694.**
Study type:	Cross-sectional study to evaluate food allergy knowledge, attitudes and resources among restaurant employees, and identify differences based on restaurant mode of operation.

Study population:	Canada
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size and conducted in full-service restaurants in one part of Canada, which could limit generalisability. Potential selection bias as participants self-selected. Potential measurement error as answers hand-coded.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	A total of 209 food-service workers were surveyed in full-service restaurants across Southern Ontario, Canada. A paper-based questionnaire was used to evaluate participants' food allergy knowledge, attitudes toward handling food allergy requests and emergencies, and the availability of food allergen resources at the restaurant. Questionnaires were checked for completion, and hand-coded.
Findings:	The mean food allergy knowledge score was 6.33±0.96 out of a maximum score of 7, and about 55.3% of participants responded correctly to all seven questions. Almost all (99.5%) participants understood that food allergies can be serious and potentially life-threatening. Also, 94.7% knew that touching a food allergen can trigger an allergic reaction, and 93.3% recognized that removing an allergen from a prepared meal is not an appropriate approach to mitigating food allergy risks. However, more than one in five respondents (21.2%) incorrectly suggested that individuals with food allergies could safely ingest small amounts of food allergens, and 12.1% of respondents incorrectly thought that heating foods to high temperatures could effectively eliminate food allergens.

Strengths/ Limitations:	Limitations: Questionnaires were distributed to a convenience sample of restaurants provided by University faculty, limiting the generalizability of the results. Also, this study only included English-speaking restaurant staff, limiting the ability to evaluate how language barriers could influence food allergy knowledge and attitudes. Also, given that participation in this study was voluntary, it is possible that individuals who completed the questionnaires were especially motivated and interested in the topic of food allergies. Self-reported data on employee food allergy attitudes and resources could have been subject to social desirability bias.
Relevant outcomes:	Findings highlight knowledge gap on food allergies among restaurant staff

Study reference:	**Radke, T. J., Brown, L. G., Hoover, E. R., Faw, B. V., Reimann, D., Wong, M. R., Nicholas, D., Barkley, J., & Ripley, D. (2016). Food Allergy Knowledge and Attitudes of Restaurant Managers and Staff: An EHS-Net Study. Journal of food protection, 79(9), pp. 1588–1598.**
Study type:	Cross-sectional study to understand and identify factors associated with food allergy knowledge and attitudes among restaurant managers, food workers, and servers.
Study population:	U.S.
Publication date:	2016
Study quality and applicability:	Very Low

	Comment: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size, which could limit generalisability. Potential selection bias and workers and servers chosen by manager, thus manager might choose workers with more knowledge.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Data was collected from 278 randomly selected restaurants through interviews with restaurant managers, food workers, and servers. We used a random sample from a nonrandomly selected cluster. Interviewers asked 19 questions to assess manager, food worker, and server food allergy knowledge (e.g., identifying major food allergens and knowing what to do when a customer has a bad food allergic reaction). Five questions were scored on a Likert scale to assess staff food allergy attitudes. Data collectors also observed the restaurant and examined its menu to assess additional restaurant characteristics and food allergy documentation.
Findings:	Overall, managers correctly identified peanuts (95.0%), milk and dairy (91.0%), shellfish (92.4%), and eggs (81.6%) as major allergens. Managers also recognized that trouble breathing (97.1%), hives or rash (98.2%), and swelling of tongue and throat (97.5%) are symptoms of an allergic reaction to food. Nearly all managers knew to call 911 (99.3%) when a customer has a bad food allergic reaction, such as trouble breathing. However, more than 1 in 10 managers (11.9%) incorrectly believed that a person allergic to a specific food ingredient can safely eat small amounts of that food. However, more than 1 in 10 food workers (11.8%) incorrectly believed that a person allergic to a specific food ingredient can safely eat small amounts of that food.
Strengths/ Limitations:	Limitations: The findings might not generalize to non-English speakers as only English speakers interviewed. Similarly, because the interviewed food workers and servers were chosen by managers rather

	than randomly, the food worker and server data might not be representative of these groups as a whole. This study also had a low participation rate (32.6%).
Relevant outcomes:	Findings highlight knowledge gap on food allergies among restaurant staff

Study reference:	**Giniş, T., Koç, N., Güvenir, H., Çetin, C., Toyran, M., Civelek, E., & Kocabaş, C. N. (2016). The level of knowledge of dietitians about dietary management of children with food allergy. Asim, Allerji, Immunoloji, 14(2), pp. 81–87.**
Study type:	Cross-sectional study to evaluate the knowledge of dietitians and dietetic students about food allergy in order to develop suggestions for educational activities.
Study population:	Turkey
Publication date:	2016
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size and conducted on dieticians/dietetic students from a specific region of Turkey, which could limit generalisability.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	125 dietitians and dietetics students were surveyed via a self-administered questionnaire. The questionnaires included questions on the demographic characteristics of the participants and their

	knowledge and attitudes regarding the symptoms, severity, triggers, some hidden food content such as dairy, eggs and management of food allergies including the effects of cooking methods on food allergenicity and procedures causing cross-contact. It also included questions related to symptoms of anaphylaxis and their suggestions about what formulas should be given for children with cow's milk allergy (CMA).
Findings:	122 valid questionnaires were returned (response rate was 81.3%). About 60% of respondents rated themselves 'moderate' for identifying some clinical manifestations of FA, developing elimination diets, providing avoidance education, managing the dietary needs of children with cows' milk allergy (CMA). Only 72.1% of respondents answered the questions about foods that can cause anaphylaxis correctly. About 40% of respondents did not recognize that food allergens could be transmitted by means of tools used for service such as knives and spoons and thought that smoke of the cooking food does not cause allergy. About 60% of respondents also thought that touching the food never causes allergic reactions. Of all the respondents, only about 18.9% suggested amino acid-based formulas for children with CMA, 23% suggested fully hydrolized formulas and 39.3% thought that lactose free formulas can be given to patients with CMA.
Strengths/ Limitations:	Limitations: Small number of participants. The use of a non-validated questionnaire and reliance on the dietitians' self-reports might pose another limitation to assess for management of food allergy.
Relevant outcomes:	Findings highlight knowledge gap on food allergies among dietitians despite rating themselves 'moderate'

Study reference:	**Geiger, J. , Rhee, Y. , Stastny, S. N. , Brunt, A. , & Salafia, E. B. (2017). Celiac Disease and the Gluten-free Diet: Registered Dietitian Nutritionists' Self-reported Knowledge Varies. International Journal of Celiac Disease, 5(2),pp. 56-61.**

Study type:	Cross-sectional study to measure registered dietitian nutritionists (RDN) self-reported celiac disease (CD) knowledge and preferences for resources for self-education and patient education.
Study population:	U.S.
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Low response rate.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	A cross-sectional survey was used to recruit RDNs (n=405) from participating state affiliates Alaska, Colorado, Connecticut, Delaware, Montana, Nebraska, and North Dakota in 2013. A 35-item internet-based survey was distributed and included Likert scale questions based on a previous RDN allergy survey. Demographic and gluten-free diet and CD multiple-choice questions were also included.
Findings:	RDNs reported either moderate or high levels of knowledge for all seven self-reported knowledge topics. Over 85% of RDNs selected correct answers for five CD knowledge questions. Professional and academic publications were the most commonly used resources by RDNs for self-education whereas handouts were the most commonly used resource by RDNs for patient education.
Strengths/ Limitations:	Limitations: Low response rate and lack of sex diversity. Also, some RDNs with limited exposure to CD may have struggled on the survey knowledge questions.

Relevant outcomes:	Findings highlight there is good knowledge of CD among RDNs

Study reference:	**Sanagavarapu, P., & Huang, Y. (2017). Young children's knowledge of food allergy and transition to school. Cogent Education, 4(1).**
Study type:	Qualitative study to investigate young children's knowledge of food allergy and their capacity to resist food temptations and seek help when needed at school and their feelings about starting school and their views on a safe start to school with food allergy.
Study population:	Australia
Publication date:	2017
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has extremely small sample size, which could limit generalisability.
Key themes/ topics:	FH knowledge and preparedness among children/parents of children with FHs
Method:	This pilot study interviewed six children—aged four-to six-years in their family homes in Sydney, Australia about their food allergy and starting school. Only children, who had a medically diagnosed food allergy or allergies, had been prescribed an adrenaline auto-injector, started school in the beginning of 2013, and spoke English, as a first language were recruited. Data from Photo Elicitation Interviews (PEI) utilising photos as prompts were analysed thematically.

Findings:	The results suggest that a child's knowledge of food allergy, their self-control to resist temptation and their ability to communicate the need for help may help them to stay safe at school, and therefore are vital in their transition to school. Key themes were: awareness, avoidance, action, feelings about starting school and advice to other children with food allergy starting school.
Strengths/ Limitations:	Strengths: The PEI method of interviewing or using photos as prompts was valuable to collect data relevant to the study and its aims. Limitations: Very small sample size. It was also difficult to determine the extent to which their mother's presence, or prior experience of transition to an early childhood setting, had influenced the children's responses. Also, PEI may not have been an effective means for capturing the children's emotional issues and concerns. Children who were not proficient in English were not selected, which limits generalisability.
Relevant outcomes:	Findings provide insight into young children's knowledge of their food allergies

Study reference:	**Soon J.M. (2018), 'No nuts please': Food allergen management in takeaways. Food Control.**
Study type:	Cross-sectional study to investigate the food allergy knowledge, attitudes and practices of staff in takeaways.
Study population:	UK
Publication date:	2018

Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has extremely small sample size, which could limit generalisability.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Data were collected through a postal survey developed. Questions were divided into four sections: (i) demographics (8 questions); (ii) knowledge (12 questions); (iii) attitudes towards food allergen management (20 questions); and (iv) practices (20 questions). Three hundred and twenty takeaways based in north-west of England were contacted using the FSA's food hygiene ratings advanced search options. Twenty nine takeaways responded to the survey and 28 completed the questionnaire.
Findings:	Although more than half of the takeaways' staff demonstrated good food allergy knowledge, some misunderstanding existed among the respondents. There were confusion about lactose intolerance and milk allergy, a third of the takeaways' staff were uncertain that hands could transfer allergens. 43% would mistakenly offer water to dilute a food allergen to stop the reaction. Respondents strongly agreed that customers should inform staff if they have food allergies. Takeaways' staff would enquire customers if they need allergen information when taking orders over the telephone.
Strengths/ Limitations:	Limitations: Low response rate, small sample size (n = 28) and self-reported practices.
Relevant outcomes:	Findings highlight knowledge gap on food allergies among restaurant staff

Study reference:	**Yrjänä, J., Bloigu, R., & Kulmala, P. (2018). Parental confusion may result when primary health care professionals show heterogeneity in their knowledge, attitudes, and perceptions regarding infant nutrition, food allergy, and atopic dermatitis. Allergologia et immunopathologia, 46(4), pp. 326–333.**
Study type:	Cross-sectional study to characterize the knowledge, attitudes, and perceptions regarding these issues among primary health care professionals
Study population:	Finland
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data, which could have recall bias and social desirability bias. Study also has small sample size, which could limit generalisability. Potential selection bias as particpants self-selected.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	An online questionnaire was distributed and 80 health care professionals took part in the survey, of whom 72.5% were PHNs and 27.5% GPs. The questionnaire consisted of 94 items, of which 68 questions related to FA and AD, and six to infant feeding recommendations. The remaining 20 Likert scale questions assessed attitudes and perceptions. In addition, parents of one-year-old children were recruited to a separate survey at the time of their regular check-up visit. Thirty-one % of those asked (248 of 800) returned the questionnaire.

Findings:	The median overall knowledge score was 77% and significantly higher among the general practitioners than among the nurses (p=0.004). However, only 35% of all the professionals recognized either severe airway or cardiovascular symptoms as potential food allergy-related symptoms. Among 248 one-year-old children, the incidence of food allergy was 4% and atopic dermatitis 13%. During this period, parents intentionally avoided giving at least one food to 23% of the children, and more than 80% of these restrictions can be regarded as unnecessary.
Strengths/ Limitations:	Strengths: The availability of the health care system's primary care services is homogeneous throughout Finland, this it is likely that the current results can be extrapolated to apply to the whole country. Limitations: As only 64% of the PHNs, 37% of the GPs and 31% of the families returned the questionnaires, it cannot be certain that the respondents are fully representative of the population. The self-selection of participants may indicate a higher confidence of knowledge or a higher level of education and so may be somewhat biased.
Relevant outcomes:	Findings highlight knowledge gap on food allergies symptoms and management among primary care professionals

Study reference:	**Halmos, E. P., Deng, M., Knowles, S. R., Sainsbury, K., Mullan, B., & Tye-Din, J. A. (2018). Food knowledge and psychological state predict adherence to a gluten-free diet in a survey of 5310 Australians and New Zealanders with coeliac disease. Alimentary pharmacology & therapeutics, 48(1), pp. 78–86.**
Study type:	Cross-sectional study to comprehensively assess the patient factors that influence gluten-free diet adherence in patients with coeliac disease.

Study population:	Australia & New Zealand
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Potential bias in participant selection as all were members of a coeliac advocacy group, also limiting generalisability.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Patients with coeliac disease completed an online survey comprising the validated Celiac Dietary Adherence Test in addition to data on demographics, details of diagnosis and management and assessment of diet knowledge, quality of life and psychological distress. Participants were diagnosed with coeliac disease for at least 6 months and aged ≥13 years were to complete the survey. Survey data were analysed for predictors of adherence and quality of life.
Findings:	Of 7393 responses, 5310 completed the Celiac Dietary Adherence Test and 3230 (61%) were adherent to a gluten-free diet. Multivariate regression showed older age, being male, symptoms after gluten ingestion, better food knowledge and lower risk of psychological distress were independent predictors of adherence (each $P \leq 0.008$). Additionally, dietary adherence was associated with better quality of life ($P < 0.001$; multiple regression). Respondents who considered themselves to have poor food knowledge were more likely to incorrectly identify gluten-free foods, but could still recognise gluten-containing foods, suggesting that poor knowledge may lead to over-restriction of diet.

Strengths/ Limitations:	Limitations: There were a large proportion of respondents who were members of a coeliac disease advocacy organisations (68%). It is probable these respondents are more informed and health conscious, so the rate of adherence described may over-estimate what is seen in the general coeliac disease population.
Relevant outcomes:	Findings highlight knowledge of celiac disease although this is in the context of its relationship to adherence to a GF diet.

Study reference:	**Lee Y.M., Sozen E. (2018), Who knows more about food allergies – restaurant managerial staff or employees? British Food Journal, 120(6).**
Study type:	Cross-sectional study to compare restaurant managerial staff and employees' attitudes toward food allergies, their food allergy knowledge and food allergy-related training.
Study population:	U.S.
Publication date:	2018
Study quality and applicability:	Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. However, Cronbach's alpha was calculated to test the inter-item reliability, with the desired value of $\alpha \geq 0.70$ and a pilot study was done.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs

Method:	An online questionnaire was administered through a market research company. A total of 110 managerial staff and 229 restaurant employees completed this questionnaire. The questionnaire included demographic and restaurant information, respondents' attitudes toward food allergies using a five-point Likert scale and food allergy knowledge and food allergy training in restaurants.
Findings:	Respondents felt that the customers should be responsible for expressing their food allergy needs. Both groups were able to identify certain symptoms of allergic reactions to food but lacked knowledge of allergen-handling practices. In total, 70% of the managerial staff indicated that they provided employee food allergy training but only 40% of employees indicated receiving such training. The managerial staff identified a lack of employee commitment and interest as barriers to training provision. However, the employees identified different reasons (i.e. it is unnecessary and not beneficial).
Strengths/ Limitations:	Limitations: Sample selection is limited because respondents were recruited by a market research company; thus only respondents whose contact information already existed in the company's database were included. Restaurants where the managerial staff and employees worked were not matched, so the differences in attitudes, knowledge and training may be due to being from different restaurants. The questionnaire did not ask the respondents about their geographic location so it is not possible to account for different state training rules. This study involved only English-speaking respondents so may not represent the sentiments of non-English-speaking restaurant managerial staff and employees
Relevant outcomes:	Findings highlight knowledge gap and attitudes towards allergen risk management among restaurant staff

Study reference:	**Avena-Woods, C., Mangione, R. A., & Wu, W. K. (2018). Exploring the Community Pharmacist's Knowledge of Celiac Disease. American journal of pharmaceutical education, 82(2), 6353.**

Study type:	Cross-sectional study to evaluate pharmacists' knowledge of celiac disease, and identify potential areas where additional continuing education may be needed.
Study population:	U.S.
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Participants from one national chain pharmacy and only in one region New York and New Jersey, which could limit generalisability.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	A survey was sent to community pharmacists practicing in a national chain pharmacy in one region of New Jersey and New York. 418 community pharmacists completed the survey. Based on their self-reported understanding of the disease, participants were categorized into two study groups: poor/limited or basic/advanced. A comparison of the pharmacists' self-assessed level of understanding and their actual knowledge and awareness of the disease was performed.
Findings:	Only 27% of all respondents who reported their understanding of celiac disease to be basic or advanced correctly defined celiac disease as both an autoimmune and a chronic lifelong disease. The majority (60%) of respondents correctly stated there are no federal regulations requiring manufacturers to designate medications as gluten-free. Twenty % of respondents said they often recommended a change in diet to people suspected to have celiac disease before a confirmed diagnosis. Approximately 59% of respondents

	(n= 225) considered their level of understanding to be basic or advanced, while 41% (n= 154) of respondents considered their level to be limited or poor.
Strengths/ Limitations:	Strengths: A conservative approach was used to assess the understanding of pharmacist knowledge regarding the disease or measures to cope with the disease. All respondents had to answer correctly on all items based on the literature and expert opinions to be considered correct. Limitations: The results of this study are specific to only one geographic division within one chain pharmacy. Comprehensive pilot testing of survey questions was not performed.
Relevant outcomes:	Findings highlight knowledge gap on CD among pharmacists

Study reference:	**van Gils, T., Senler, T. G., van der Horst, H. E., Mulder, C., Bouma, G., & de Vries, H. (2018). The daily practice of (suspected) coeliac disease management by general practitioners: A qualitative approach. The European journal of general practice, 24(1), pp. 236–242.**
Study type:	Qualitative study to provide insights into the daily practice of diagnosis, treatment, and follow-up of CD by GPs.
Study population:	Netherlands
Publication date:	2018
Study quality and applicability:	Very Low

	Comment: Study based on self-reported data which is subject to different biases and is usually not as robust. Extremely small sample size and lack of sex diversity of GPs, which could limit generalisability.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	Topic list-based semi-structured in-depth interviews were conducted with 7 Dutch GPs with more than five years' experience. GPs were purposively sampled. The number of GPs interviewed depended on when data saturation was reached. Content analysis was applied to the semi-structured interviews.
Findings:	Analysis of the interviews resulted in three main themes: 'awareness,' 'diagnostics' and 'management.' Vague gastrointestinal symptoms and diarrhoea were often mentioned as a possible presentation of CD. Antibodies were used in CD diagnosis, although some GPs would start a gluten-free diet as a first diagnostic tool. Some GPs diagnosed CD only based on positive antibodies without referring to secondary care or duodenal biopsy analysis. GPs mentioned no role for primary care physicians in the follow-up of CD and noted the important role of dieticians in CD management.
Strengths/ Limitations:	Strength: This is the first study exploring the daily practice of CD management by GPs. Limitations: GPs may have read the CD guidelines before the interview, resulting in answers based on guidelines rather than daily clinical practice.
Relevant outcomes:	Findings highlight some knowledge gaps of CD among GPs

Study reference:	**Harrison J. A., Critzer F. J., and Harrison M. A. (2016). Regulatory and food safety knowledge gaps associated with small and very small food businesses as identified by regulators and food safety educators - implications for food safety training. Food Protection Trends, 36(6), pp. 420-427.**
Study type:	Cross-sectional study to survey state regulatory officials and food safety educators nationwide to determine their ratings of the prevalence of practices that contribute to food safety risks associated with products from small and very small businesses
Study population:	U.S.
Publication date:	2016
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Extremely small sample size and only focusing on small or very small FBOs, which could limit generalisability. Indirect as asking about knowledge gap of FBOs through food regulators and educators.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	This exploratory survey used a convenience sample of 65 state regulatory personnel and state food safety educators to determine observed and perceived prevalence of potential food safety risks that could impact training designed for small and very small food businesses. Participants were asked to rate the prevalence of food safety knowledge factors and practices observed among small food businesses with which they work that could lead to food safety risks for consumers.

Findings:	Mean ratings indicate a lack of awareness of food safety risks associated with products and how to mitigate those risks, lack of capital for training, lack of understanding of laws that pertain to them, and lack of knowledge of food allergens and mandatory labelling among owner/operators with whom they work. Only 10 to 24% of owner/operators were rated as being able to identify all eight major food allergens and mandatory labelling requirements.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight knowledge and training gap among small and very small businesses via food regulatory personnel and food educators

Study reference:	**Stockhammer, D., Katelaris, C. H., Simpson, M. D., & Vanniasinkam, T. (2020). Parent perceptions in managing children with food allergy: An Australian perspective. The World Allergy Organization journal, 13(10), 100468.**
Study type:	Mixed methods study to explore parental perceptions and knowledge as they navigate a new reality of keeping their child safe.
Study population:	Australia
Publication date:	2020
Study quality and applicability:	Very Low

	Comment: Study based on self-reported data which is subject to different biases and is usually not as robust. Study has small sample size, which could limit generalisability. Indirect as asking about knowledge gap of parents of children with FHs through willingness to use adrenaline auto-injector and signing up to a registry as well as quality of life.
Key themes/ topics:	FH knowledge and preparedness among children/parents of children with FHs
Method:	This study was conducted throughout Australia, using an online platform and parental interviews (n=306). Phase one was a cross-sectional online survey involving participants either living with food allergy (under 8 years, 8–12 years, teenagers under 19 years) or parents of children with food allergy, while phase two encouraged parents who had completed the online survey to opt-in for a phone interview.
Findings:	Questionnaire analysis showed that 44.1% of parents hesitated to use an adrenaline auto-injector and may be influenced by a classification system where symptom severity is not universally understood. While 79% would sign up to a national Anaphylaxis Registry, intention to participate in clinical trials using vaccines was disclosed by only 56%. Allergen labelling and community acceptance continue to be the most challenging aspects of managing a food allergy, and 50% of parents reported that food allergy played a role in choosing a preschool or primary school.
Strengths/ Limitations:	Strength: Inclusion of participants outside large metropolitan centres. The exploration of multiple topics uncovered current perceptions around health behaviours, knowledge, and perceptions, which are fundamental in safeguarding against psychosocial stressors. Limitations: With open surveys, there is inability to determine response rates and motivation behind those who, not only completed the online survey but also chose to be interviewed, and this may limit generalisations. IgE-mediated allergy status was unconfirmed; however, the use of an adrenaline auto-

	injector served as a proxy. The length of the survey and only being in English may have discouraged participants from completing the survey.
Relevant outcomes:	Findings highlight knowledge gap and attitudes towards allergen risk management among parents of children with FHs

Study reference:	**Gutowski, E. D., Weiten, D., Green, K. H., Rigaux, L. N., Bernstein, C. N., Graff, L. A., Walker, J. R., Duerksen, D. R., & Silvester, J. A. (2020). Can individuals with celiac disease identify gluten-free foods correctly?. Clinical nutrition ESPEN, 36, pp. 82–90.**
Study type:	Cohort study to assess whether recently diagnosed CD patients can determine whether a food is gluten-free based on labelling, and to assess skills over time. A secondary aim was to identify factors associated with label reading proficiency.
Study population:	Canada
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Study has small sample size and only based in a city in Canada, which could limit generalisability. Different items were tested each time, which meant that the scores might not be accurate over time.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs

Method:	Inception cohort with follow-up at 6, 12, and 24 months after diagnosis. Participants were asked to determine whether 25 food items were gluten-free based on labelling information. Diet adherence was assessed using the Celiac Diet Assessment Tool (CDAT) and the Gluten-Free Eating Assessment Tool (GF-EAT). 144 adults with newly diagnosed celiac disease were enrolled. The initial quiz at 6 months was completed by 83%. Quizzes were completed by 72% at 12 months and 70% at 24 months.
Findings:	Median overall accuracy scores were: 23/25, 24/25 and 21/25 at 6, 12 and 24 months respectively. Gluten-free products with explicit “gluten-free” claims had the fewest errors. Quiz scores were not correlated with tTG IgA levels, or CDAT or GF-EAT scores. Diet adherence was generally good (>85% with CDAT <13 suggesting adequate GFD adherence); however, at 24 months, only 11% reported no gluten exposure.
Strengths/ Limitations:	Limitations: Only 25 grocery items were included at each time point, which cannot adequately cover the scope of labels and ingredients encountered by patients with CD. Additionally, there were 25 different items at each time point which made it difficult to determine if participants' skills (and scores) for the same foods improved over time. Additionally, scoring for each item was based on yes/no responses. An unintended consequence was that once a gluten-containing ingredient was identified, participants proceeded to the next item without evaluating the remaining ingredients. This may have led to certain ingredients towards the end of the list being under-recognized merely because participants did not evaluate them.
Relevant outcomes:	Results indicate possible knowledge gaps in people with CD identifying gluten free foods correctly.

Study reference:	**Hua, T., Sambell, R., Wallace, R., Vale, S., & Devine, A. (2020). Food allergy management in Early Childhood Education and Care Services in Australia. Journal of paediatrics and child health, 56(3), pp. 394–399.**
Study type:	Cross-sectional study to assess Australian Early Childhood Education and Care Services (ECEC) staff on their preparedness to manage children with food allergy (FA) and anaphylaxis.
Study population:	Australia
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust.
Key themes/ topics:	FHs knowledge and preparedness among childcare providers
Method:	An online survey developed in a previous Western Australian study was applied to all other Australian states and territories. The survey collected data about knowledge, skills, training, and confidence of staff to manage FA and anaphylaxis and barriers to implementation of policy and guidelines in ECEC services. The survey was distributed to 5956 ECEC services, and 494 complete surveys were received (response rate 8.3%).
Findings:	One in 10 (9.5%) ECEC services did not require staff to undertake anaphylaxis training. Staff felt confident in managing FA and anaphylaxis, regardless of their level of training. Against recommendations, 37% of

	participating ECEC services stored adrenaline autoinjectors (AAI) in a locked location. Only 51.4% of ECEC services reported having an AAI trainer device.
Strengths/ Limitations:	Limitations: Respondents were assumed to be representative of the ECEC sector, and as such, this study relies on self-reported data, which might be subject to social desirability bias.
Relevant outcomes:	Findings highlight gaps in relation to childcare staff knowledge, specifically regarding how to correctly store and administer AAI devices, despite feeling confident in managing FA and anaphylaxis.

Study reference:	**Kwon, J., Lee, Y. Ming, & Wen, H. (2020). Knowledge, attitudes, and behaviors about dining out with food allergies: A cross-sectional survey of restaurant customers in the United States. Food control, 107.**
Study type:	Mixed methods study in the used cross-sectional surveys and focus groups to assess participants' dining out experience and knowledge. Participants were either FHs sufferers or carers of children with FHs.
Study population:	U.S.
Publication date:	2020
Study quality and applicability:	Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Study has small sample size, which could limit generalisability. Potential selection bias as participants are subscribers of a food allergy dining out website, thus they could have more knowledge than the average FH sufferer. However, a pilot study was conducted with a convenience sample of 12

	Cronbach's alpha was calculated to test the inter-item reliability, with the desired value of $\alpha \geq 0.70$ customers with food allergies.
Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	A mixed methods approach utilizing qualitative (focus groups) and quantitative (online survey) research was used. Customers with food allergies (n = 63) and parents or guardians of children with food allergies (n = 257), who were members of a food allergy social networking website, participated in the survey. Themes related to the participants' past dining experiences, factors that triggered food allergy reactions, preventive measures taken when dining out, and attitudes and expectations toward restaurants in serving allergen-free foods were identified by using the constant comparative method. Ten knowledge questions covered common food allergens, proper food allergen–handling methods, and prevention strategies for food allergy reactions.
Findings:	The average knowledge score of participants was 24.7 out of 30 (82.3%), and they recognized typical causes of food allergy reactions in restaurants (i.e., hidden allergens, cross-contacts, and restaurant employees' lack of knowledge, care, and communication about food allergies). Consumers with food allergies had fair (~80%) food allergy knowledge and are aware of the need to inform servers about special accommodations. Depending on the types of food allergens and previous dining experiences, respondents voiced diverse concerns about different types of restaurants.
Strengths/ Limitations:	Limitations: Participants were subscribers of AllergyEats.com, a social networking website offering restaurant information for customers with food allergies; these individuals may be more informed about allergy prevention strategies. Second, the researchers classified ethnic (e.g., Asian, Italian, Mexican, etc.) cuisines under a single umbrella term of "ethnic" restaurant. Thus, results may not reflect the true perceptions of each specific type of ethnic restaurant. Results may not be generalisable beyond the US and commercial restaurants.

Relevant outcomes:	Findings highlight consumers have fair knowledge on allergy risk management when dining out

Study reference:	**Tamburro M., Sammarco M.L., Di Eleonora L., Ripabelli G. (2020). Food service operators behavior and knowledge on gluten-free meals and requirements of public canteens. Italian journal of food science, 32(2).**
Study type:	Cross-sectional study to describe the epidemiological background regarding CD occurrence in Italy, as well as an overview of the public canteens administrating GF meals and training on this issue
Study population:	Italy
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Study has extremely small sample size and only based on public canteens in Italy, which could limit generalisability.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	The survey involved 20 public canteens involved in the production and/or administration and/or sale of GF products located in a region of central Italy. Data were collected during the regular inspection activities using two different approaches, an interview and a checklist, which were both administered to 20 food service operators (FSOs) (one for each inspected canteen) in charge of the entire food processing.

Findings:	Among various listed food, all FSOs demonstrated to know that bread, pasta and cutlet are forbidden food in the diet for CD individuals, whilst 15% (n=3) and 20% (n=4) erroneously answered that cookies and barley coffee can be consumed, respectively. Furthermore, 30% (n=6) erroneously stated that CD patients can introduce small amounts of gluten with diet, and only 75% (n=15) proved to be aware that gluten is not removed by cooking foods. 20% (n=4) of FSOs did not know that GF food should be stored in clearly identified and separated areas. Only 25% (n=5) of FSOs knew that equipment (i.e. oven, deep fryer, plates, etc.) and utensils (i.e. cookware, tableware, etc.) should be used exclusively for GF food preparation.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight knowledge gaps on GF food preparation among public canteens

Study reference:	**Krugman, S. D., Chiaramonte, D. R., & Matsui, E. C. (2006). Diagnosis and management of food-induced anaphylaxis: a national survey of pediatricians. Pediatrics, 118(3), pp. 554–560.**
Study type:	Cross-sectional survey to assess paediatricians' knowledge of diagnosis and management of children with food-induced anaphylaxis.
Study population:	U.S.
Publication date:	2006

Study quality and applicability:	Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust.
Key themes/ topics:	FHs knowledge and management among healthcare providers
Method:	A survey designed to assess food allergy diagnosis and management was mailed to a US national random sample of 1130 paediatricians. Survey questions were based on a clinical scenario involving a child having an anaphylactic reaction after ingesting peanut. Primary outcome measures included correct responses to the 11 questions about anaphylaxis. A total of 468 paediatricians (41%) responded to the survey.
Findings:	Overall, 70% of the paediatricians agreed that the clinical scenario was consistent with anaphylaxis, and 72% chose to administer epinephrine. However, only 56% of respondents agreed with both the diagnosis of anaphylaxis and treating with epinephrine. Most paediatricians (70%) did not recognize that a 30-minute observation period after anaphylaxis was too short. Paediatricians who reported providing care for food allergy patients were more likely to agree with the diagnosis of anaphylaxis (73% vs 59%), with treating the reaction with epinephrine (73% vs 64%), and with prescribing self-injectable epinephrine (83% vs 66%) than paediatricians who did not care for food allergy patients.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight knowledge gaps in clinical knowledge of FA among paediatricians

Study reference:	**Karajeh, M. A., Hurlstone, D. P., Patel, T. M., & Sanders, D. S. (2005). Chefs' knowledge of coeliac disease (compared to the public): a questionnaire survey from the United Kingdom. Clinical nutrition (Edinburgh, Scotland), 24(2), pp. 206–210.**
Study type:	Cross-sectional study to compare chefs' knowledge with the public's knowledge about CD.
Study population:	U.K.
Publication date:	2005
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Study based on only one city in the UK, which could limit generalisability. Potential bias from sampling method.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	A questionnaire survey about CD was performed in South Sheffield, United Kingdom (UK). The study involved three groups; 319 adult CD patients at a single university teaching hospital established on GFD; 322 chefs, half of which (n=161) worked in restaurants and the other in various take-away establishments in the same area; control group comprised 513 members of the public, who were questioned as they entered or exited several large local shopping areas. Chefs were questioned as to whether they had any previous awareness of CD or PA (in an identical manner to the public).
Findings:	Chefs were less likely to have heard of CD when compared to the public (17.1% (55/322) versus 44.2% (227/513), respectively, P<0.0001). Coeliac patients ate less frequently at a friend's house than the

	general public (P=0.003). Coeliac patients ate less frequently from take-away establishments (P<0.0001). However, coeliac patients' ate as frequently in restaurants (P=0.078).
Strengths/ Limitations:	Limitations: Their method of obtaining a sample of the general public could result in bias as they did not make any social or demographic comparisons between our sample and national data. There is a mismatch in demographics between chefs and the public, which could invalidate the results.
Relevant outcomes:	Findings highlight knowledge gaps on CD among chefs as compared to the public

Study reference:	**Sicherer, A. R. (2007). Deficits in knowledge about allergy among restaurant staff. Nursing Standard, 21(44), p. 17.**
Study type:	Cross-sectional study to investigate factors that affect the provision of allergen-safe meals
Study population:	U.S.
Publication date:	2007
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data which is subject to different biases and is usually not as robust. Small sample size which could limit generalisability. Information on recruitment and methods is limited.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs

Method:	A structured questionnaire was completed by 100 individuals in 100 establishments (48 restaurants, 18 fast food outlets and 34 takeaways).
Findings:	Food allergy training was reported by 42% of respondents. On a five-point Likert scale, 72% were 'very' or 'somewhat' comfortable about providing a safe meal, 70% about 'guaranteeing' a safe meal and 47% about managing a food allergy emergency. In the knowledge questions, 24% thought eating a small amount of allergen would be safe, 35% believed that heat from a fryer would destroy allergens, 54% considered a buffet safe if kept 'clean' and 25% thought that removing an allergen from a finished dish, for example taking nuts off, made it safe. More than 80% recognised peanut, milk and seafood as major allergens and 61% recognised egg. In practice, 58% indicated having a plan in case of a reaction and 62% had a plan to provide safe meals. An interest in further training was expressed by 61 % of the participants.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight knowledge gap on allergen management among FBO staff

Study reference:	**Hu, W., Grbich, C., & Kemp, A. (2007). Parental food allergy information needs: a qualitative study. Archives of disease in childhood, 92(9), pp. 771–775.**
Study type:	Qualitative study to examine information needs and preferences of parents regarding food allergy.
Study population:	Australia
Publication date:	2007

Study quality and applicability:	Very Low **Comment**: Study based on self-reported data and is qualitative which is subject to different biases and is usually not as robust. Small sample size which could limit generalisability. Potential selection bias as participants recruited from allergy clinics and consumer organisations.
Key themes/ topics:	FH knowledge and preparedness among children/parents of children with FHs
Method:	84 parents of children with food allergy took part in a qualitative study including in-depth semi-structured interviews and focus group discussions. Participants were recruited from three paediatric allergy clinics and a national consumer organisation. Questions were asked on need for allergen information.
Findings:	Parents experienced different phases in their need for information: at diagnosis when there is an intense desire for information, at follow-up when there is continuing uncertainty about allergy severity and appropriate management, and at new events and milestones. Parents wished to know the reasoning behind doctor's opinions and identified areas of core information content, including unaddressed topics such as what to feed their child rather than what to avoid. Suboptimal information provision was cited by parents as a key reason for seeking second opinions.
Strengths/ Limitations:	Limitations: Findings are of unknown generalisability as the study was conducted in specific settings with a selected population. The inclusion of consumer organisation members may have also skewed results towards a preference for greater information provision, as patients tend to seek out health consumer organisations to find more information.
Relevant outcomes:	Findings highlight parents’ needs on knowledge and information of allergen management

Study reference:	**Jacobsen, K. H., Sambell, R., Devine, A., & Vale, S. (2018). Food Allergy Readiness and Anaphylaxis Management in Early Childhood Education and Care in Western Australia. Australasian Journal of Early Childhood, 43(4), pp. 43–47.**
Study type:	Cross-sectional study to assess knowledge of childhood FHs among early childhood education and care providers
Study population:	Australia
Publication date:	2018
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data and is qualitative which is subject to different biases and is usually not as robust. Small sample size and only in Western Australia. which could limit generalisability.
Key themes/ topics:	FHs knowledge and preparedness among childcare providers
Method:	An online survey was conducted with 53 long day care services in Western Australia. Survey asked about preparedness and knowledge of FA and anaphylaxis management.
Findings:	Overall, 7% of ECEC services did not require staff to undertake anaphylaxis training. All services felt confident they had access to trained staff who could appropriately respond to anaphylaxis. Against recommendations, 36% of participating ECEC services stored adrenaline autoinjectors (AAI) in a locked location. Only 51.4% of ECEC services reported having an AAI trainer device.

Strengths/ Limitations:	Did not report any
Relevant outcomes:	There are gaps in knowledge of dealing with FHs in children among childcare providers

Study reference:	**Bailey, S., Albardiaz, R., Frew, A. J., & Smith, H. (2011). Restaurant staff's knowledge of anaphylaxis and dietary care of people with allergies. Clinical and experimental allergy: journal of the British Society for Allergy and Clinical Immunology, 41(5), pp. 713–717.**
Study type:	Cross-sectional study aimed at assessing restaurant staff's knowledge about food allergies
Study population:	Europe/UK
Publication date:	2011
Study quality and applicability:	Very Low **Comment**: Study based on self-reported data and is qualitative which is subject to different biases and is usually not as robust. Small sample size and only based on one city, which could limit generalisability.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Conducted telephone surveys with 90 restaurant staff in Brighton, UK. Survey pm knowledge, beliefs, and management of food allergy. Survey was replicated from allergytraining.com (this is acknowledged)

Findings:	There are certain gaps in staff's knowledge of food allergies which calls for more rigorous training. Restaurant staff had some false believes about food allergies that in a case of allergic reaction of a customer can pose as a risk. There is lack of understanding of signs, management, and severity of food allergy emergency.
Strengths/ Limitations:	Limitations: There is low generalisability beyond the city in UK; self-reported data could have social desirability bias.
Relevant outcomes:	Findings highlight knowledge gaps and lack of understanding of allergy management among FBO staff

Study reference:	**McLaughlin, A. M., Macaulay, T., & Peterson, C. C. (2020). College students' knowledge and management of food allergies. Journal of American college health, pp. 1–7.**
Study type:	Cross-sectional study on predictors of food allergy management and allergy knowledge in college students
Study population:	USA
Publication date:	2020
Study quality and applicability:	Very Low **Comment**: Small sample size and unbalanced gender proportion. All self-reported data on allergy diagnosis, knowledge, and management, which could result in several biases. No confirmatory allergy tests were done.

Key themes/ topics:	FHs knowledge, attitude, and management among consumers with FHs
Method:	Participants were recruited from a larger nationwide study, with purposeful oversampling of students with food allergies. Participants completed measures assessing their food allergy(ies), symptoms, history of reactions, and current allergy management behaviours. They and a control group without food allergies completed a measure of food allergy knowledge. (n = 51 students with food allergies, n = 50 for control)
Findings:	Food allergy knowledge accounted for an additional 20% of variance in students' allergy management behaviours, above and beyond severity and allergic reactions ($p<.001$). No statistically significant difference in knowledge between participants with food allergy and matched controls.
Strengths/ Limitations:	Limitations: Unable to confirm diagnosis of food allergy and all self-reported data. Small sample size and largely female. Relatively low internal consistency of knowledge measure.
Relevant outcomes:	Food allergy knowledge is important for allergy management

Study reference:	**Shashoua, R., & Barnett, J. (2019). Understanding Food Allergy Knowledge and Practice in Takeaway Restaurants in South Gloucestershire. University of Bath, [Unpublished report].**
Study type:	A pre-publication UK qualitative study on food allergy knowledge and practices among takeaway staff.
Study population:	UK

Publication date:	2019
Study quality and applicability:	Very Low Comment: Study based on self-reported data and is qualitative which is subject to different biases and is usually not as robust. Extremely small sample size and only based on takeaway staff in one city, which could limit generalisability.
Key themes/ topics:	FHs knowledge, attitude, and training among FBOs
Method:	Face-to-face or phone interviews were conducted with takeaway staff (n=18) in South Gloucestershire, UK. Questions were on knowledge of range of allergens, legislation, and practices.
Findings:	Overall, knowledge of allergens and of the 2014 European food legislation was poor, particularly in independent takeaways, especially where clear communication in the English language is difficult. Gluten and nut allergens were most often mentioned and known to be associated with serious health consequences. There was minimum awareness of many other allergens.
Strengths/ Limitations:	None reported
Relevant outcomes:	Findings highlight knowledge gaps of allergens and food legislation among takeaway staff