Prevalence estimates of eight big food allergies in Europe: Updated systematic review and meta-analysis

Received: 1 January 2023 | Revised: 31 May 2023 | Accepted: 20 June 2023

DOI: 10.1111/all.15801

Allergy EUROPEAN JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY EAACI WILEY

REVIEW

Prevalence estimates of eight big food allergies in Europe: Updated systematic review and meta-analysis

Giulia C. I. Spolidoro[1] | Mohamed Mustafa Ali[2] | Yohannes Tesfaye Amera[2] | Sungkutu Nyassi[3] | Daniil Lisik[3] | Athina Ioannidou[3] | Graciela Rovner[4,5] | Ekaterina Khaleva[6] | Carina Venter[7] | Ronald van Ree[8,9] | Margitta Worm[10] | Berber Vlieg-Boerstra[11,12] | Aziz Sheikh[13] | Antonella Muraro[14] | Graham Roberts[6,15] | Bright I. Nwaru[3,16]

[1]Department of Clinical Sciences and Community Health, University of Milan, Milan, Italy

[2]School of Public Health and Community Medicine, Institute of Medicine, University of Gothenburg, Gothenburg, Sweden

[3]Krefting Research Centre, University of Gothenburg, Gothenburg, Sweden

[4]ACT Institutet Sweden, Gothenburg, Sweden

[5]Division of Physiotherapy, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm, Sweden

[6]Faculty of Medicine, University of Southampton, Southampton, UK

[7]Section of Allergy & Immunology, School of Medicine, University of Colorado Denver, Children's Hospital Colorado, Anschutz Medical Campus, Aurora, Colorado, USA

[8]Department of Experimental Immunology, Amsterdam University Medical Centers, Amsterdam, The Netherlands

[9]Department of Otorhinolaryngology, Amsterdam University Medical Centers, Amsterdam, The Netherlands

[10]Division of Allergy and Immunology, Department of Dermatology, Allergy and Venerology, Charité Universitätsmedizin Berlin, Berlin, Germany

[11]Department of Pediatrics, OLVG Hospital, Amsterdam, The Netherlands

[12]Department of Pediatrics, Rijnstate Hospital, Arnhem, The Netherlands

[13]Usher Institute, University of Edinburgh, Edinburgh, UK

[14]Department of Mother and Child Health, The Referral Centre for Food Allergy Diagnosis and Treatment Veneto Region, University of Padua, Padua, Italy

[15]David Hide Asthma and Allergy Centre, St Mary's Hospital, Isle of Wight, UK

[16]Wallenberg Centre for Molecular and Translational Medicine, University of Gothenburg, Gothenburg, Sweden

Correspondence
Bright I. Nwaru, Krefting Research Centre, Institute of Medicine, University of Gothenburg, Gothenburg, Sweden.
Email: bright.nwaru@gu.se

Funding information
DBV Technologies SA

Abstract

In 2014, the European Academy of Allergy and Clinical Immunology published prevalence estimates for food allergy (FA) and food sensitization (FS) to the so-called eight big food allergens (i.e. cow's milk, egg, wheat, soy, peanut, tree nuts, fish and shellfish) in Europe for studies published between 2000 and 2012. The current work provides 10-year updated prevalence estimates for these food allergens. A protocol was registered on PROSPERO before starting the research (reference number CRD42021266657). Six databases were searched for studies published 2012–2021, added to studies published up to 2012, resulting in a total of 93 studies. Most studies were graded as at moderate risk of bias. The overall pooled estimates for all age groups of self-reported lifetime prevalence were as follows: cow's milk (5.7%, 95%

confidence interval 4.4–6.9), egg (2.4%, 1.8–3.0), wheat (1.6%, 0.9–2.3), soy (0.5%, 0.3–0.7), peanut (1.5%, 1.0–2.1), tree nuts (0.9%, 0.6–1.2), fish (1.4%, 0.8–2.0) and shellfish (0.4%, 0.3–0.6). The point prevalence of food challenge-verified allergy were as follows: cow's milk (0.3%, 0.1–0.5), egg (0.8%, 0.5–1.2), wheat (0.1%, 0.01–0.2), soy (0.3%, 0.1–0.4), peanut (0.1%, 0.0–0.2), tree nuts (0.04%, 0.02–0.1), fish (0.02%, 0.0–0.1) and shellfish (0.1%, 0.0–0.2). With some exceptions, the prevalence of allergy to common foods did not substantially change during the last decade; variations by European regions were observed.

KEYWORDS
epidemiology, Europe, food allergy, sensitization, systematic review

1 | INTRODUCTION

Over a decade ago, the European Academy of Allergy and Clinical Immunology (EAACI) commissioned a systematic review and meta-analysis on the frequency of food allergy (FA) and food sensitization (FS) in Europe, which were to provide underpinning evidence to support the development of the EAACI food allergy and anaphylaxis guidelines.[1,2] Part of that work was to provide the prevalence estimates of FA/FS to the eight most common foods in Europe (i.e. cow's milk, egg, wheat, soy, peanut, tree nuts, fish and shellfish) based on studies published between January 2000 and September 2012.[2] Several studies have now been published since then, indicating that an update of the previous review is now warranted. In the current manuscript, we provide the 10-year updated prevalence estimates to that work.

2 | METHODS

2.1 | Protocol registration, search strategies, and study identification and selection

A protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) with reference number CRD42021266657 before starting the research. The search strategies were customized from the methodology already employed in the previous EAACI review.[1,2] Briefly, six electronic databases (MEDLINE, EMBASE, CINAHL, Web of Science, Cochrane Library and Scopus) were searched to collect relevant papers or conference abstracts published between September 2012 and June 2021. All keywords employed in the 2014 reviews were retained; additionally, new keywords were added to avoid missing any relevant studies, as well as to account for developments that have occurred in the respective databases over the last decade. The search strategies have been reported previously.[3] No language restriction was applied in searching the databases. Studies published in a language other than English were translated by a researcher fluent in the language. When translation was not possible, but an English abstract was available, relevant information was extracted from the paper abstract, while at the same time using Google Translate to translate the text. This precaution allowed us to have a clear idea of the content of the paper from the summary of the abstract, thus limiting the risk of data misinterpretation.

Systematic reviews, population-based studies, cross-sectional studies, cohort studies, and case–control studies, clinical trials and routine healthcare studies were eligible for inclusion, while narrative review, discussion papers, non-research letters or editorials, case-series, case-studies, and animal studies were excluded. All relevant papers published during 2012–2021 that were retrieved from the database searches were screened first by title and/or abstract, thereafter by full text, by four independent reviewers, working in pairs (SN/GS and YA/MA). Any disagreement between the pairs was resolved with consensus or by consultation with the project PI (BN). All eligible studies were then added to the studies already included in the EAACI 2014 review. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram was employed to report the screening process.

2.2 | Outcomes

The systematic review aimed to provide up-to-date data on the incidence, prevalence and time trends for common FA in Europe. We included the same eight food allergens investigated in the 2014 review, that is cow's milk, egg, wheat, soy, peanut, tree nuts, fish and shellfish.[2] Studies reporting on incidence or time trends were insufficient and not homogenous enough to allow meta-analysis. Therefore, only data on lifetime and point prevalence were included in meta-analysis, similar to what was done in the 2014 EAACI review.[1,2]

We defined the following meta-analysis outcomes: 1. Lifetime prevalence (i.e. prevalence of subject reporting ever having a reaction or hypersensitivity to respective foods) and point prevalence (i.e. prevalence of subjects reporting having a reaction or hypersensitivity to respective foods currently or during the past 12 months) of self-reported FA; 2. lifetime and point prevalence of self-reported physician-diagnosed FA (i.e. doctor-diagnosed FA reported by a subject in a questionnaire); 3. point prevalence of specific immunoglobulin E (sIgE) sensitization; 4. point prevalence of skin prick test (SPT)

sensitization; 5. point prevalence of symptoms plus sIgE sensitization; 6. point prevalence of symptoms plus SPT sensitization; 7. point prevalence of food challenge (oral food challenge- OFC or double-blind placebo-controlled food challenge- DBPCFC) positivity; and 8. point prevalence of food challenge positivity (OFC or DBPCFC) and/or clinical history of FA (i.e. FA confirmed by a convincing clinical judgment by a physician without food challenge). For each of these outcomes, we estimated the updated prevalence of FA/FS to the eight common food allergens for the period 2000–2021. In addition, we also analysed separately the data extracted from studies published during 2012–2021, which were then compared with the estimate obtained in the previous review for the period 2000–2012.

2.3 | Data analysis and synthesis

All new data were included in a customized data extraction form. When sufficient data were available, the estimates were recalculated using minimally measured event, rather than extrapolated ones, similar to what was done in the 2014 review. The Wilson score method without continuity correction was employed to obtain the 95% confidence intervals (95% CI).[4] In case of the need of clarification regarding the data presented in a study, a request of clarification was sent to the corresponding author of the said paper. Similar to the EAACI review in 2014,[1,2] European countries outside the Organization for Economic Cooperation and Development (OECD) were included in the systematic review, but not in the meta-analysis. An exception was made for Russia and Lithuania, which were included in the meta-analysis even in the 2014 review.[1,2]

Random-effects meta-analyses were performed to derive pooled estimates of the prevalence of each FA from all studies that provided adequate numerical data and shared clinically and methodologically comparable data. Stata (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC) software was employed for analysis. Heterogeneity was assessed using the I^2 statistic. The meta-analysis combined the studies included in the previous EAACI review and the new studies published during 2012–2021. When possible, the meta-analysis data were also stratified by age groups (≤1 year, 2–5 years, 6–17 years and ≥ 18 years for outcomes with enough records to perform meta-analysis on these detailed age groups; otherwise, the age groups were divided into children 0–17 years and adults ≥18 years) and by European regions (Northern, Eastern, Southern, Western Europe) following the classification by the United Nations (see Table A1 in Appendix 1). The United Kingdom was exceptionally assigned to Western instead of Northern Europe, as was done in the previous EAACI review.[1,2]

2.4 | Risk of bias assessment

The risk of bias for individual studies was assessed by the same pairs of reviewers (SN/GS and YA/MA) based on the adapted Critical Appraisal Skills Programme (CASP http://www.casp-uk.net) quality assessment tool, which was the same employed by the authors of the 2014 review. Any discrepancy between the pairs was either revolved by consensus or after consultation with the project PI (BN).

3 | RESULTS

The study selection and screening process are illustrated in the PRISMA flow chart (Figure 1). Briefly, 38,903 new records published during 2012–2021 were identified. After duplicates removal, and upon completion of the screening procedure, 43 new studies were included from the relevant literature and were added to the 50 studies already included in the previous EAACI reviews, giving a total of 93 studies included in this updated systematic review and meta-analysis.[5–127] The characteristics (i.e. age of the subjects involved and type of study) of the studies included in the review are summarized in Table 1. Of the 93 included studies, 50 were cross-sectional studies, 37 cohort studies, three systematic reviews and three case–control studies (including one nested case–control study). Some of the studies were multi-centres international studies, therefore reporting multiple estimates for each outcome investigated (i.e. one estimate for each centre/country involved). In the meta-analysis, each of these centres was treated as an independent study. The majority of the studies ($n = 67$) were undertaken only in children. Most studies were graded at a moderate risk of bias. Table 2 summarizes the grading of the main CASP quality assessment features for all studies.

3.1 | Frequency of FA

The frequency estimates for specific FA/FS are summarized in Tables 3 and 4. The pooled prevalence estimates for the specific FA/FS according to the different assessment methods for both point and lifetime prevalence are presented in Figures 2-6. Detailed results for each specific FA stratified by age groups and by European regions are presented in Figures S1–S55. Overall, the heterogeneity between the pooled studies was significant, regardless of the assessment method used ($I^2 \geq 80\%$ in each case), which is an indication of the notable variations in the prevalence of FA across European countries. Below we report the meta-analysis-derived estimates of the prevalence of the specific FA/FS.

For each of the specific FAs, there were insufficient data to pool prevalence estimates for point prevalence of self-reported physician-diagnosed FA.

3.2 | Cow's milk allergy

Cow's milk allergy (CMA) or sensitization was investigated in 79 studies. The overall lifetime and point prevalence for self-reported CMA were 5.7% (95% CI 4.4–6.9) and 3.1% (95% CI 2.4–3.8), respectively (Figure 2). The overall lifetime prevalence of self-reported

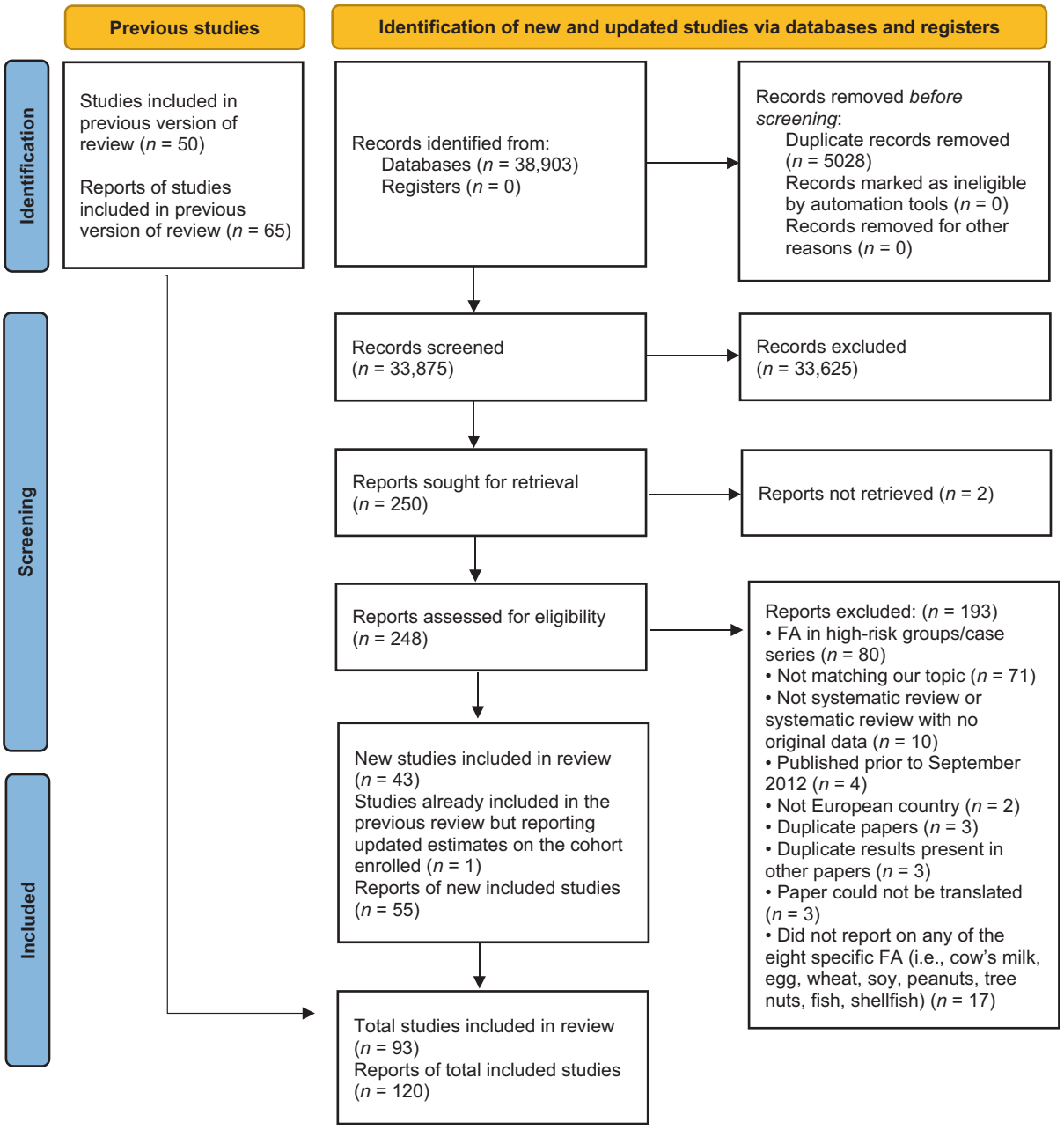

FIGURE 1 PRISMA flow diagram for updated systematic review on prevalence of food allergy to the eight common foods in Europe, 2000–2021.

physician-diagnosed CMA was 4.1% (95% CI 2.5–5.6) (Figure 3). Point prevalence of sIgE positivity to cow's milk was 5.5% (95% CI 3.8–7.2), 0.7% (0.4–1.2) for SPT positivity (Figure 4), 0.1% (95% CI 0.05–0.2) for sIgE positivity plus symptoms (Figure 5), 0.3% (95% CI 0.1–0.5) for FC positivity and 1.8% (95% CI 0.6–3.1) for FC positive or clinical history of CMA (Figure 6).

Similar to the 2014 EAACI review, the estimates for cow's milk allergy or sensitization were generally higher in children than in adults, although for point prevalence of sIgE positivity and FC positivity, only two estimates each were available for adults (Figures S1, S2, and S5–S7). For point prevalence of SPT positivity and FC positivity or clinical history of CMA, as well as for lifetime prevalence of self-reported physician-diagnosed CMA, no data were available for the adult population (Figures S3, S4, and S8). No consistent pattern was found in terms of distribution of cow's milk allergic or sensitized subjects across Europe (Figures S1–S8).

Point prevalence of self-reported CMA increased between 2000–2012 and 2012–2021 from 2.3% to 3.9%, while lifetime prevalence was not substantially changed (6.0% vs. 6.4%) (Figure 2). Lifetime prevalence of self-reported physician-diagnosed CMA and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT positive cow's milk sensitization increased more than

TABLE 1 Summary of the characteristics of the studies in the reviews: studies published 1 January 2000–30 June 2021.

		Study population, (children/adults; source of study population)			Outcome studied and assessment method			
Reference, country	Study design	Number approached	Number participated	Age of subjects	Outcome(s) studied	Method of outcome assessment	Occurrence measure(s)	Overall risk of bias assessment
Baricic et al. 2015, Croatia[5]	Cross-sectional study	Not indicated	702	6–48 months	Any FA, milk, egg, peanut, other (apple, pear, carrot, hazelnut, fish, pecan, banana, ketchup, tomato, cherry, chicken, soy, citrus fruit, do not know)	SR, SPT, sIgE	Point prevalence	Moderate
Barlik et al. 2013, Turkey[6]	Cross-sectional study	2390	1280	3–6 years	Any FA, hen's egg, chocolate, foods additives, strawberry, cow's milk, nut, peanuts, tomatoes, fish, spices, corn, purslane, oranges, banana, sesame, honey	SR	Point prevalence	Moderate
Bröms et al. 2013, Sweden[7]	Cross-sectional study	5959 (of which 1001 AADC)	5886 (of which 1000 AADC)	1–6 years	Any FA, milk, egg, fish, peanuts, nuts, soy or stone fruits	SR	Point prevalence	Weak
Burney et al. 2010; Woods et al. 2001, Europe, United States of America, Australia, New Zealand[8,9]	Cross-sectional study	Not indicated	17,280	18–27 years	Any FA, fish, egg, cow's milk, mustard, melon, poppy seed, soya, sunflower, walnut, banana, peanut, buckwheat, rice, tomato, corn, celery, kiwifruit, carrot, sesame, apple, wheat, shrimp (shellfish), peach, hazelnut	SR, sIgE	Point and lifetime prevalence	Moderate
Burney et al. 2014; Lyons et al. 2019, Switzerland, Spain, Greece, Poland, Bulgaria, Lithuania, Iceland, The Netherlands[10,11]	Cross-sectional study	All countries 30,420	All countries 17,366 Switzerland 2250 Spain 943 The Netherlands 3865 Poland 1499 Bulgaria 2118 Greece 1979 Lithuania 2598 Iceland 2114	20–54 years	Any FA, priority FA (hazelnut), peach, apple, carrot, celery, kiwi, tomato, wheat, sesame, shrimp (shellfish), banana, corn, sunflower, poppy, melon, buckwheat, walnut, lentils, peanut, soya, mustard, egg, milk, fish	SR, SR-physician diagnosis, sIgE, DBPCFC	Point prevalence	Strong
Butiene et al. 2013, Lithuania[12]	Cohort study	Not indicated	1558	0-more than 18 months	Cow's milk	sIgE	Point prevalence	Moderate
Caffarelli et al. 2011, Italy[13]	Cross-sectional study	900	625	5–14 years	Any FA, cow's milk, egg, tomato, peanut, wheat, chocolate, kiwi, strawberry, melon, orange, hazelnut, sesame	SR	Point and lifetime prevalence	Moderate
Chafen et al. 2010, World-wide[14]	Systematic review	12,378 studies identified	72 studies included	All age groups	Cow's milk, egg, peanut, fish, shellfish	SR, physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point, period, lifetime prevalence; cumulative incidence, incidence rate	Strong

(Continues)

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Clausen et al. 2017, Goksör et al. 2018, Sweden[15,16]	Cohort study	5654	3637	0–12 years	Any FA, egg, milk, fish, wheat, peanuts, soy and peas, hazelnuts, almonds, other nuts	SR, SR-physician diagnosis, SPT, sIgE, physician diagnosis	Point prevalence	Moderate
De Jong et al. 2019, The Netherlands[17]	Cohort study	7393	5471	10 years	Any FA, hazelnut, cashew nut, peanuts, peach	SPT, SR-physician diagnosis	Point prevalence	Moderate
Depner et al. 2012, Austria, Finland, France, Germany, and Switzerland[18]	Cohort study	1133	793	0–12 months	Any FA, hen's egg, cow's milk, hazelnut, carrot, wheat flour	SR-physician diagnosis, sIgE	Point prevalence	Weak
Dereci et al. 2016; Turkey[19]	Cross-sectional study	20,800	15,783	6–18 years	Blueberry, hazelnut, kiwi	SR, SPT/PTP, DBPCFC, OFC	Lifetime and point prevalence	Strong
Diwakar et al. 2017, United Kingdom[20]	Cohort study	1,500,000	1,500,000	0–17 years	All FA, nut, egg	Physician diagnosis	Prevalence trend	Weak
Doğruel et al. 2016; Karakoc et al. 2015, Turkey[21]	Cohort study	1475	1377	0–4 years	Any FA, cow's milk, hen's eggs, soy, wheat, fish, peanuts, banana, chicken meat and beef	SR, SPT, sIgE, OFC	Point prevalence and cumulative incidence	Moderate
Du Toit et al. 2008, United Kingdom and Israel[22]	Cross-sectional study	10,786	8826	4–18 years	Peanut, sesame, tree nuts, egg, milk	SR, clinical history, OFC	Point prevalence	Moderate
Dubakiene et al. 2012, Lithuania[23]	Cohort study	1558	1558	6–12 months	Any FA, milk, egg, wheat, peanut, potato, and fish	SR, SPT, sIgE, DBPCFC	Point prevalence	Moderate
Eckers et al. 2015, Germany[24]	Cohort study	1579	1321	0–30 months	Hen's egg allergy	DBPCFC	Cumulative incidence	Moderate
Eggesbø et al. 2003, 2001a and 2001b, Norway[25–27]	Cohort study	4973	3754	2.5 years	Any FA, cow's milk, hen's egg, fish, nuts, cereals, chocolate, fruits, vegetables	SR, physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point prevalence, cumulative incidence	Moderate
Eller et al. 2009, Kjaer et al. 2008, Johnke et al. 2006, Denmark[28–30]	Cohort study	1095	562	6 years	Any FA, cow's milk, hen's egg, peanut, wheat, codfish, soy, shrimp (shellfish), hazelnut, Brazil nut, celery	SR, SPT, sIgE, OFC, DBPCFC	Point prevalence, cumulative incidence	Moderate
Erhard et al. 2021, Germany[31]	Cohort study	1570 both for children, mothers/fathers	1001; parents were not studied at follow-up	Children: 8 years Parents: 30–40 years	Any FA, hazelnut allergy, cow's milk, wheat, hen's egg, peanut, soy, white fish, oily fish, crustaceans (shellfish), any FA in mothers, any FA in fathers	SR, SPT, sIgE, DBPCFC	Point prevalence	Moderate
Falcaõ et al. 2004, Portugal[32]	Cross-sectional study	1565	659	>39 years	Any FA, fresh fruits, meat, fish, eggs, octopus and squid (shellfish), chocolate, milk, spices, legumes	SR	Point prevalence	Moderate

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Fedorova et al. 2014a; 2014b; 2016, Russia[33–35]	Cross-sectional study	Not indicated	13,010	7–10 years	Peanut, hazelnut, fish, hen's egg	SR, SPT, sIgE	Point prevalence	Moderate
Fox et al. 2009, United Kingdom[36]	Case–control study	133 cases, 310 controls	133 cases, 310 controls	<4 years	Peanut allergy	SPT, sIgE, DBPCFC	Point prevalence	Moderate
Frongia et al. 2005, Italy[37]	Cross-sectional study	5040	4602	1–2 years	Any FA, peanut, egg, milk, tomato	SR	Lifetime prevalence	Moderate
Gaspar-Marques et al. 2014, Portugal[38]	Cross-sectional study	2228	1217	0–6 years	Any FA, cow's milk chocolate, kiwi orange strawberry peach fish, egg, wheat, peanut, fish, shellfish, tree nut. soy.	SR	Point and lifetime prevalence	Moderate
Gelincik et al. 2008, Turkey[39]	Cross-sectional study	17,064	11,816	≥18 years	Any FA, any non-allergic food hypersensitivity, tomatoes, hen's egg, cacao, orange, eggplant, peanut, strawberry, carrot, banana, hazelnut, pear, spinach, red chili, black pepper, food additives, chocolate, walnut, potato, fish	SR, SPT, sIgE, DBPCFC	Point and lifetime prevalence	Moderate
Gomez-Galan et al. 2017, Sweden[40]	Cohort study	278	258	0–12 months	Cow's milk	SR, SPT, sIgE	Cumulative incidence	Moderate
Grabenhenrich et al. 2020, Iceland, United Kingdom, The Netherlands, Germany, Poland, Lithuania, Spain and Greece[41]	Cohort study	10,563 at birth 6150	All countries 6069 Iceland 945 United Kingdom 454 The Netherlands 652 Germany 1001 Poland 819 Greece 561 Spain 688 Lithuania 2598	6–10 years	Any FA, core foods (cow's milk, hen's egg, wheat, soy, peanut, hazelnut, white fish, oily fish, crustaceans (shellfish)), non-core foods (nuts excluding hazelnut, tomato, kiwi, strawberry, apple, citrus fruits, not specified)	SR, SR-physician diagnosis, SPT, DBPCFC	Lifetime and point prevalence	Moderate
Grimshaw et al. 2016, United Kingdom[42]	Cohort study	1140 both children and mothers/fathers	823	Children: 2 years Parents (mothers and fathers) not indicated	Any FA, hens' egg, cows' milk, peanut, soy, wheat, fish, lentils, broccoli	SR, SPT, sIgE, DBPCFC	Cumulative incidence, point prevalence for parents	Moderate
Grundy et al. 2002, United Kingdom[43]	Cohort study	2858	1273	3–4 years	Peanut and milk allergy	SR, SPT, OFC	Point prevalence	Moderate

(Continues)

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Haftenberger et al. 2013, Germany[44]	Cross-sectional study	8152	7988	18–79 years	At least one FA, cow's milk, peanut hazelnut, soya, sesame, rice, wheat, shrimp (shellfish), apple, tomato, potato, apple strawberry, kiwi, celery, almond	SR-physician diagnosis, sIgE	Point and lifetime prevalence	Moderate
Hicke-Roberts et al. 2020, Sweden[45]	Cross-sectional study	1838	1027	7–8 years	Any FA or intolerance, cows' milk, hens' eggs, fish, peanuts, tree nuts, cereals/wheat	SR	Cumulative incidence	Moderate
Høst et al. 2002, Denmark[46]	Cohort study	1758	1749	15 years	Any FA, cow's milk allergy	SPT, sIgE, OFC, DBPCFC	Point prevalence	Moderate
Hourihane et al. 2007, United Kingdom[47]	Cross-sectional study	5072	1125	4–5 years	Peanut allergy	SPT, sIgE, DBPCFC	Point prevalence	Moderate
Isolauri et al. 2004, Finland[48]	Cross-sectional study	400	400	7, 27, 47, 67 years	Any FA, milk	SR, sIgE	Lifetime prevalence and point prevalence	Moderate
Ivakhnenko et al. 2013, Ukraine[49]	Cross-sectional study	5457	1000	0–30 months	Infant milk formula, cow's milk, eggs, citrus, fruit, vegetables, chocolate, fish, other foods	SR	Lifetime time prevalence	Moderate
Järvenpää et al. 2014, Finland[50]	Cross-sectional study	Not indicated	1653	6–7 years	Any FA, basic FA (cow's milk, eggs or grains), cows' milk, Eggs, grains, wheat, rye, barley, oat, multi-allergy, soya, fish, legumes, nuts, spices, fruits, vegetables	SR	Point prevalence	Strong
Johansson et al. 2005, Sweden and Norway[51]	Cross-sectional study	Not indicated	Sweden 1002; Norway 500	Adults	Any FA, peanut, soya bean, egg white, cow's milk, codfish, wheat flour, hazel nut, peanuts	sIgE	Point prevalence	Moderate
Jorge et al. 2017, Portugal[52]	Cross-sectional study	4545	2474	3–11 years	Any FA, milk, egg, fresh fruit, nuts, fish, shellfish, legumes, cereals, other vegetables, spices, meat	SR, sIgE, SPT	Point prevalence	Moderate
Julge et al. 2001, Vasar et al. 2000, Estonia[53,54]	Cohort study	455	298	5 years	Egg white, cow's milk	SPT, sIgE	Point prevalence	Moderate
Jürisson et al. 2015, Estonia[55]	Cohort study	Not indicated	258	0–24 months	Cow's milk, egg's white, peanut, soy, wheat, codfish	SPT, sIgE	Point prevalence	Moderate

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Kaya et al. 2013, Turkey[56]	Cross-sectional study	11,233	10,096	11–15 years	Any FA, hen's egg (egg white), cow's milk, tree nuts allergy (hazelnut, peanuts, walnuts, pistachio), chocolate (cocoa), tomato, kiwi, honey, banana, sesame, black pepper, strawberry	SR, SR-physician diagnosis, physician diagnosis, SPT, sIgE, OFC; DBPCFC	Lifetime and point prevalence	Moderate
Kelleher et al. 2014, Ireland[57]	Cohort study	2037	1745 (1402 at 24 months)	0–24 months	Any FA, cow's milk, eggs, peanut, codfish, wheat, soya	SR, SPT, clinical history, OFC	Point prevalence	Moderate
Kotz et al. 2011, United Kingdom[58]	Cohort study	2,958,366	2,958,366	All age groups	Peanut allergy	Physician diagnosis	Lifetime prevalence, incidence rate	Moderate
Krause et al. 2002, Greenland[59]	Cross-sectional study	1213	1068	5–18 years	Any FA, egg, milk, fish, peanut, wheat, soy	sIgE	Point prevalence	Moderate
Kristinsdottir et al. 2011, Iceland[60]	Cohort study	No information	1341	1 year	Any FA, hen's egg, cow's milk, peanut, nuts, fish, wheat, soy, shrimp (shellfish), cranberry, potato, pineapple, almond, nutramigen, green peas	SR, SPT, specific sIgE, DBPCFC	Point prevalence	Moderate
Kucosmanoglu et al. 2008, Turkey[61]	Cross-sectional study	1415	1015	8–18 months	Egg allergy	SPT	Point prevalence	Moderate
Kurulaaratchy et al. 2005, Arshad et al. 2001, Tariq et al. 2000, United Kingdom[62–64]	Cohort study	1536	1456	4 years	Any FA, milk, egg, peanut, codfish, wheat, soya	SPT	Point prevalence, cumulative incidence	Moderate
Kvenshagen et al. 2009, Norway[65]	Cohort study	Not indicated	609	2 years	Any FA, egg, milk, peanut, hazelnut	SR, SPT, sIgE, OFC, DBPCFC	Point prevalence	Moderate
Le et al. 2015, The Netherlands[66]	Cross-sectional study	6600	3864	20–54 years	Any FA, hen's egg, cow's milk, peanut, soy, hazelnut, walnut, celery, kiwi, apple, peach, sesame, mustard, wheat, fish and shrimp (shellfish), buckwheat, corn, carrot, tomato, melon, banana, lentils, sunflower, poppy seeds	SR, sIgE, DBPCFC	Point prevalence	Moderate
Lozoya-Ibáñez et al. 2020, Portugal[67]	Cross-sectional study	3168	1702	10–23 years	Any FA, fruit, seafood/shellfish, milk, nuts, latex fruit, eggs, fish, peanuts, beef, vegetables, pork, chicken, other	SR, OFC, SPT (or prick by prick skin test), sIgE	Point prevalence	Moderate

(Continues)

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Lyons et al. 2020, Switzerland, Spain, Greece, Poland, Bulgaria, Lithuania, Iceland, and The Netherlands[68]	Cross-sectional study	28,589	16,935	7–10 years	Any FA, priority foods: hen's egg, cow's milk, fish, shrimp (shellfish), peanut, hazelnut, walnut, peach, apple, kiwi, melon, banana, tomato, celery, carrot, corn, lentils, soy, wheat, buckwheat, sesame seed, mustard seed, sunflower seed and poppy seed.	SR, sIgE, DBPCFC	Point prevalence	Strong
Majkowska-Wojciechowska et al. 2009, Poland[69]	Cross-sectional study	3260	2148	7–10 years	Any FA, milk, chocolate, dairy, strawberries, eggs, tomatoes, cocoa, nuts, fruits, oranges	SR	Lifetime prevalence	Moderate
Marklund et al. 2004, Sweden[70]	Cross-sectional study	2064	1488	13–21 years	Any food hypersensitivity	SR	Point prevalence	Moderate
Matricardi et al. 2007, Germany[71]	Cohort study	7609	1314	2–10 years	Cow's milk, hen's egg, soy and wheat	sIgE	Point prevalence	Moderate
Matsyura et al. 2017, Ukraine[72]	Cross-sectional study	Not indicated	1245	1–6 years	Any FA, milk, egg, wheat, soybeans, peanut	Self -reported	Point prevalence	Moderate
Mortz et al. 2013, Denmark[73]	Cross-sectional study	Not indicated	460	Not indicated	Sesame, peanut, hazelnut	SPT and sIgE	Point prevalence	Moderate
Mossakowska et al. 2008, Poland[74]	Cross-sectional study	Not indicated	301	>100 years	Strawberries, bananas, oranges, eggs, pepper, garlic, chamomile, ice cream	SR	Point prevalence	Moderate
Mustafayev et al. 2013, Turkey[75]	Cross-sectional study	7653	6963	10–11 years	Any FA, pistachio, walnut, peanut, hazelnut, cow's milk, fish, hen's eggs	SR, SPT (positive test reported by parents), SPT (measured), sIgE, OFC, DBPCFC	Point and lifetime prevalence	Moderate
Nicolaou et al. 2010, United Kingdom[76]	Cohort study	1499	1085	8 years	Peanut, milk, egg, fish, tree nut	SR, SPT, sIgE, OFC, DBPCFC	Point and lifetime prevalence	Moderate
Niggemann et al. 2011, Germany[77]	Cross-sectional study	26,787	17,641	0–17 years	Peanut allergy	sIgE	Point prevalence	Moderate
Orhan et al. 2009, Turkey[78]	Cross-sectional study	3500	2739	6–9 years	Any FA, cocoa, hen's egg, beef, cow's milk, fish, tomato, hazelnut, kiwi, black pepper, chickpea, peanut, walnut, corn, banana, strawberry, potato	SR, SPT, OFC, DBPCFC	Lifetime and point prevalence	Moderate

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Östblom et al. 2008a, 2008b, 2008c and Almqvist et al. 2005, Sweden[79–82]	Cohort study	7221	4089	4–8 years	Any FA, cow's milk, citrus, peanut, tree nuts/almond, hen's egg, stone fruit, chocolate, fish, pea, soybean, wheat, banana, codfish	SR, sIgE	Point and period prevalence	Moderate
Osterballe et al. 2009, Denmark[83]	Cross-sectional study	1094	843	Mean age 22 years	Any FA, additives, codfish, cow's milk, hen's egg, octopus, peanut, nuts, shrimp (shellfish), soy, wheat, beer, cheese, red wine (other secondary food allergies also reported in the paper)	SR, SPT, OFC, DBPCFC	Point prevalence	Moderate
Osterballe et al. 2005, Denmark[84]	Cohort study	Not indicated	1834	Children and adults	Any FA, additives, codfish, cow's milk, hen's egg, peanut, shrimp (shellfish), soy, wheat, fruit/vegetables	SR, physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point prevalence	Moderate
Patelis et al. 2014, Sweden and Iceland[85]	Cross-sectional study	3044	2307	20–45 years	Food hypersensitivity of any food, egg, fruits, nuts, vegetables, fish, seafood and shellfish, chocolate, milk and dairy products, meat, herbs, chills garlic, gluten cereal wheat products	SR, sIgE	Point and lifetime prevalence, cumulative incidence	Strong
Pawlińska-Chmara et al. 2015, Poland[86]	Cross-sectional	450	440	7–10 years	Any FA, cow's milk, hen's egg's, strawberries, oranges, other milk derivates, nut, chocolate, other foods	SR	Point prevalence	Moderate
Penard-Morand et al. 2005, France[87]	Cross-sectional study	9615	7781	9–11 years	Any FA, nuts, fruits or vegetables, egg, milk, peanut, fish, seafood/shellfish	SR, SPT	Point prevalence	Moderate
Pereira et al. 2005, United Kingdom[88]	Cross-sectional study	3144	1532	11- and 15-year-old	Any FA, milk, egg, wheat, fish, peanut, sesame, tree nuts, additives, shellfish	SR, physician diagnosis, SPT, OFC, DBPCFC	Point prevalence	Moderate
Protudjer et al. 2018, Sweden[89]	Cohort study	4089	2985	0–16 years (children by 4 years for any FA)	Any FA, milk	SR (for milk), SR-physician diagnosed	Lifetime prevalence, cumulative incidence	Moderate
Pyrhönen et al. 2011 and 2009, Finland[90,91]	Cohort study	5973	3899	0–4 years	Any FA, milk, egg, wheat, barley or rye, nut, fish, citrus fruit	SR, physician diagnosis, SPT, sIgE, OFC	Lifetime prevalence, cumulative incidence	Moderate
Pyziak and Kamer 2011, Poland[92]	Cross-sectional study	115	83	6–17 years	Any FA, cow's milk, hen's egg, soy, pork, beef	SR, sIgE, SPT, OFC	Point prevalence	Moderate

(Continues)

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Rance et al. 2005, France[93]	Cross-sectional study	3500	2716	Mean age 8.9 years	Any FA, cow's milk, egg, kiwi, peanut, fish, tree nut, shrimp (shellfish)	SR	Point and lifetime prevalence	Moderate
Raciborski et al. 2012, Poland[94]	Cross-sectional study	3366	1801	6–8 years	Any FA, dairy product, nuts, cocoa and chocolate	SR	Point prevalence	Moderate
Rentzos et al. 2019, Sweden[95]	Cross-sectional study	30,000 (1172 for stage 2)	18,083 (1042 for stage 2)	16–75 years	Any food hypersensitivity, 56 food allergens investigated, among which milk, egg, wheat, soy, peanuts, tree nuts, fish, shellfish, apple, kiwi, milk wheat, red meat, hazel nut	Self -reported, sIgE	Point prevalence	Moderate
Roberts et al. 2005 and Lack et al. 2003, United Kingdom[96,97]	Cohort study	13,971	12,090	0–7 years	Egg, milk, codfish, soya, sesame, peanut, tree nut, cashew, almond, walnut, hazelnut, brazil nut, pecan nut	SR, SPT, DBPCFC	Point Prevalence	Moderate
Rona et al. 2007, World-wide[98]	Systematic review	934 studies identified	Number of studies included in review not indicated	All age groups	Any FA, cow's milk, hen's egg, peanut, fish, shellfish	SR, physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point, period, lifetime prevalence, cumulative incidence and incidence rate	Moderate
Ronchetti et al. 2008, Italy[99]	Cross-sectional study	Not indicated	380	9 and 13 years	Any FA, cow's milk, hen's egg, tomato, wheat flour	SPT	Point prevalence	Moderate
Sandin et al. 2005, Sweden and Estonia[100]	Case–control study	All 985 Sweden 645 Estonia 340	All 770 Sweden 483 Estonia 287	10–11 years	Any FA; apple, peach, kiwi, or carrot; nut or peanut; orange, mandarin or tomato; milk, egg, fish or wheat	SR, sIgE	Point prevalence	Moderate
Schäfer et al. 2001, Germany[101]	Nested case–control study	2539	1537	25–74 years	Any FA	SR, SPT	Point prevalence, lifetime prevalence	Moderate
Schnabel et al. 2010, Germany[102]	Cohort study	3097	1082	6 years	Any FA	SR, sIgE	Point prevalence	Moderate
Skypala et al. 2013, United Kingdom[103]	Cross-sectional study	10,000	3590	18–75 years	Any FA fruits, vegetables, Citrus fruit, non-citrus fruit, Curry and spices, Tomatoes, Beans and lentils, Seeds fish/shellfish, Nuts, egg, chocolate, soya, cheese, cow milk, wheat	Self-reported	Lifetime prevalence	Moderate
Soost et al. 2009 and Zuberbier et al. 2004, Roehr et al. 2004, Germany[104–106]	Cross-sectional study	13,300	All: 4093 Age 0–17 years: 739 Age 18–79 years: 3227	0–79 years	Any FA, vegetables, legumes, soy, spices, fish, cereals, meat and fat, stonefruit, chocolate/sweets, cow's milk, hen's egg, pipfruit, nuts, vegetable oil, carrot, celery, sesame, apple, apple, hazelnut, potato, wheat, peanut, walnut, shrimp, mussels (shellfish)	SR, physician diagnosis, SPT, sIgE, OFC, SBPCFC, DBPCFC	Point and lifetime prevalence	Moderate

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
Stefanaki et al. 2018, Greece[107]	Cohort study	Not indicated	917	4–6 years	Any FA fruits vegetables, dried fruits, milk, egg white, fish and peanut, nuts	Self -reported, SR-physician diagnosis	Lifetime prevalence	Moderate
Steinke et al. 2007, Europe[108]	Cross-sectional study	Not indicated	40,426	<18 years	Any FA, fish, seafood/shellfish, wheat, meat, eggs, milk, fruits, legumes, vegetables, nuts	SR	Point prevalence	Moderate
Sterner et al. 2019, Sweden[109]	Cohort study	2568	1333	13–14 years	Any food hypersensitivity, egg white, wheat, codfish, peanut, soybean, apple, peach, hazelnut (some of the cited allergens were evaluated with a specific-allergen components test)	Self -reported, sIgE	Point prevalence	Moderate
Strinnholm et al. 2014; Winberg et al. 2015, Sweden[110,111]	Cohort study	2612	2585	7–12 years	Any food hypersensitivity, milk, egg wheat, fish, soy kiwi fruits, oranges, apples, raw carrots and/or bananas, tree nuts, peanuts, almonds	Self -reported, sIgE, DBPCFC	Point prevalence	Moderate
Van den Hoogen et al. 2014, The Netherlands[112]	Cohort study	804	804	0–12 months	Cow's milk	Physician diagnosis, OFC, DBPCFC	Point prevalence	Moderate
Venkataraman et al. 2017, United Kingdom[113]	Cohort study	1536	1456	0–18 years	Any FA, cow's milk, hen's egg, wheat, soya, codfish, peanut, shellfish, tree nuts, fruits, kiwi, tomatoes.	Self -reported, SPT	Point prevalence	Moderate
Venter et al. 2010, United Kingdom[114]	Cohort study	5283	3382	3–4 years	Cow's milk, egg, wheat, peanut allergy, fish	Physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point prevalence	Moderate
Venter al 2008; Dean et al. 2007; Venter et al. 2006, United Kingdom[115–117]	Cohort study	1063	969	3 years	Any FA, milk, egg, fish, peanut, cashewnut, hazelnut, sesame, wheat	SR, SPT, OFC, DBPCFC	Point and period prevalence, cumulative incidence	Moderate
Venter et al. 2006, United Kingdom[118]	Cross-sectional study	1440	798	6 years	Any FA, milk, peanut, egg, additives & colourings, tree nuts, wheat, strawberry, sesame, fish, chocolate, banana	SR, SPT, OFC, DBPCFC	Point prevalence	Moderate
Venter et al. 2016a and 2016b, United Kingdom[119,120]	Cohort study	969	827	1–11 years	Any FA, milk, wheat, egg, codfish, peanut and sesame (but only data on peanut were reported)	SR, SPT, sIgE, FC	Point and lifetime prevalence	Moderate

(Continues)

TABLE 1 (Continued)

Reference, country	Study design	Study population, (children/adults; source of study population)		Age of subjects	Outcome studied and assessment method		Occurrence measure(s)	Overall risk of bias assessment
		Number approached	Number participated		Outcome(s) studied	Method of outcome assessment		
von Hertzen et al. 2006, Finland and Russia[121]	Cross-sectional study	Finland: 546 child–mother pairs	Finland: 413 children, 409 mothers	7–16 years children	Fish, egg, wheat, cow's milk, peanut, hazelnut	SPT	Point prevalence	Moderate
Westerlaken-van Ginkel et al. 2020, The Netherlands[122]	Cohort study	167,729	78,890	Adult	Any FA, egg, wheat, cow's milk, peanut, hazelnut, kiwi, cashew, pistachio, soy, sesame, strawberry, cherry, pearn, peach, banana, fish, shellfish	SR	Point prevalence	Moderate
Xepapadaki et al. 2015, Iceland United Kingdom The Netherlands Germany[123] Poland Lithuania Spain Italy Greece	Cohort study	12,049	9336	0–2 years	Hen's egg	Physician diagnosis, DBPCFC	Cumulative incidence	Moderate
Zeyrek et al. 2015, Turkey[124]	Cross-sectional	614	614	0–2 years	Egg and cow's milk allergy	SPT/sIgE positive	Point prevalence	Moderate
Zivic et al. 2018, Croatia[125]	Cohort study	Not indicated	250	1–12 months	Cow's milk	Physician diagnosis	Point prevalence	Moderate
Zuidmeer et al. 2008, World-wide[126]	Systematic review	396 studies identified	33 studies included	All age groups	Fruits, vegetables, tree nuts, soy, wheat	SR, physician diagnosis, SPT, sIgE, OFC, DBPCFC	Point, period, and lifetime prevalence	Moderate

Note: The following records were extracted from conference abstracts (or posters), or from letters published in scientific journals: Butiene et al., Diwaker et al., Ecker et al., Fedorova et al. (2014a, 2014b, and 2016), Jürisson et al., Karakoc et al., Kelleher et al., Matsyura et al., Mortz et al. Pawlińska-Chmara et al., Raciboroski et al., Stefanaki e al., Zivic et al. and Clausen et al. data were extracted from a university thesis. Data recorded were reported as 'studies'; therefore, one row may combine data extracted from more than one paper reporting on the same study. Grabenhenrich et al. 2020 together with Erhard et al. 2021 reported on the same multi-centres study. However, since Erhard et al. reported only on the data collected in one of the study centres, the two papers were reported in different rows. Similarly, Grimshaw et al. 2016 together with Butiene et al. 2013, Eckers et al. 2015 and Xepapapdaki et al. 2015 reported single-centre data originating from the same multi-centres study. The four papers were therefore reported in four separate rows. Finally, Le et al. 2015 reported the single-centre data of the same multi-centres study reported by Burney et al. 2014 and Lyons et al. 2019. The paper was therefore reported in a separate row from Burney et al. 2014 and Lyons et al. 2019.

Abbreviations: CI, confidence interval; DBPCFC, double-blind placebo-controlled food challenge; FA, food allergy; OFC, oral food challenge; sIgE, specific immunoglobulin E; SPT, skin prick test; SR, self-reported.

TABLE 2 Quality assessment of studies included in the systematic review: included studies 1 January 2000–30 June 2021.

Reference, country	Overall risk of bias assessment	Components of risk of bias assessment			
		Study design	Selection bias	Exposure assessment	Outcome assessment
Baricic et al., 2015, Croatia[5]	Moderate	Strong	Moderate	Not applicable	Moderate
Barlik et al., 2013, Turkey[6]	Moderate	Strong	Moderate	Not applicable	Moderate
Bröms et al. 2013, Sweden[7]	Weak	Strong	Moderate	Not applicable	Weak
Burney et al. 2010; Woods et al. 2001, Europe, United States of America, Australia, New Zealand[8,9]	Moderate	Moderate	Moderate	Moderate	Moderate
Burney et al. 2014; Lyons et al. 2019, Switzerland, Spain, Greece, Bulgaria, Poland, Lithuania, Iceland, The Netherlands[10,11]	Strong	Strong	Moderate	Not applicable	Strong
Butiene et al. 2013, Lithuania[12]	Moderate	Strong	Moderate	Not applicable	Moderate
Caffarelli et al. 2011, Italy[13]	Moderate	Strong	Moderate	Moderate	Weak
Chafen et al. 2010, World-wide[14]	Strong	Strong	Moderate	Not applicable	Strong
Chytiroglou et al. 2015, Greece[19]	Moderate	Strong	Moderate	Not applicable	Moderate
Clausen et al. 2017, Goksör et al. 2018, Sweden[15,16]	Moderate	Strong	Moderate	Not applicable	Moderate
De Jong et al. 2019, The Netherlands[17]	Moderate	Strong	Strong	Not applicable	Moderate
Depner et al. 2012, Austria, Finland, France, Germany, and Switzerland[18]	Weak	Strong	Moderate	Not applicable	Weak
Dereci et al. 2016, Turkey[19]	Strong	Strong	Strong	Not applicable	Strong
Diwakar et al. 2017, United Kingdom[20]	Weak	Strong	Moderate	Not applicable	Weak
Doğruel et al. 2016; Karakoc et al. 2015, Turkey[21,127]	Moderate	Strong	Moderate	Not applicable	Moderate
Du Toit et al. 2008, United Kingdom and Israel[22]	Moderate	Moderate	Moderate	Moderate	Strong
Dubakiene et al. 2012, Lithuania[23]	Moderate	Strong	Moderate	Moderate	Strong
Eckers et al. 2015, Germany[24]	Moderate	Strong	Moderate	Not applicable	Strong
Eggesbø et al. 2003, 2001a, 2001b, Norway[25–27]	Moderate	Strong	Moderate	Moderate	Strong
Eller et al. 2009, Kjaer et al. 2008, Johnke et al. 2006, Denmark[28–30]	Moderate	Strong	Moderate	Not applicable	Strong
Erhard et al. 2021, Germany[31]	Moderate	Strong	Strong	Not applicable	Moderate
Falcaõ et al. 2004, Portugal[32]	Moderate	Strong	Moderate	Not applicable	Weak
Fedorova et al. 2014a; 2014b; 2016, Russia[33–35]	Moderate	Strong	Strong	Not applicable	Moderate
Fox et al. 2009, United Kingdom[36]	Moderate	Strong	Moderate	Moderate	Strong
Frongia et al. 2005, Italy[37]	Moderate	Strong	Moderate	Not applicable	Weak
Gaspar-Marques et al., 2014, Portugal[38]	Moderate	Strong	Strong	Not applicable	Moderate
Gelincik et al. 2008, Turkey[39]	Moderate	Moderate	Weak	Moderate	Strong
Gomez-Galan et al. 2017, Spain[40]	Moderate	Strong	Moderate	Not applicable	Moderate
Grabenhenrich et al. 2020, Iceland, United Kingdom, the Netherlands, Germany, Poland, Lithuania, Spain and Greece[41]	Moderate	Strong	Moderate	Not applicable	Moderate
Grimshaw et al. 2016, United Kingdom[42]	Moderate	Strong	Moderate	Not applicable	Moderate
Grundy et al. 2002, United Kingdom[43]	Moderate	Strong	Moderate	Not applicable	Strong
Haftenberger et al., 2013, Germany[44]	Moderate	Strong	Moderate	Not applicable	Moderate
Hicke-Roberts et al. 2020, Sweden[45]	Moderate	Strong	Moderate	Not Applicable	Moderate
Høst et al. 2002, Denmark[46]	Moderate	Strong	Moderate	Not applicable	Strong
Hourihane et al. 2007, United Kingdom[47]	Moderate	Moderate	Weak	Moderate	Strong
Isolauri et al. 2004, Finland[48]	Moderate	Strong	Moderate	Moderate	Moderate
Ivakhnenko et al. 2013, Ukraine[49]	Moderate	Strong	Moderate	Not applicable	Moderate

(Continues)

TABLE 2 (Continued)

Reference, country	Overall risk of bias assessment	Components of risk of bias assessment			
		Study design	Selection bias	Exposure assessment	Outcome assessment
Järvenpää et al. 2014, Finland[50]	Strong	Strong	Moderate	Not applicable	Strong
Johansson et al. 2005, Sweden and Norway[51]	Moderate	Moderate	Weak	Not applicable	Moderate
Jorge et al. 2017, Portugal[52]	Strong	Moderate	Moderate	Not applicable	Moderate
Julge et al. 2001, Vasar et al. 2000, Estonia[53,54]	Moderate	Strong	Moderate	Moderate	Moderate
Jürisson et al. 2015, Estonia[55]	Moderate	Strong	Moderate	Not applicable	Moderate
Kaya et al. 2013, Turkey[56]	Moderate	Strong	Strong	Not applicable	Moderate
Kelleher et al. 2014, Ireland[57]	Moderate	Strong	Moderate	Not applicable	Moderate
Kotz et al. 2011, United Kingdom[58]	Moderate	Moderate	Moderate	Moderate	Moderate
Krause et al. 2002, Greenland[59]	Moderate	Strong	Moderate	Not applicable	Moderate
Kristinsdottir et al. 2011, Iceland[60]	Moderate	Strong	Moderate	Not applicable	Strong
Kucukosmanoglu et al. 2008, Turkey[61]	Moderate	Strong	Moderate	Not applicable	Moderate
Kurulaaratchy et al. 2005, Arshad et al. 2001, Tariq et al. 2000, United Kingdom[62–64]	Moderate	Strong	Moderate	Not applicable	Moderate
Kvenshagen et al. 2009, Norway[65]	Moderate	Strong	Moderate	Moderate	Strong
Le et al. 2015, The Netherlands[66]	Moderate	Strong	Moderate	Not applicable	Moderate
Lozoya-Ibáñez et al., 2020, Portugal[67]	Moderate	Strong	Moderate	Not applicable	Moderate
Lyons et al. 2020, Switzerland, Spain, Greece, Bulgaria, Poland, Lithuania, Iceland, and The Netherlands[68]	Strong	Strong	Strong	Not applicable	Strong
Majkowska-Wojciechowska et al. 2009, Poland[69]	Moderate	Strong	Moderate	Not applicable	Weak
Marklund et al. 2004, Sweden[70]	Moderate	Strong	Moderate	Not applicable	Weak
Matricardi et al. 2007, Germany[71]	Moderate	Strong	Moderate	Not applicable	Moderate
Matsyura et al. 2017, Ukraine[72]	Strong	Moderate	Moderate	Not applicable	Moderate
Mortz, et al. 2013, Denmark[73]	Strong	Moderate	Moderate	Not applicable	Moderate
Mossakowska et al. 2008, Poland[74]	Moderate	Strong	Moderate	Not applicable	Weak
Mustafayev et al. 2013, Turkey[75]	Moderate	Strong	Moderate	Not Applicable	Moderate
Nicolaou et al. 2010, United Kingdom[76]	Moderate	Strong	Moderate	Moderate	Strong
Niggemann et al. 2011, Germany[77]	Moderate	Strong	Moderate	Not applicable	Moderate
Orhan et al. 2009, Turkey[78]	Moderate	Strong	Moderate	Not applicable	Strong
Östblom et al. 2008a, 2008b, 2008c; Almqvist et al. 2005, Sweden[79–82]	Moderate	Strong	Moderate	Not applicable	Moderate
Osterballe et al. 2009, Denmark[83]	Moderate	Strong	Moderate	Not applicable	Strong
Osterballe et al. 2005, Denmark[84]	Moderate	Strong	Moderate	Not applicable	Strong
Patelis et al. 2014, Sweden and Iceland[85]	Strong	Strong	Strong	Not applicable	Strong
Pawlińska-Chmara et al.2015, Poland[86]	Moderate	Moderate	Moderate	Not applicable	Moderate
Penard-Morand et al. 2005, France[87]	Moderate	Moderate	Moderate	Moderate	Moderate
Pereira et al. 2005, United Kingdom[88]	Moderate	Strong	Moderate	Not applicable	Strong
Protudjer et al. 2018, Sweden[89]	Strong	Strong	Strong	Not applicable	Strong
Pyrhönen et al. 2011 and 2009, Finland[90,91]	Moderate	Moderate	Moderate	Moderate	Strong
Pyziak and Kamer 2011, Poland[92]	Moderate	Moderate	Weak	Moderate	Strong
Rance et al. 2005, France[93]	Moderate	Strong	Moderate	Not applicable	Weak
Raciborski et al. 2012, Poland[94]	Moderate	Moderate	Moderate	Not applicable	Moderate
Rentzos et al. 2019, Sweden[95]	Strong	Strong	Strong	Not applicable	Moderate
Roberts et al. 2005 and Lack et al. 2003, United Kingdom[96,97]	Moderate	Strong	Moderate	Moderate	Strong

TABLE 2 (Continued)

Reference, country	Overall risk of bias assessment	Components of risk of bias assessment			
		Study design	Selection bias	Exposure assessment	Outcome assessment
Rona et al. 2007, World-wide[98]	Moderate	Strong	Moderate	Not applicable	Strong
Ronchetti et al. 2008, Italy[99]	Moderate	Moderate	Moderate	Not applicable	Moderate
Sandin et al. 2005, Sweden and Estonia[100]	Moderate	Moderate	Moderate	Not applicable	Moderate
Schäfer et al. 2001, Germany[101]	Moderate	Strong	Moderate	Not applicable	Moderate
Schnabel et al. 2010, Germany[102]	Moderate	Strong	Moderate	Moderate	Moderate
Skypala et al. 2013, United Kingdom[103]	Moderate	Strong	Moderate	Not applicable	Moderate
Soost et al. 2009 and Zuberbier et al. 2004, Roehr et al. 2004, Germany[104–106]	Moderate	Moderate	Moderate	Moderate	Strong
Stefanaki et al. 2018, Greece[107]	Strong	Strong	Strong	Not applicable	Strong
Steinke et al. 2007, Europe[108]	Moderate	Strong	Moderate	Not applicable	Weak
Sterner et al. 2019, Sweden[109]	Moderate	Strong	Moderate	Not applicable	Moderate
Strinnholm et al. 2014; Winberg et al. 2015, Sweden[110,111]	Moderate	Strong	Moderate	Not applicable	Moderate
Van den Hoogen et al. 2014, The Netherlands[112]	Moderate	Strong	Weak	Not applicable	Moderate
Venkataraman et al. 2017, United Kingdom[113]	Moderate	Strong	Moderate	Not applicable	Moderate
Venter et al. 2010, United Kingdom[114]	Moderate	Strong	Moderate	Moderate	Strong
Venter et al. 2008; Dean et al. 2007; Venter et al. 2006, Venter et al. 2016a and Venter et al. 2016b United Kingdom[115–117]	Moderate	Strong	Moderate	Moderate	Strong
Venter et al. 2006, United Kingdom[118]	Moderate	Strong	Moderate	Not applicable	Strong
Venter et al. 2016a and 2016b, United Kingdom[119,120]	Moderate	Strong	Moderate	Not applicable	Strong
von Hertzen et al. 2006, Finland and Russia[121]	Moderate	Moderate	Moderate	Moderate	Moderate
Westerlaken-van Ginkel et al., 2020, The Netherlands[122]	Moderate	Strong	Moderate	Not applicable	Moderate
Xepapadaki et al. 2015, Europe[123]	Moderate	Strong	Moderate	Not applicable	Moderate
Zeyrek et al. 2015, Turkey[124]	Moderate	Moderate	Moderate	Not applicable	Moderate
Zivic et al., 2018, Croatia[125]	Moderate	Strong	Moderate	Not applicable	Moderate
Zuidmeer et al. 2008, World-wide[126]	Moderate	Strong	Weak	Not applicable	Strong

Note: The following records were extracted from conference abstracts (or posters), or from letters published in scientific journals: Butiene et al., Diwaker et al., Ecker et al., Fedorova et al. (2014a, 2014b, and 2016), Jürisson et al., Karakoc et al., Kelleher et al., Matsyura et al., Mortz et al. Pawlińska-Chmara et al., Raciboroski et al., Stefanaki e al., Zivic et al. and Clausen et al. data were extracted from a university thesis. Data recorded were reported as 'studies'; therefore, one row may combine data extracted from more than one paper reporting on the same study. Grabenhenrich et al. 2020 together with Erhard et al. 2021 reported on the same multi-centres study. However, since Erhard et al. reported only on the data collected in one of the study centres, the two papers were reported in different rows. Similarly, Grimshaw et al. 2016 together with Butiene et al. 2013, Eckers et al. 2015 and Xepapapdaki et al. 2015 reported single-centre data originating from the same multi-centres study. The four papers were therefore reported in four separate rows. Finally, Le et al. 2015 reported the single-centre data of the same multi-centres study reported by Burney et al. 2014 and Lyons et al. 2019. The paper was therefore reported in a separate row from Burney et al. 2014 and Lyons et al. 2019. The components of the CASP quality assessment tool are graded as follows: "strong" (green), "moderate" (orange), "weak" (red), and "not applicable" (white).

ten times between 2000–2012 (0.3%) and 2012–2021 (3.8%), but 8 out of the 10 available estimates were extracted from studies published between 2000 and 2012 (Figure 4). Point prevalence of sIgE positivity increased from 4.6% to 6.5% (Figure 4). Point prevalence of FC positivity decreased from 0.6% to 0.2% between 2000–2012 and 2012–2021, while point prevalence of FC positivity or clinical history decreased from 1.6% to 0.7%. However, for both outcomes only one estimate was available from 2012 to 2021 (Figure 6).

3.3 | Egg allergy

Egg allergy (EA) or sensitization was investigated in 76 studies. The overall lifetime and point prevalence for self-reported EA were 2.4% (95% CI 1.8–3.0) and 1.8% (95% CI 1.4–2.3), respectively (Figure 2). The overall lifetime prevalence of self-reported physician-diagnosed EA was 2.7% (95% CI 1.7–3.6) (Figure 3). Point prevalence sIgE positivity was 4.2% (95% CI 2.9–5.5), 0.7% (95% CI 0.4–0.9) for SPT positivity (Figure 4), 0.1% (95% CI 0.1–0.2) for sIgE positivity plus

symptoms (Figure 5), 0.1% (95% CI 0.03–0.1) for FC positivity and 0.8% (95% CI 0.5–1.2) for FC positivity or clinical history (Figure 6).

In most cases, the estimates were higher in children than in adults, confirming what was observed in the previous EAACI 2014 paper (Figures S9, S10, and S13–S15). For point prevalence of sIgE positivity, only one estimate was available for adults (Figure S13). For point prevalence of SPT positivity and FC positivity or clinical history, as well as for lifetime prevalence of self-reported physician-diagnosed EA, no data were available for adults (Figures S11, S12, and S16). No consistent pattern was found in frequency of EA across European regions (Figures S9–S16). Point prevalence of self-reported EA slightly increased between 2000–2012 and 2012–2021 from 1.5% to 2.1%, while lifetime prevalence (2.5%) did not change (Figure 2). Lifetime prevalence of self-reported physician-diagnosed EA and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT positivity slightly decreased from 0.8% to 0.4%, while sIgE positivity slightly increased from 3.6% to 4.6% (Figure 4). Point prevalence of FC positivity decreased from 0.2% to 0.02%, although fewer estimates were available for 2012–2021 (Figure 6). As for FC positivity or clinical history, point prevalence decreased from 1.0% to 0.6%, but only one estimate out of four was available for 2012–2021 (Figure 6).

3.4 | Wheat allergy

Wheat allergy (WA) or sensitization was investigated in 47 studies. The overall lifetime and point prevalence of self-reported WA were 1.6% (95% CI 0.9–2.3) and 1.4% (95% CI 1.0–1.8), respectively (Figure 2). The overall lifetime prevalence of self-reported physician-diagnosed WA was 0.5% (95% CI 0.2–0.7) (Figure 3). Point prevalence sIgE positivity was 6.5% (95% CI 4.8–8.1), 0.7% (95% CI 0.4–1.1) for SPT positivity (Figure 4), 0.1% (95% CI 0.02–0.1) for sIgE plus symptoms (Figure 5), 0.1% (95% CI 0.01–0.2) for FC positivity and 0.3% (95% CI 0.02–0.6) for FC positivity or clinical history (Figure 6).

The prevalence estimates of wheat allergy or sensitization were higher in children than in adults for sIgE positivity, sIgE plus symptoms and FC positivity (Figures S21–S23). The lifetime prevalence was highest in children aged 2–5 years, followed by adults, than in other age groups, although the estimate for children aged 2–5 years

TABLE 3 Summary of evidence on the frequency of allergy to cow's milk, hen's egg, wheat and soy in Europe: studies published 1 January 2000–30 June 2021.

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Baricic et al. 2015, Croatia[5]	SR point prevalence: At 6–12 months: 8.1% (4.8–13.4) At 12–24 months: 4.4% (2.3–8.1) At 24–48 months: 3.9% (2.3–6.5) All children: 5.0% (3.6–6.9)	SR point prevalence: At 6–12 months: 3.1% (4.8–13.4) At 12–24 months: 4.4% (2.3–8.1) At 24–48 months: 2.1% (1.0–4.2) All children: 3.0% (2.0–4.5)		Outcome investigated but specific estimate not presented	The author specifically reported about milk, egg and peanut allergy. They also investigated other food allergens which include, apple, pear, carrot, hazelnut, fish, pecan, banana, ketchup, tomato, cherry, chicken, soy, citrus fruit but a specific estimate for each of these allergens was not reported by the authors.
Barlik et al. 2013, Turkey[6]	In children aged 3–6 years, 7.1% of the SR allergic symptoms occurred after milk consumption	In children aged 3–6 years, 25.3% of the SR allergic symptoms occurred after egg consumption			The authors also reported about chocolate, foods additives, strawberry, nut, peanuts, tomatoes, fish, spices, corn, purslane, oranges, banana, sesame and honey allergy.
Bröms et al. 2013, Sweden[7]	SR point prevalence: At 1–2 years 3.4% (2.5–4.6) At 3–4 years 4.4% (3.6–5.4) At 5–6 years 4.2% (3.4–5.3)	SR point prevalence: At 1–2 years 3.3% (2.4–4.5) At 3–4 years 2.4% (1.8–3.2) At 5–6 years 1.9% (1.3–2.6)		SR point prevalence: At 1–2 years 0.5% (0.2–1.2) At 3–4 years 0.8% (0.5–1.3) At 5–6 years 0.4% (0.2–0.9)	The author also reported about fish, peanuts, nuts and stone fruits allergy
Burney et al. 2010; Woods et al. 2001, Europe, United States of America, Australia, New Zealand[8,9]	sIgE point prevalence for all countries at 18–27 years: 0.7%	sIgE point prevalence for all countries at 18–27 years: 0.2%	sIgE point prevalence for all countries at 18–27 years: 3.4%	sIgE point prevalence for all countries at 18–27 years: 1.4%	Estimate of sensitization is a weighted average over all countries in the study excluding birth positivity. No weighting factor or baseline data given, so we were unable to recalculate the estimate

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Burney et al. 2014; Lyons et al. 2019, Switzerland, Spain, The Netherlands, Poland, Bulgaria, Greece, Lithuania, Iceland[10,11]	sIgE point prevalence in adults (20–54 years): All centres: 0.8%; Switzerland: 0.7%; Spain: 1.6%; The Netherlands: 0.8%; Poland: 0.7%; Bulgaria: 0.0%; Iceland: 1.2% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.2% (0.0–1.0), Spain 0.2% (0.0–1.0), Iceland 0.0% (0.0–0.3), Poland 0.1% (0.0–0.7) The Netherlands 0.0% (0.0–0.2), Greece 0.0% (0.0–0.7)	sIgE point prevalence in adults (20–54 years): All centres: 0.9%; Switzerland: 1.3%; Spain: 0.6%; The Netherlands: 0.7%; Poland: 1.1%; Bulgaria: 0.9%; Iceland: 0.7% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.0% (00–0.2), Spain 0.1% (0.0–0.7), Iceland 0.2% (0.0–0.8), Poland 0.3% (0.0–1.1), The Netherlands 0.0 (0.0–0.2), Greece% 0.0 (0.0–0.8)	sIgE point prevalence in adults (20–54 years): All centres: 4.5%; Switzerland: 8.5%; Spain: 10.5%; The Netherlands: 3.0%; Poland: 4.1%; Bulgaria: 4.5%; Iceland: 0.7% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.2 (0.0–0.7), Spain 0.4% (0.0–1.3), Iceland 0.1% (0.0–0.6), Poland 0.0% (0.0–0.4), The Netherlands 0.0% (0.0–0.4), Greece 0.0% (0.0–0.7)	sIgE point prevalence in adults (20–54 years): All centres: 2.3%; Switzerland: 4.6%; Spain: 6.5%; The Netherlands: 1.4%; Poland: 2.3%; Bulgaria: 1.8%; Iceland: 0.1% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.1% (0.0–0.6) Spain 0.0% (0.0–0.4) 0.0% (0.0–0.3), Poland 0.0% (0.0–0.4), The Netherlands 0.0% (0.0–0.3), Greece 0.0% (0.0–0.7)	In Burney et al. 2014. the author also reported about sIgE for cow's milk, hen's egg, soy, hazelnut, peach, apple, celery, carrot, kiwi, tomato, sesame, shrimp, banana, corn, sunflower, poppy, melon, buck wheat, walnut, lentils, mustard. For Lithuania and Greece data was not reported. sIgE point prevalence was estimated as the prevalence of those with a specific IgE response to a particular food among 'cases' and 'controls' weighted back to the general population according to the sampling fraction by which these had been selected for further study. Since the sampling fraction was not mentioned by the authors, it was not possible to define precise confidence intervals for meta-analysis. Therefore, data for sIgE positivity have not been included in meta-analysis. In Lyons et al. 2019, the authors also investigated symptoms plus IgE positivity to walnut, peanut, kiwi, peach, carrot, shrimps, celery, tomato, sunflower seed banana corn sesame seed, fish, mustard seed, peanuts honey, banana, sesame, hazelnut. Data on population prevalence estimation were obtained by the authors using a weighting procedure fully explained in the paper online repository. DBPCFC was employed to assess FA to hazelnut, peanut, apple, peach, celery, shrimps. No challenges were performed for fish, milk, or egg.
Butiene et al. 2013, Lithuania[12]	sIgE point prevalence in young children (0–18+ months): 3.3% (2.5–4.3)				Data were extracted from a conference abstract. In this study, the author only reported on cow's milk sensitization.
Caffarelli et al. 2011, Italy[13]	SR lifetime prevalence at 5–14 years: 3.5% (2.3–5.3)	SR lifetime prevalence at 5–14 years: 2.4% (1.5–3.9)	SR lifetime prevalence at 5–14 years: 1.0% (0.4–2.1)		
Chafen et al. 2010, World-wide[14]	See Rona et al.	See Rona et al.			The same frequency estimates as given in Rona et al. 2007

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Clausen et al. 2017; Goksör et al. 2018, Sweden[15,16]	SR physician diagnosed point prevalence in 12 years children: Milk: 1.2% (0.9–1.6) Lactose: 2.2% (1.7–2.7) Milk products: 0.8% (0.6–1.1) SR physician diagnosed point prevalence at 12 months: 3.5% (3.0–4.0)	SR physician diagnosed point prevalence in 12 years children: 0.9% (0.7–1.3)	SR physician diagnosed point prevalence in 12 years children: 0.4% (0.3–0.7)	SR physician diagnosed point prevalence in 12 years children: 0.5% (0.3–0.8)	Data from Clausen et al. 2017 were extracted from a thesis. The data here reported were extrapolated by reporting the sum of possible FA and probable FA in Table 2 of the thesis. Data from Goksör et al. were extracted an international meeting abstract
Depner et al. 2012, Austria, Finland, France, Germany, and Switzerland[18]	Data on sIgE positivity to milk are presented in a bar graph for children aged 0–12 months	Data on sIgE positivity to egg are presented in a bar graph for children aged 0–12 months	Data on sIgE positivity to wheat are presented in a bar graph for children aged 0–12 months		The authors measured sIgE for hen's egg, cow's milk, hazelnut, carrot and wheat flour. Data on FA as defined by sIgE at birth and/or at 12 months are presented in bar graphs figures in the paper (for all centers and for each separate center), but it is not possible to extract a precise value.
Diwakar et al. 2017, UnitedKingdom[20]		Prevalence trend between 2000 and 2015 increased by 81% (1.5 to 2.7 per 1000 children aged 0–17 years).			Data were extracted from a conference abstract. The author reported about prevalence increased trend for any FA, egg and nut allergy.
Doğruel et al. 2016; Karakoc et al. 2015, Turkey[21,127]	Cumulative incidence (between 3 and 12 months of age): SPT and/or sIgE 4.0% (2.9–5.5); SPT only: 2.3% (1.5–3.46); sIgE only; 3.6% (2.6–5.0); OFC: 1.4% (0.9–2.2) OFC point prevalence at 4 years: 0.2% (0.1–0.7)	Cumulative incidence (between 3 and 12 months of age): SPT and/or sIgE 7.3% (5.8–9.1); SPT only: 2.2% (1.4–3.3); sIgE only: 6.7% (5.3–8.5); OFC: 1.2% (0.8–2.0) OFC point prevalence at 4 years: 0.1% (0.0–0.5)	Cumulative incidence (between 3 and 12 months of age): SPT and/or sIgE: 0.6% (0.3–1.4); SPT only: 0.4% (0.2–1.1); sIgE only: 0.6% (0.3–1.4)	Data on sIgE positivity not shared	The authors also reported about fish, peanuts, soy chicken meat, beef and banana allergy. Specifically, for fish, peanut and soy, the authors mention sIgE were measured, but no data ae given For Karakoc et al., data were extracted from a conference abstract.
Du Toit et al. 2008, United Kingdom and Israel[22]	SR point prevalence 2.2% (1.8–2.7) in United Kingdom in children aged 4–18 years	SR point prevalence 1.5% (1.1–1.9) in United Kingdom in children aged 4–18 years			Study involved United Kingdom and Israel.
Dubakiene et al. 2012, Lithuania[23]	Point prevalence at 6 months: History + sensitization 1.0% (0.6–1.6); DBPCFC 0.1% (0.0–0.5); Point prevalence at 12 months: History + sensitization 1.7% (1.1–2.4)	Point prevalence at 6 months: History + sensitization 0.8% (0.4–1.3); DBPCFC 0.1% (0.0–0.0), Point prevalence at 12 months: History + sensitization 1.7% (1.1–2.5)	Point prevalence at 6 months: History + sensitization 0.1% (0.0–0.5); DBPCFC 0.1% (0.0–0.0); Point prevalence at 12 months: History + sensitization 0.5% (0.3–1.0)		
Eckers et al. 2015, Germany[24]		Cumulative incidence at 24 months: DBPCFC: 0.9% (0.5–1.6) Clinical history or DBPCFC-confirmed 1.9% (1.3%–2.7%)			

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Eggesbø et al. 2003, 2001a and 2001b, Norway[25–27]	Point prevalence at 2.5 years: SR 3.6% (3.0–4.4); By history and sIgE: 0.1% (0.0–0.3) History or OFC/DBPCFC 0.5% (0.3–0.8); History or DBPCFC 0.4% (0.2–0.7); OFC/DBPCFC 0.4% (0.2–0.7); DBPCFC 0.3% (0.2–0.6)	Point prevalence at 2.5 years: SR 2.4% (1.9–3.0); By history and sIgE: 0.5% (0.3–0.8) History or OFC/DBPCFC 0.8% (0.5–1.2); History or DBPCFC 0.7% (0.4–1.0); OFC/DBPCFC 0.3% (0.2–0.6); DBPCFC 0.2% (0.1–0.4)			
Eller et al. 2009, Kjaer et al. 2008, Johnke et al. 2006, Denmark[28–30]	Point prevalence: At 3 months: sIgE 0.7% (0.2–2.0); SPT 0.4% (0.1–1.4) At 6 months: sIgE 1.6% (0.7–3.4); SPT, 0.8% (0.3–2.1) At 12 months: sIgE 1.3% (0.6–3.0); SPT 1.3% (0.6–2.8) At 18 months: sIgE, 0.9% (0.3–2.6); SPT 0.7% (0.2–2.0) At 6 years by OFC/DBPCFC: 0.0% (0.0–0.9) Cumulative incidence by 18 months: sIgE 3.4% (2.1–5.4); SPT 2.0% (1.1–3.5)	Point prevalence: At 3 months: sIgE 1.1% (0.5–2.6); SPT 0.4% (0.1–1.4) At 6 months: sIgE 3.4% (2.0–5.7); SPT, 1.9% (1.0–3.5) At 12 months: sIgE 3.6% (2.2–5.9); SPT 3.6% (2.3–5.8) At 18 months: sIgE 6.0% (3.9–9.1); SPT 2.6% (1.4–4.5) At 6 years by OFC/DBPCFC: 0.7% (0.3–2.2) Cumulative incidence by 18 months: sIgE 6.6% (4.7–9.1); SPT 4.5% (3.1–6.6)	Data not shared	Data not shared	
Erhard et al. 2021, Germany[31]	0%	Point prevalence SPT in school-age children (8–9 years): 0.8% (0.2–2.7)	0%	Point prevalence SPT in school-age children (8–9 years): 0.4% (0.1–2.1)	The authors also reported about hazelnut, white and oily fish, cretaceous. The main outcome of the paper was hazelnut allergy in school-age children. For DBPCFC to hazelnut, only 2 of the eligible 11 subjects underwent the test.
Falcaõ et al. 2004, Portugal[32]	SR point prevalence in adults older than 39 years: 0.3% (0.1–1.1)	SR point prevalence in adults older than 39 years: 0.6% (0.2–1.6)			
Fedorova et al. 2014a; 2014b; 2016, Russia[33–35]		Point prevalence in children aged 7–10 years: SR: 2.9% (2.6–3.2); History + SPT and/or sIgE: 0.1 (0.0–0.1)			Data were extracted from a conference abstract. This outcome was specifically reported in Fedorova et al. 2016
Frongia et al. 2005, Italy[37]	SR lifetime prevalence at 1–2 years: 5.4% (4.8–6.1)	Estimates not given in the paper			
Gaspar-Marques et al. 2014, Portugal[38]	SR point prevalence: All (0–6 years; mean age 3.5 years): 2.8% (2.0–3.9) At 0–3 years: 1.5% (0.7–3.1) At 4–6 years: 3.6% (2.5–5.2)	SR point prevalence: All (0–6 years; mean age 3.5 years): 1.0% (0.6–1.7) At 0–3 years: 1.1% (0.46–2.5) At 4–6 years: 0.9% (0.4–1.9)	SR point prevalence: All (0–6 years; mean age 3.5 years): 0.16% (0.0–0.6) At 0–3 years: 0.2% (0.0–1.2) At 4–6 years: 0.1% (0.0–0.7)	No data available/0%	The authors also reported about chocolate, egg, kiwi orange strawberry peach fish

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Gelincik et al. 2008, Turkey[39]		SR lifetime prevalence in adults: 2.0% (1.8–2.3) Point prevalence in adults: History + SPT 0.1% (0.0–0.1) History + sIgE 0.1% (0.0–0.1) DBPCFC 0.1% (0.0–0.1)			Estimates for SR lifetime prevalence for other foods given in a figure in the paper.
Gomez-Galan et al. 2017, Spain[40]	Cumulative incidence by 12 months: SR: 3.4% (1.7–6.6); SPT and/or sIgE by 12 months: 0.8% (0.2–3.0)				
Grabenhenrich et al. 2020, Iceland, United Kingdom, The Netherlands, Germany, Poland, Lithuania, Spain and Greece[41]	Estimates for school age children aged 6–10 years: Lifetime prevalence All centers: SR: 8.3% (7.7–9.1); SR physician diagnosed: 8.16% (7.5–8.9) Iceland: SR: 14.1% (12–16.4); SR physician diagnosed: 4.9% (3.7–6.4) United Kingdom: SR: 8.8% (6.5–11.8); SR physician diagnosed: 5.3% (3.6–7.7) The Netherlands: SR: 11.8% (9.5–14-51); SR physician diagnosed: 7.4% (5.6–9.6); Germany: SR: 8.2% (6.6–10.0) SR physician diagnosed: 2.1% (1.4–3.2) Poland: SR: 12.8% (10.7–15.3); SR physician diagnosed: 9.8% (7.9–12.0) Lithuania: SR: 4.5% (3.4–6.0); SR physician diagnosed: 3.4% (2.4–4.7) Spain: SR: 2.9% (1.9–4.4); SR physician diagnosed: 1.9% (1.1–3.2) Greece: SR: 1.2% (0.6–2.5); SR physician diagnosed: 1.1% (0.5–2.3)	Estimates for school age children aged 6–10 years: Lifetime prevalence All centers: SR: 23.3% (2.9–3.8); SR physician diagnosed: 2.9% (2.5–3.4) Iceland: SR: 3.8% (2.8–5.2); SR physician diagnosed: 3.7% (2.7–5.1) United Kingdom: SR: 4.2% (2.7–6.4); SR physician diagnosed: 3.3% (2.0–5.4) The Netherlands: SR: 4.1% (2.9–5.96); SR physician diagnosed: 3.7% (2.5–5.4) Germany: SR: 1.9% (1.2–2.9); SR physician diagnosed: 13% (0.8–2.2) Poland: SR: 5.5% (4.1–7.3); SR physician diagnosed: 4.6% (3.4–6.3) Lithuania: SR: 3.1% (2.1–4.3); SR physician diagnosed: 2.7% (1.88–4.0) Spain: SR: 3.5% (2.4–5.1); SR physician diagnosed: 3.3% (2.2–5.0) Greece: SR: 0.7% (0.3–1.8), SR physician diagnosed: 0.5% (0.2–1.6) DBPCFC point prevalence: 0.6% (0.4–1.1)	Estimates for school age children aged 6–10 years: Lifetime prevalence All centers: SR: 1.3% (1.1–1.6); SR physician diagnosed: 0.7% (0.5–0.9) Iceland: SR: 1.6% (0.96–2.6); SR physician diagnosed: 0.4% (0.16 = 1.1) United Kingdom: SR: 3.3% (2.0–5.4); SR physician diagnosed: 1.1% (0.5–2.5) The Netherlands: SR0.8% (0.3–1.8); SR physician diagnosed: 0.6% (0.2–1.6) Germany: SR: 1% (0.5–1.8); SR physician diagnosed: 0.4% (0.16–1.0) Poland: SR: 1.2% (0.7–2.2); SR physician diagnosed: 0.7% (0.3–1.6) Lithuania: SR: 1.8 (1.12–2.8); SR physician diagnosed: 1.6% (0.96–4.0) Spain: SR: 1.16% (0.6–2.3), SR physician diagnosed: 0.6% (0.2–1.5) Greece: SR: 0%; SR physician diagnosed: 0%	Estimates for school age children aged 6–10 years: Lifetime prevalence All centers: SR: 0.5% (0.4–0.7); SR physician diagnosed: 0.4% (0.3–0.6) Iceland: SR: 0.9% (0.5–1.8); SR physician diagnosed: 0.8% (0.4–1.7) United Kingdom: SR: 1.3% (0.6–2.2); SR physician diagnosed: 0.9% (0.3–2.2) The Netherlands: SR: 0.6%(0.2–1.6); SR physician diagnosed: 0.3% (0.1–1.1) Germany: SR: 0.2% (0.0–0.7); SR physician diagnosed: 0.2% (0.0–0.7) Poland: SR: 0.6% (0.3–1.4); SR physician diagnosed: 0.6% (0.3–1.4) Lithuania: SR: 0.5% (0.2–1.2); SR physician diagnosed: 0.5% (0.2–1.2) Spain: SR: 0.1% (0.0–0.8); SR physician diagnosed: 0.1% (0.0–0.8) Greece: SR: 0%; SR physician diagnosed: 0%	The author also reported lifetime prevalence of tomato, kiwi, peanut, hazelnut, other nut, white fish, oily fish, crustaceans, strawberry, apple, citrus, fruit allergy. For other FA to specific allergens with SPT positivity data are presented in a bar graph (Figure 3).

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Grimshaw et al. 2016, United Kingdom[42]	Clinical history or DBPCFC cumulative incidence by 2 years: 2.4% (1.4–3.5) DBPCFC and SPT and/or sIgE by 2 years: 0.7% (0.2–1.3)	Clinical history or DBPCFC cumulative incidence by 2 years: 2.7% (1.6–3.8) DBPCFC and SPT and/or sIgE by 2 years: 2.1% (1.1–3.0)	Clinical history or DBPCFC cumulative incidence by 2 years: 0.2% (0.0–0.5) DBPCFC and SPT and/or sIgE by 2 years: 0.1% (0.0–0.4)	Clinical history or DBPCFC cumulative incidence by 2 years: 0.4% (0.0–0.8) DBPCFC and SPT and/or sIgE by 2 years: 0.1% (0.0–0.4)	The author also recorded other food allergy such as lentil and broccoli
Grundy et al. 2002, United Kingdom[43]	SPT point prevalence at 3–4 years: 0.7% (0.4–1.4)	SPT point prevalence at 3–4 years: 1.4% (0.9–2.2)			
Haftenberger et al. 2013, Germany[44]	sIgE point prevalence at age 18–79 years: 1.6% (1.3–2.0)		sIgE point prevalence at age 18–79 years: 5.6% (5.0–6.3)	sIgE point prevalence in 18–79 years adults: 3.7% (3.2–4.3)	The author reported also IgE prevalence of tomato, kiwi, peanut, hazelnut, other nut, strawberry, apple, celery, cherries, chickpea lupin seed, cherries chickpea, lupin seed
Hicke-Roberts et al., 2020, Sweden[45]	SR cumulative incidence by 8 years: 11.7% (9.9–13.8)	SR cumulative incidence by 8 years: 2.7% (1.9–3.9)	SR cumulative incidence by 8 years: 0.1% (0.0–0.4)		The outcome investigated was SR FA or intolerance. The author also looked at fish, peanuts, tree nuts and cereal allergy.
Høst et al. 2002, Denmark[46]	Clinician diagnosed point prevalence at 15 years: 2.2% (1.6–3.0)				
Isolauri et al. 2004, Finland[48]	SR lifetime prevalence: 7-years 14% (7.9–22.4) 27-years 10% (4.9–17.6) 47-years 14% (8.0–22.6) 67 years 13% (7.1–21.2) sIgE point prevalence 7-years 9% (4.2–16.4) 27-years 4.4% (1.2–10.8) 47-years 1.0% (0.0–5.5) 67-years 7.1% (2.9–14.0)				No absolute data were presented to recalculate the estimates
Ivakhnenko et al. 2013, Ukraine[49]	SR lifetime prevalence up to 24–30 months: 8.3% (6.7–10.2)	SR lifetime prevalence up to 24–30 months: 8.4% (6.8–10.3)			The author reported about cow's milk, hen's egg, citrus, fruit, vegetables, chocolate and others FA
Järvenpää et al., 2014, Finland[50]	SR point prevalence at 6–7 years: 1.3% (0.9–2.0)	SR point prevalence at 6–7 years: 1.5% (1.0–2.1)	SR point prevalence at 6–7 years: 0.7% (0.4–1.3)	SR point prevalence at 6–7 years: 0.5% (0.2–1.0)	The author also looked at other food allergies such as łegumes, fruits, spices, vegetables, nut and fish.
Johansson et al. 2005, Sweden and Norway[51]	sIgE point prevalence in adults: Sweden 0.7% (0.3–1.4) Norway 0% Sweden + Norway 0.5% (0.2–1.0)	sIgE point prevalence in adults: Sweden 0.5% (0.2–1.2) Norway 0.6% (0.2–1.8) Sweden + Norway 0.5% (0.3–1.1)	sIgE point prevalence in adults: Sweden 2.0% (1.3–3.1) Norway 0.4% (0.1–1.5) Sweden + Norway 1.5% (1.0–2.2)	sIgE point prevalence in adults: Sweden 2.0% (1.3–3.1) Norway 0% Sweden + Norway 1.3% (0.9–2.1)	

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Jorge et al. 2017, Portugal[52]	CMA/sensitization among subjects with Q2-confirmed food reaction: SR point prevalence: 0.69% (0.43–1.11) sIgE point prevalence: 0.2% (0.09–0.48) SPT point prevalence: 0.04%(0.01–0.23)	Egg allergy/sensitization among subjects with Q2-confirmed food reaction: SR point prevalence: 1.15% (0.76–1.59) sIgE point prevalence: 0.49% (0.28–0.85) SPT point prevalence: 0.33% (0.17–0.64)			176 out of 2474 subjects self-reported an adverse reaction to food (Q1), of whom 159 responded to a second questionnaire (Q2) which was used by authors to confirm food reaction. 115 subject had a confirmed reaction. Only those who were positive to both Q1 and Q2 were then tested for IgE sensitization (positive sIge or SPT). Data on specific FA were therefore reported narratively, but not included in meta-analysis.
Julge et al. 2001, Vasar et al. 2000, Estonia[53,54]	SPT point prevalence: At 6 months 1.7% (0.6–5.0) At 12 months 0.9% (0.2–3.3) At 24 months 0.0% (0.0–0.0)	SPT point prevalence: At 6 months 5.2% (2.8–9.6) At 12 months 4.1% (2.2–7.6) At 24 months 1.8% (80.7–4.5)			sIgE estimates are available but these are selective because they included only children who took part in all three study assessments.
Jürisson et al. 2015, Estonia[55]	SPT point prevalence At 6 months: 7.0% (4.46–10.8) At 12 months: 3% (1.5–5.9) At 24 months: 0% sIgE point prevalence At 6 months: 9.0% (6.0–13.0) At 12 months: 8.0% (5.4–12.1)	SPT point prevalence At 6 months: 8% (5.3–12.0) At 12 months: 14% (10.3–18.8) At 24 months: 4% (2.2–7.1) sIgE point prevalence At 6 months: 10.1% (6.97–14.4) At 12 months: 9.0% (6.0–13.0) At 24 months: 5.0% (3.0–8.4)	SPT point prevalence At 12 months: 0% At 24 months: 0.4% (0.1–2.16)	SPT point prevalence At 12 months 0% At 24 months: 0.4% (0.1–2.16)	Data were extracted from a conference abstract.
Kaya et al. 2013, Turkey[56]	SR lifetime prevalence at school age (sixth to eighth grade): 1.1% (0.9–1.3)	SR lifetime prevalence at school age (sixth to eighth grade) 3.6% (3.2–4.0) Point prevalence at school age (sixth to eighth grade): SPT: 0.2% (0.0–0.7); sIgE: 0.0% (0.1–0.1); OFC 0.0% (0.0–0.1)			The author also investigated walnut, peanut, kiwi, cocoa, honey, banana, pistachio, sesame, hazelnut, black pepper, strawberry, tomato allergy.
Kelleher et al. 2014, Ireland[57]	SPT was performed in children aged 0–24 months	SPT was performed in children aged 0–24 months	SPT was performed in children aged 0–24 months	SPT was performed in children aged 0–24 months	Data were extracted from a conference abstract. Food allergen measured: cow's milk, egg, peanut, codfish, wheat and soya. Estimates on specific foods allergy were not reported by the authors
Krause et al. 2002, Greenland[59]	sIgE point prevalence at 5–18 years: 0.5% (0.2–1.1)	sIgE point prevalence at 5–18 years: 0.4% (0.2–1.0)	sIgE point prevalence at 5–18 years: 0.7% (0.3–1.4)	sIgE point prevalence at 5–18 years: 1.2% (0.7–2.0)	

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Kristinsdottir et al. 2011, Iceland[60]	Point prevalence at 1 year: SR 4.2% (3.2–5.4) History + SPT 0.7% (0.4–1.4) History + sIgE 1.7% (1.2–2.6)	Point prevalence at 1 year: SR 0.5% (0.3–1.1) History + SPT 1.3% (0.8–2.0) History + sIgE 2.2% (1.5–3.1) History + SPT or sIgE 2.4% (1.7–3.3) DBPCFC 1.4% (0.9–2.2)	Point prevalence at 1 year: SR 0.5% (0.3–1.1) History + SPT 0% History + sIgE 0.6% (0.3–1.2) History + SPT or sIgE 0.6% (0.3–1.2) DBPCFC 0.1% (0.0–0.5)	Point prevalence at 1 year: SR 0.1% (0.0–0.5) History + SPT 0% History + sIgE 0.3% (0.1–0.8) History + SPT or sIgE 0.3% (0.1–0.8) DBPCFC 0.1% (0.0–0.4)	
Kucosmanoglu et al. 2008, Turkey[61]		SPT point prevalence at 8–18 months: 1.9% (1.2–2.9)			
Kurulaaratchy et al. 2005, Arshad et al. 2001, Tariq et al. 2000, United Kingdom[62–64]	Data not shared	SPT point prevalence at 4 years 0.8% (0.4–1.6) SPT cumulative incidence by 2 years 1.9% (1.3–2.7)	Data not shared	Data not shared	Estimates for other foods given in a figure in the paper.
Kvenshagen et al. 2009, Norway[65]	Point prevalence by clinician history or OFC at 2 years: 5.5% (3.8–7.9)	Clinician history or OFC point prevalence at 2 years: 1.0% (0.4–2.3)			
Le et al. 2015, The Netherlands[66]	SR point prevalence at age 20–54 years: 2.7% (2.2–3.2)	SR point prevalence at age 20–54 years: 0.6% (0.4–0.9)	Data not shared	Data not shared	Data are also reported for SR and IgE FA to hazelnut, walnut, apple, peach, kiwi, melon, banana, tomato, carrot
Lozoya-Ibáñez et al. 2020, Portugal[67]	Cow's milk food reaction investigated by sensitization tests and OFC in adolescents (10–23 years)	Egg's food reaction investigated by sensitization tests in adolescents (10–23 years)			183 out of 1702 subjects completing a questionnaire reported ad adverse food reaction (phase 1). In 81 subjects, the adverse food reaction was confirmed by an allergist by phone (phase 2). These subjects were further investigated by performing IgE sensitization tests (sIgE and/or SPT) and oral food challenge (phase 3). Data on specific FA/sensitization are only shared for subject who participated to phase 3, but no sufficient data are available for narrative report of the prevalence estimates on each specific food.

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Lyons et al. 2020, The Switzerland, Spain, Iceland, Lithuania, Bulgaria, Poland, Netherlands, Greece[68]	SR point prevalence FA in European children aged 7–10 years: 20.3% (19.7–20.9) sIgE point prevalence: Switzerland: 8.3% (7.1–9.4), Spain: 8.1% (6.7–9.6), Greece: 15.1% (13.4–16.7), The Netherlands: 8.2% (7.1–9.4), Lithuania: 8.7% (7.7–9.1), Poland: 5.1% (4.1–6.1), Iceland: 3.7% (2.9–4.5) Symptoms + sIgE positivity point prevalence: Switzerland: 0.0% (0.0–0.5), Spain: 0.9% (0.1–2.46), Greece: 0.6% (0.0–2.5), The Netherlands: 1.16% (0.3–2.5), Lithuania: 0.9% (0.0–3.2), Poland: 1.7% (0.7–3.2), Iceland: 0.4% (0.0–1.2)	SR point prevalence FA in European children aged 7–10 years: 9.9% (9.46–10.4) sIgE point prevalence: Switzerland: 6.1% (5.1–7.1), Spain: 7.3% (5.9–8.7), Greece: 6.6% (5.4–7.7), The Netherlands: 4.8% (3.9–5.7), Lithuania: 3.4% (2.7–4.1), Poland: 4.7% (3.7–5.6), Iceland: 3.1% (2.4–3.8) Symptoms + sIgE positivity point prevalence: Switzerland: 0.0% (0.0–0.5), Spain: 0.9% (0.1–2.46), Greece: 0.8% (0.0–3.1), The Netherlands: 0.2% (0.0–1.0), Lithuania: 0.4% (0.0–2.3), Poland: 0.8% (0.16–1.9), Iceland: 0.7% (0.1–1.8) DBPCFC point prevalence at age 7–10 years: 0.0% (0–0.0)	SR point prevalence FA in European children aged 7–10 years: 1.7% (1.5–1.9) sIgE point prevalence: Switzerland: 14.4% (13.0–15.9), Spain: 10.8% (9.1–12.5), Greece: 6.6% (5.4–7.7), The Netherlands: 8.9% (7.7–10.1), Lithuania: 3.8% (3.1–4.5), Poland: 6.1% (5.0–7.1), Iceland: 3.1% (2.4–3.8) Symptoms + sIgE positivity point prevalence: Switzerland: 0.1% (0.0–1.0), Spain: 0.0% (0.0–0.6), Greece: 0.0% (0.0–0.9) The Netherlands: 0.2% (0.0–1.0), Lithuania: 0.0% (0.0–0.9), Poland: 0.0% (0.0–0.4), Iceland: 0.1% (0.0–0.8)	sIgE point prevalence: Switzerland: 7.7% (6.6–8.8), Spain: 5.9% (4.6–7.16), Greece: 4.1% (3.2–5.0), The Netherlands: 4.1% (3.3–5.0), Lithuania: 2.6% (2.1–3.2), Poland: 4.3% (3.4–5.1), Iceland: 1.2% (0.7–1.6) Symptoms + sIgE positivity point prevalence: Switzerland: 0.0% (0.0–0.5), Spain: 0.2% (0.0–1.1), Greece: 0.0% (0.0–0.9), The Netherlands: 0.2% (0.0–1.0), Lithuania: 0.0% (0.0–0.9), Poland: 0.3% (0.0–1.1), Iceland: 0.1% (0.0–0.6)	The authors also investigated walnut, peanut, kiwi, peach, carrot, shrimps, celery, tomato, sunflower seed, banana, corn sesame seed, fish, mustard seed, peanuts honey, hazelnut. Data on population prevalence estimation were obtained by the authors using a weighting procedure fully explained in the paper online repository. Data on DBPCFC were not reported in meta-analysis as the authors claim that the number of subjects who agreed to be tested was too low to infer a valid population prevalence estimate on confirmed FA by DBPCFC
Majkowska-Wojciechowska et al. 2009, Poland[69]	SR lifetime prevalence in children (age group 6–17 years): 15% (13.6–16.6):	SR lifetime prevalence in children (age group 6–17 years): 2.9% (2.3, 3.7)			
Marklund et al. 2004, Sweden[70]	SR point prevalence at 13–21 years: 1.3% (0.8–2.0)	SR point prevalence at 13–21 years: 1.0% (0.6–1.6)		SR point prevalence at 13–21 years: 1.3% (0.8–2.0)	These are indirect-recalculated estimates as the authors provided only the percentage estimates.
Matricardi et al. 2007, Germany[71]	sIgE point prevalence at age 10 1.0% (0.5–2.3)	sIgE point prevalence at age 10: 0.9% (0.4–2.0)	sIgE point prevalence 8.8% (6.8–11.4)	sIgE point prevalence 6.1% (4.4–8.3)	
Matsyura et al. 2017, Ukraine[72]	Point prevalence at mean age 1.2 years: 2.7% (1.93–3.75)	Point prevalence at mean age 1.2 years: 2.02% (1.38–2.97)	Point prevalence at mean age 1.2 years: 1.35% (0.84–2.16)	Point prevalence at mean age 1.2 years: 0.34% (0.13–0.85)	Data extracted form a conference abstract. Data on prevalence were obtained under the assumption that the subjects tested for sIgE positivity corresponded to the number of subjects reporting SR FA
Mossakowska et al. 2008, Poland[74]		SR point prevalence in older adults: 0.3% (0.1–1.9)			
Mustafayev et al., 2013, Turkey[75]	SPT point prevalence at to 10–11 years: 1.1% (0.9–1.4) SR point prevalence at 10–11 years: 1.5% (1.2–1.8)	SPT point prevalence at to 10–11 years: 0.3% (0.2–0.46) SR point prevalence at 10–11 years: 5.6% (5.1–6.2) OFC or clinical history point prevalence 0.0% (0–0.1)	SR point prevalence at 10–11 years: 2.3% (2.0–2.7)		Data are also reported for SR and OFC-confirmed FA to pistachio, walnut, peanut, hazelnut, fish. The author also reported data about OFC positivity to beef, peach, spinach, cheese, kiwi allergy.
Nicolaou et al. 2010, United Kingdom[76]	SR lifetime prevalence at 8 years: 1.5% (0.9–2.4)	SR lifetime prevalence at 8 years: 2.3% (1.6–3.4)			

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Orhan et al. 2009, Turkey[78]	SR lifetime prevalence at 6–9 years: 0.9% (0.6–1.4) Point prevalence at 6–9 years: Hisory and SPT 0.4% (0.2–0.7) DBPCFC 0.1% (0.0–0.3)	SR lifetime prevalence at 6–9 years 1.9% (1.5–2.5) Point prevalence at 6–9 years: History and SPT 0.9% (0.6–1.3) DBPCFC 0.1% (0.0–0.3)			
Östblom et al. 2008a, 2008b, 2008c and Almqvist et al. 2005, Sweden[79–82]	Estimates at 4 years: SR point prevalence 3.5% (3.0–4.1) sIgE point prevalence 8.4% (7.4–9.6)	Estimates at 4 years: SR point prevalence 2.5% (2.1–3.1) sIgE point prevalence 4.8% (4.0–5.7)	Estimates at 4 years: SR point prevalence 0.5% (0.3–0.8) sIgE point prevalence 3.8% (3.1–4.6)	Estimates at 4 years: SR point prevalence 0.8% (0.6–1.2) sIgE point prevalence 3.0% (2.4–3.8)	Estimates also available at 8 years but these were only presented in figures.
Osterballe et al. 2009, Denmark[83]	SR point prevalence at mean age 22 years: 3.3% (2.3–4.8) DBPCFC point prevalence at mean age 22 years: 0.1% (0.0–0.7)	SR point prevalence at mean age 22 years: 0.9% (0.5–1.9) DBPCFC point prevalence at mean age 22 years: 0%	SR point prevalence at mean age 22 years: 0.8% (0.4–1.7)	SR point prevalence at mean age 22 years: 0.6% (0.3–1.4) DBPCFC point prevalence at mean age 22 years: 0.1% (0.0–0.7)	
Osterballe et al. 2005, Denmark[84]	History or SPT point prevalence: At <3 years 0.9% (0.2–4.9); at 3 years 1.6% (0.8–3.2); at >3 years 1.0% (0.3–2.9); All children 1.3% (0.8–2.3); Adults 0.9% (0.4–1.7) DBPCFC point prevalence: At <3 years 0%; at 3 years 0.6% (0.2–1.8); at >3 years 0.3% (0.1–1.9); All children 0.4% (0.2–1.1); Adults 0.3% (0.1–0.9)	History or SPT point prevalence: At <3 years 1.8% (0.5–6.3); at 3 years, 2.9% (1.7–4.8); at >3 years 0%; All children 1.8% (1.1–2.9); Adults 0.2% (0.1–0.8) DBPCFC point prevalence: At <3 years 0%; at 3 years 1.6% (0.8–3.2); at >3 years 0%; All children 0.9% (0.5–1.7); Adults 0.1% (0.0–0.6)	History or SPT point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0%; All children 0%; Adults 0.1% (0.0–0.6) DBPCFC point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0%; All children 0%; Adults 0%	History or SPT point prevalence: At <3 years 0%; at 3 years 0.4% (0.1–1.5); at >3 years 0.3% (0.1–1.9); All children 0.3% (0.1–1.0); Adults 0.3% (0.1–0.9) DBPCFC point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0%; All children 0%; Adults 0%	
Patelis et al. 2014, Sweden and Iceland[85]	SR lifetime prevalence at mean age 33.6 years: 0.8% (0.5–1.3)	SR lifetime prevalence at mean age 33.6 years: 0.8% (0.5–1.3)	SR lifetime prevalence at mean age 33.6 years: 0.6% (0.4–1.0)		Estimates for SR point prevalence for other foods are reported: fruits, nuts, vegetables, fish, seafood and shellfish, chocolate, meat, herbs, chills garlic.
Pawlińska-Chmara et al. 2015, Poland[86]	In children aged 7–10 years, 35.1% of the SR allergic symptoms occurred after cow's milk consumption	In children aged 7–10 years, 12.2% of the SR allergic symptoms occurred after egg consumption			Data were also available for SR FA to any food, strawberries, oranges, other milk derivates, nut, chocolate, other foods
Penard-Morand et al. 2005, France[87]	SR point prevalence at 9–11 years: 0.3% (0.2–0.4)	SR point prevalence at 9–11 years: 0.2% (0.1–0.4) SPT point prevalence at 9–11 years: 0.3% (0.2–0.5)			

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Pereira et al. 2005, United Kingdom[88]	SR point prevalence: 11 years 2.8% (1.9–4.3) 15 years 3.4% (2.4–5.0) Both 3.1% (2.4–4.1) SPT point prevalence: 11 years 0.3% (0.1–1.0) 15 years 0.3% (0.1–1.1) Both 0.3% (0.1–0.8) DBPCFC point prevalence: 11 years 0.1% (0.0–0.7) 15 years 0.3% (0.1–1.0) Both 0.2% (0.1–0.6)	SR point prevalence: 11 years 1.5% (0.9–2.7) 15 years 3.0% (2.0–4.5) Both 2.3% (1.6–3.2) SPT point prevalence: 11 years 0.3% (0.1–1.0) 15 years 0.2% (0.0–0.9) Both 0.2% (0.1–0.7)	SR point prevalence: 11 years 1.3% (0.7–2.4) 15 years 1.2% (0.6–2.2) Both 1.2% (0.8–1.9) SPT point prevalence: 11 years 0.6% (0.2–1.5) 15 years 1.2% (0.6–2.4) Both 0.9% (0.5–1.5) DBPCFC point prevalence: 15 years 0.1 (0.0–0.7)		
Protudjer et al. 2018, Sweden[89]	SR lifetime prevalence up to age 4 years: 18.0% (16.6–19.4)				Estimates also available at 8 and 16 years but these were only presented in figures.
Pyrhönen et al. 2011 and 2009, Finland[90,91]	Lifetime prevalence at 0–4 years: SR parent-perceived 6.4% (5.7–7.3) SR physician diagnosed 6.4% (5.7–7.3) SR parent-perceived or physician diagnosed 12.8% (11.8–14.0) Cumulative up to age 4 By SPT or sIgE: 3.1% (2.6–3.6) By OFC: 2.7% (2.2–3.3)	Lifetime prevalence at 0–4 years: SR parent-perceived 3.4% (2.9–4.1) SR physician diagnosed 2.8% (2.3–3.5) SR parent-perceived or physician diagnosed 6.3% (5.5–7.1) Cumulative incidence: sIgE or SPT or OFC 3.1% (2.6–3.7) sIgE or SPT 3.1% (2.6–3.7) OFC 0.1% (0.0–0.2)	Lifetime prevalence at 0–4 years: SR parent-perceived 1.5% (1.2–2.0) SR physician diagnosed 2.6% (2.1–3.2) SR parent-perceived or physician diagnosed 4.1% (3.5–4.9)		
Pyziak and Kamer 2011, Poland[92]	Data not shared	Frequency estimates not given in the study		Frequency estimates not given in the study	
Rance et al. 2005, France[93]	SR lifetime prevalence for all children 1.1% (0.7–1.5)	SR lifetime prevalence for all children 0.8% (0.6–1.3)			Lifetime prevalence estimates also given for age groups 2–5, 6–10 and 11–14 years, but only the point prevalence were given, no CI and the number of endpoints
Rentzos 2019 et al. Sweden[95]	SR point prevalence at age 17–78 years: 7.4% (5.8–9.0); excluding lactose intolerance symptoms: 1.1% (0.4–1.7) sIgE point prevalence: 1.8% (1.0–2.6) Symptoms + sIgE positivity point prevalence: 0.1% (0.1–0.3)	SR point prevalence at age 17–78 years: 1.3% (0.6–2.0) sIgE point prevalence: 1.7% (0.9–2.5) Symptoms + sIgE positivity point prevalence: 0.3% (0.0–0.6)	SR point prevalence at age 17–78 years: 1.6% (0.9–2.4); excluding gluten intolerance symptoms: 0.1% (0.1–0.3) sIgE point prevalence: 2.2% (1.3–3.1) Symptoms + sIgE positivity point prevalence: 0.0% (0.0–0.0)	SR point prevalence at age 17–78 years: 0.3% (0.0–0.6) sIgE point prevalence: 1.6% (0.8–2.4) Symptoms + sIgE positivity point prevalence: 0.0% (0.0–0.0)	Estimates for SR point prevalence for other foods are reported.
Roberts et al. 2005 and Lack et al. 2003, United Kingdom[96,97]	SPT point prevalence at 0–7 years: 0.2% (0.1–0.5)	SPT point prevalence at 0–7 years: 0.4% (0.3–0.6)		SPT point prevalence at 0–7 years: 0.2% (0.1–0.6)	

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Rona et al. 2007, World-wide[98]	All ages groups: Pooled estimate for SR point prevalence: 3.5% (2.9–4.1) Ranges of estimates: SR 1.2% to 17%; sIgE 2% to 9%; SPT 0.2% to 2.5%; History + SPT or IgE 0% to 0.2%; OFC or DBPCFC 0% to 3%	All ages groups: Pooled estimate for SR point prevalence: 1.3% (1.0–1.6) Range of estimates: SR 0.2% to 7%; sIgE <1% to 9%; SPT 0.5% to 5%; History + SPT or IgE 0.5% to 2.5%; OFC or DBPCFC 0% to 1.7%			
Ronchetti et al. 2008, Italy[99]	APT point prevalence: 9 years 11.4% (7.6–16.8) 13 years 4.1% (2.1–7.9) All children 7.6% (5.4–10.7) SPT point prevalence: 9 years 0.5% (0.1–3.0) 13 years 2.0% (0.8–5.1) All children 1.3% (0.6–3.0)	APT point prevalence: 9 years 8.2% (5.0–13.0) 13 years 10.2% (6.7–15.2) All children 9.2% (6.7–12.5) SPT point prevalence: 9 years 0% 13 years 1.0% (0.3–3.6) All children 0.5% (0.1–1.9)	APT point prevalence: 9 years 6.0% (3.4–10.4) 13 years 5.6% (3.3–10.8) All children 5.8% (3.9–8.6) SPT point prevalence: 9 years 0.5% (0.1–3.0) 13 years 1.5% (0.5–4.4) All children 1.1% (0.4–2.7)		
Sandin et al. 2005, Sweden and Estonia[100]	Estimates for each specific not given in the paper	Estimates for each specific not given in the paper	Estimates for each specific not given in the paper		Specific foods studied in the paper but estimates for each food not given by the authors rather several foods were studied together
Schäfer et al. 2001, Germany[101]	SR lifetime prevalence in adults 1.8% SPT point prevalence in adults 2.3%	SR lifetime prevalence in adults 0.4% SPT point prevalence *n* adults 1.9%	SPT point prevalence in adults 2.8%	SR lifetime prevalence in adults0.3% SPT point prevalence in adults1.7%	Estimates are weighted for the general population. The authors did not provide numbers used for weighting; hence, we were unable to recalculate the estimates.
Schnabel et al. 2010, Germany[102]	SR point prevalence at 6 years: Doctor diagnosis 4.7% (3.6–6.1) New onset 3.1% (2.3–4.4) sIgE point prevalence: At 2 years 5.0% (3.8–6.5) At 6 years 4.3% (3.3–5.7)	SR point prevalence at 6 years: Doctor diagnosis 4.7% (3.6–6.1) New onset 3.1% (2.3–4.4) sIgE point prevalence: At 2 years 5.7% (4.5–7.3) At 6 years 2.7% (1.9–4.0)	sIgE point prevalence at 6 years 4.6% (3.5–6.0)	sIgE point prevalence at 6 years 3.8% (2.8–5.1)	
Skypala et al. 2013, United Kingdom[103]	SR lifetime prevalence in subjects aged 18–75 years: 2.4% (1.9–2.9)	SR lifetime prevalence in subjects aged 18–75 years: 1.6% (1.2–2.1)	SR lifetime prevalence in subjects aged 18–75 years: 3.0% (2.5–3.6)	SR lifetime prevalence in subjects aged 18–75 years: 0.3% (0.2–0.5)	Estimates for SR lifetime prevalence for other foods are reported: fruits, nuts, vegetables, fish, Citrus fruit, non-citrus fruit, curry and spices, tomatoes, beans and lentils, Seeds

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Soost et al. 2009 and Zuberbier et al. 2004, Roehr et al. 2004, Germany[104–106]	SR lifetime prevalence 1.5% (0.8–2.6) History and SPT point prevalence 0–17 years 0.1% (0.0–0.8) Children and adults 0.6% (0.3–1.4)	SR lifetime prevalence 1.6% (0.9–2.8) History and SPT point prevalence 0–17 years 0.5% (0.2–1.4) Children and adults 0.8% (0.3–1.6) DBPCFC point prevalence: 0–14 years 0.2% (0.0–0.9) 15–17 years 0% All children 0.1% (0.0–0.8)	History and SPT point prevalence 0–17 years 1.1% (0.5–2.1) Children and adults 4.7% (3.5–6.4) DBPCFC point prevalence: 0–14 years 0.5% (0.2–1.5) 15–17 years 0% All children 0.4% (0.1–1.2)	SR lifetime prevalence 0.3% (0.1–1.0) History and SPT point prevalence 0–17 years 1.4% (0.7–2.5) Children and adults 3.4% (2.3–4.8) DBPCFC point prevalence: 0–14 years 0.7% (0.3–1.7) 15–17 years 0% All children 0.5% (0.2–1.4)	
Stefanaki et al. 2018 Greece[107]	SR lifetime prevalence up to 4 years of age: 1.7% (1.0–2.8) SR-physician diagnosed lifetime prevalence up to 6 years of age: 2.1% (1.2–3.5)	SR lifetime prevalence up to 4 years of age: 1% (0.5–1.9) SR-physician diagnosed lifetime prevalence up to 6 years of age: 1.9% (1.1–3.3)			Data were extracted from a conference abstract Data also reported for tomato, peanut, fish (cod), tree nuts.
Steinke et al. 2007, Europe[108]	SR point prevalence in subjects <18 years: Austria 28.6%; Belgium 55.8%; 22.7%; Finland 41.7%; Germany 23.8%; Greece 16.7%; Italy 33.3%; Poland 55.7%; Slovenia 27.9%; Switzerland 34.8%; all countries 38.5%	SR point prevalence in subjects <18 years: Austria 7.1%; Belgium 14.0%; Denmark 0%; Finland 14.6%; Germany 9.5%; Greece 27.1%; Italy 15.2%; Poland 27.3%; Slovenia 27.9%; Switzerland 21.7%; all countries 19.0%	SR point prevalence in subjects <18 years: Austria 28.6%; Belgium 9.3%; Denmark 4.5%; Finland 12.5%; Germany 19.0%; Greece 0%; Poland 6.8%; Slovenia 23.3%; Switzerland 13.0%; All countries 11.4%		The numbers the authors used in making the calculation for the estimates were not given in the paper. Therefore, it was not possible to recalculate the estimates.
Sterner et al. 2019, Sweden[109]		sIgE performed in children ages 13–14 years	sIgE performed in children ages 13–14 years	sIgE performed in children ages 13–14 years	The authors used a panel for sIgE testing which included egg, codfish, wheat, peanuts and soybean among the allergens tested, but the data on the positivity to each specific allergen were not reported
Strinnholm et al. 2014; Winberg et al. 2015, Sweden[110,111]	SR point prevalence at age 7–8 years: 9.0% (7.9–10.1)	SR point prevalence at age 7–8 years: 1.4% (1.0–1.9)	SR point prevalence at age 7–8 years: 1.0% (0.7–1.5)	SR point prevalence at age 7–8 years: 0.6% (0.3–1.0)	Estimates for SR point prevalence for other foods are reported: fruits and nuts, fish, kiwi, orange, apple, raw carrots, Banana, tree nuts, peanuts, almonds DBPCFC to cow's milk. Egg, wheat and codfish was offered to subjects with suspected FA. The result of the food challenge is reported for each patient in Table 3 In the paper from Winberg et al., although it was not possible to extract a valid data for DBPCFC positive FA to each specific food allergens.

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Van den Hoogen et al. 2014, The Netherlands[112]	Suspected CMA by clinical records and Dutch 'preventive child healthcare (PCH)' record: 6.8% (5.3–8.8) Clinical history or OFC-confirmed point prevalence in infants 0.7% (0.3–1.6)				Estimates on suspected FA as registered by on clinical and PCH records were not reported in meta-analysis
Venkataraman et al. 2017, United Kingdom[113]	SR point prevalence: At age 1 years; 3.5% (2.6–4.6) At age 2 years: 1.6% (1.0–2.5) At age 4 years: 2.6% (1.9–3.7) At age 10 years: 0.5% (0.2–1.0) At age 18 years: 0.3% (0.1–0.8)	SR point prevalence: At age 1 years: 1.1% (0.7–1.8) At age 2 years: 1.3% (0.8–2.1) At age 4 years: 1.4% (0.9–2.2) At age 10 years: 0.6% (0.3–1.1) At age 18 years: 0.3% (0.1–0.8)	SR point prevalence: At age 1 years: 0.5% (0.2–1.0) At age 2 years: 0.4% (0.2–1.0) At age 4 years: 0.2% (0.1–0.7) At age 10 years. 0.1% (0.0–0.4) At age 18 years: 0.5% (0.2–1.0)	SR point prevalence: At age 4 years: 0.3% (0.1–0.8)	Estimates given report FA according to restrictive criteria defined by authors Therefore, these estimates were not reported in meta-analysis. Estimates for SR point prevalence for other foods are also reported: fruits, fish, tomatoes, kiwi, tree nuts
Venter et al. 2010, United Kingdom[114]	SPT point prevalence at 3–4 years: 0.5% (0.2–1.4)	SPT point prevalence at 3–4 years: 1.4% (0.7–2.6)	SPT point prevalence at 3–4 years: 1.2% (0.6–2.4)		Estimates based on the latest cohort in the study, i.e. Cohort C, which is first reported in Venter al 2008; Dean et al. 2007; Venter et al. 2006, United Kingdom (see below).
Venter al 2008; Dean et al. 2007; Venter et al. 2006, United Kingdom[115–117]	SPT point prevalence: At 1 year 0.3% (0.1–1.0) At 2 years 0.5% (0.2–1.3) At 3 years 0.5% (0.2–1.4) History or OFC point prevalence: At 1 year 2.4% (1.6–3.7) At 2 years 1.2% (0.6–2.1) At 3 years 0.4% (0.2–1.1) History or OFC cumulative prevalence at 3 years 2.7% (1.8–3.9) OFC point prevalence At 9 months 1.2% (0.7–2.2) At 1 year 1.3% (0.8–2.3) At 2 years 0.6% (0.2–1.4) At 3 years 0% DBPCFC point prevalence: At 9 months 0.4% (0.2–1.1) At 1 year 0.7% (0.3–1.4) At 2 years 0.1% (0.0–0.7)	SPT point prevalence: At 1 year 1.8% (1.1–3.1) At 2 years 2.1% (1.3–3.5) At 3 years 1.4% (0.7–2.6) History or OFC point prevalence: At 1 year 1.8% (1.1–2.9) At 2 years 1.3% (0.7–2.3) At 3 years 1.0% (0.5–1.9) History or OFC cumulative prevalence at 3 years 1.9% (1.2–2.9) OFC point prevalence: At 9 months 0% At 1 year 1.4% (0.8–2.5) At 2 years 0.5% (0.2–1.2) At 3 years 0.2% (0.1–0.8) DBPCFC point prevalence: At 1 year 0.9% (0.5–1.7) At 2 years 0%	SPT point prevalence: At 1 year 0% At 2 years 0.2% (0.0–0.9) At 3 years 1.2% (0.6–2.4) History or OFC point prevalence: At 1 year 0.4% (0.2–1.1) At 2 years 0.3% (0.1–1.0) At 3 years 0.2% (0.1–0.8) History or OFC cumulative prevalence at 3 years 0.4% (0.2–1.1) OFC point prevalence: At 9 months 0.1% (0.0–0.6) At 1 year 0.2% (0.1–0.8) At 2 years 0.1% (0.0–0.7) DBPCFC point prevalence: At 1 year 0.1% (0.0–0.6)		

(Continues)

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Venter et al. 2006, United Kingdom[118]	SR point prevalence at 6 years: 3.6% (2.5–5.2) SPT point prevalence at 6 years: 0.4% (0.1–1.3) OFC point prevalence at 6 years: 0.6% (0.2–1.5) DBPCFC point prevalence at 6 years: 0.3% (0.1–1.0)	SR point prevalence at 6 years: 1.9% (1.1–3.1) SPT point prevalence at 6 years: 0.9% (0.4–1.9) OFC point prevalence at 6 years: 0%	SR point prevalence at 6 years: 1.3% (0.7–2.3) SPT point prevalence at 6 years: 0.4% (0.1–1.3) OFC point prevalence at 6 years: 0.3% (0.1–1.0) DBPCFC point prevalence at 6 years: 0.1% (0.0–0.8)		
Venter et al. 2016a and 2016b, United Kingdom[119,120]	Data not shared	Data not shared	Point prevalence at 10–11 years: SR point prevalence of 'problem' to wheat at age 2.1% (1.3–3.3) SPT point prevalence allergy to wheat flour: 0.2% (0.0–0.96) sIgE point prevalence: 15.0% (11.1–20.0) using 0.3 kUA/l as a cut off; 24.0% (19.1–29.7) using 0.0 kUA/l as a cut off OFC point prevalence: 0.5% (0–1)		For this specific outcome, data were available from Venter et al. 2016b
von Hertzen et al. 2006, Finland and Russia[121]	SPT point prevalence in Finland Children (7–16 years): 0.3% (0.0–1.5) Mothers 2.8% (1.5–5.1)	SPT point prevalence in Finland Children (7–16 years): 1.9% (0.9–3.9) Mothers 3.1% (1.7–5.4)	SPT point prevalence in Finland Children (7–16 years): 11.8% (8.9–15.5) Mothers 8.7% (6.2–12.1)		
Westerlaken-van Ginkel et al. 2020, The Netherlands[122]	SR point prevalence at mean age 47.5 years: 2.4% (2.9–2.5)	SR point prevalence at mean age 47.5 years: 0.4% (0.3–0.4)	SR point prevalence at mean age 47.5 years: 1.4% (1.3–1.5)	SR point prevalence at mean age 47.5 years: 0.4% (0.4–0.4)	The author also reported SR point prevalence almond, kiwi, cashew, pistachio, sesame, strawberry, cherry
Xepapadaki et al. 2015, Iceland United Kingdom The Netherlands Germany Poland Lithuania Spain Italy Greece[123]		SR/suspicious for FA point prevalence: 28.0% (27.1–28.9) DBPCFC cumulative incidence by 2 years: All: 0.8% (0.7–1.0) Iceland 1.5% (0.9–2.3) United Kingdom: 1.9% (1.1–3.1) The Netherlands: 1.5% (0.8–2.5) Germany: 0.8% (0.4–1.5) Poland: 0.6% (0.3–1.2) Lithuania: 0.1% (0.0–0.6) Spain: 0.8% (0.4–1.5) Italy: 0.4% (0.1–1.0) Greece: 0.1% (0.0–0.6)			
Zeyrek et al. 2015, Turkey[124]	SPT and/or sIgE point prevalence at 0–2 years: 0.16% (0.0–0.9)	SPT and/or sIgE point prevalence at 0–2 years: 1.3% (0.7–2.5)			
Zivic et al. 2018[125]	Clinician diagnosed point prevalence at 1–12 months: 10% (6.9–14.3)				

TABLE 3 (Continued)

Reference, country	Estimates of the frequency of cow's milk allergy, Percentage (95% CI)	Estimates of the frequency of hen's egg allergy, Percentage (95% CI)	Estimates of the frequency of wheat allergy, Percentage (95% CI)	Estimates of the frequency of soy allergy, Percentage (95% CI)	Comment
Zuidmeer et al. 2008, World-wide[126]			SR pooled point prevalence for adults 0.4% (0.2–0.6) SPT pooled point prevalence for children 0.4% (0.16–0.7) sIgE pooled point prevalence for adults 2.1% (0.9–3.3)	SR pooled point prevalence for children 0–18 years: 0.3% (0.1–0.6)	

Note: The following records were extracted from conference abstracts (or posters), or from /Journals' letters: Butiene et al., Diwaker et al., Ecker et al. 2016, Jürisson et al., Karakoc et al., Kelleher et al., Stefanaki e al., Zeyrek et al., Zivic et al. and Clausen et al. data were extracted from a university thesis. Data recorded before September 2012 were reported as 'studies'; therefore, one row may combine data extracted from more than one paper. Data recorded from September 2012 have been reported using the principle one paper/abstract = one row. The following papers/abstracts included in Table 3 reported about the same study population: Doğruel et al. 2016, together with Karakoc et al. 2015; Goksör et al. 2018, together with Clausen et al. 2017; Grabenhenrich et al. 2020, together with Erhard et al. 2021; Grimshaw et al. 2016, together with Butiene et al. 2013, Eckers et al. 2015, and Xepapapdaki et al. 2015; Lyons et al. 2019, together with Burney et al. 2014, and Le et al. 2015; Strinnholm et al. 2014, together with Winberg et al. 2015.

Abbreviations: CI, confidence interval; DBPCFC, double-blind placebo-controlled food challenge; FA, food allergy; OFC, oral food challenge; sIgE, specific immunoglobulin E; SPT, skin prick test; SR, self-reported.

TABLE 4 Summary of evidence on the frequency of allergy to peanut, tree nut, fish, shellfish in Europe: studies published 1 January 2000–30 June 2021.

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Baricic et al. 2015, Croatia[5]	SR point prevalence At 6–12 months: −0.6% (0.1–3.4) At 12–24 months: 1.46% (0.5–4.2) At 24–48 months: 3.6% (2.0–6.1) All children: 2.3% (1.4–3.7)	Data not shared	Data not shared		The author specifically reported about milk, egg and peanut allergy. They also investigated other food allergens which include, apple, pear, carrot, hazelnut, fish, pecan, banana, ketchup, tomato, cherry, chicken, soy, citrus fruit but a specific estimate for each of these allergens was not reported by the authors.
Barlik et al. 2013, Turkey[6]	In children aged 3–6 years, 3% of the SR allergic symptoms occurred after peanut consumption	In children aged 3–6 years, 4.1% of the SR allergic symptoms occurred after nuts consumption	In children aged 3–6 years, 3% of the SR allergic symptoms occurred after fish consumption		The authors also reported about hen's egg, cow's milk, chocolate, foods additives, strawberry, tomatoes, spices, corn, purslane, oranges, banana, sesame and honey allergy.
Bröms et al. 2013, Sweden[7]	SR point prevalence: At 1–2 years 1.16% (0.7–2.0) At 3–4 years 1.9% (1.3–2.5) At 5–6 years 2.4% (1.8–3.2)	SR point prevalence: At 1–2 years 1.2% (0.7–2.1) At 3–4 years 1.4% (1.0–2.0) At 5–6 years 2.3% (1.7–3.1)	SR point prevalence: At 1–2 years 1.0% (0.5–1.7) At 3–4 years 0.7% (0.46–1.2) At 5–6 years 1.1% (0.7–1.7)		The authors also reported about milk, egg, soy and stone fruits allergy.
Burney et al. 2010; Woods et al. 2001, Europe, United States of America, Australia, New Zealand[8,9]	sIgE point prevalence for all countries at 18–27 years: 1.4%	sIgE point prevalence for all countries at 18–27 years: Hazelnut 3.1% Walnut 1.8%	sIgE point prevalence for all countries at 18–27 years: 0.1%	sIgE point prevalence for all countries at 18–27 years: shrimp 5.2%	Estimate of sensitization is a weighted average over all countries in the study excluding birth positivity. No weighting factor or baseline data given, so we were unable to recalculate the estimate.

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Burney et al. 2014; Lyons et al. 2019, Switzerland, Spain, Netherland, Poland, Bulgaria, Greece, Lithuania, Iceland[10,11]	sIgE point prevalence in adults (20–54 years): All centres: 2.6%; Switzerland: 5.0%; Spain: 7.2%; The Netherlands: 1.6%; Poland: 3.1%; Bulgaria: 1.8%; Iceland: 0.4% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.4% (0.0–1.2) Spain 0.4% (0.0–1.4) Iceland 0.0% (0.0–0.3) Poland 0.3% (0.0–1.2) The Netherlands 0.0% (0.0–0.4) Greece 0.0% (0.0–0.8)	sIgE point prevalence in adults (20–54 years): Hazelnut: All centres: 9.3%; Switzerland: 17.8%; Spain: 6.0%; The Netherlands: 11.9%; Poland: 6.5%; Bulgaria: 6.3%; Iceland: 1.3% Walnuts: all centres: 3.0%; Switzerland: 5.6%; Spain: 7.6%; The Netherlands: 1.9%; Poland: 3.6%; Bulgaria: 2.7%; Iceland: 0.1% Symptoms + sIgE positivity point prevalence at age 20–54 years: Hazelnut Switzerland 2.6% (1.5–4.0) Spain 0.8% (0.16–2.0) Iceland 0.1% (0.0–0.6) Poland 1.3% (0.5–2.7) The Netherlands 0.9% (0.4–1.8) Greece 0.1% (0.2–1.0) sIgE point prevalence Walnut Switzerland 0.6% (0.1–1.4) Spain 0.7% (.1–1.9) Iceland 0.0% (0.0–0.5) Poland 0.1% (0.0–0.8) The Netherlands 0.1% (0.0–0.5) Greece 0.3% (0.0–1.6)	sIgE point prevalence in adults (20–54 years): All centres: 0.2% Switzerland: 0.2%; Spain: 1.2%; The Netherlands: 0.2%; Poland: 0.0%; Bulgaria: 0.0%; Iceland: 0.2% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.0(0.0–0.3), Spain 0.4% (0.0–1.4), Iceland 0.1% (0.0–0.7), Poland: 0.0% (0.0–0.4), Netherlands 0.1% (0.0–0.46), Greece 0.0% (0.0–0.7)	sIgE point prevalence in adults (20–54 years): Shrimps: All centres: 4.8%; Switzerland: 6.9%; Spain: 5.3%; The Netherlands: 3.9%; Poland: 4.9%; Bulgaria: 6.3%; Iceland: 2.8% Symptoms + sIgE positivity point prevalence at age 20–54 years: Switzerland 0.4% (0.0–1.0) Spain 0.8% (0.2–2.0) Iceland 0.4% (0.0–1.1) Poland 0.3% (0.0–1.2) The Netherlands 0.4% (0.1–1.0) Greece 0.0% (0.0–0.7)	For Burney et al. 2014, the author also reported about sIgE for cow's milk, hen's egg, soy, hazelnut, peach, apple, celery, carrot, kiwi, tomato, sesame, shrimps, banana, corn, sunflower, poppy, melon, buck wheat, walnut, lentils, mustard. For Lithuania and Greece, the data were not reported. sIgE point prevalence was estimated as the prevalence of those with a specific IgE response to a particular food among 'cases' and 'controls' weighted back to the general population according to the sampling fraction by which these had been selected for further study. Since the sampling factor was not mentioned by the authors, it was not possible to define precise confidence intervals for meta-analysis. Therefore, data for sIgE positivity have not been included in meta-analysis. For Lyons et al. 2019, the authors also investigated sIgE positivity plus symptoms to milk, egg, wheat, soy, kiwi, peach, carrot, shrimps, celery, tomato, sunflower seed, banana, corn sesame seed, fish, mustard seed, honey. Data on population prevalence estimation were obtained by the authors using a weighting procedure fully explained in the paper online repository. DBPCFC was employed to assess FA to hazelnut, peanut, apple, peach, celery, shrimps. A summary of the DBPCFC is presented by the authors in Table 3. Participation rate to DBPCFC was low, preventing the calculation of a meaningful population-based prevalence estimate. Data on DBPCFC were therefore not reported in meta-analysis.
Caffarelli et al. 2011, Italy[13]	SR lifetime prevalence at 5–14 years: 1.1% (0.5–2.3)	SR lifetime prevalence of hazelnut allergy at 5–14 years: 0.3% (0.1–1.2)			
Chafen et al. 2010, World-wide[14]	See Rona et al.		See Rona et al.	See Rona et al.	The same frequency estimates as given in Rona et al. 2007

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Clausen et al. 2017; Goksör et al. 2018, Sweden[15,16]	SR physician diagnosed point prevalence in 12 years children: 1.4% (1.1–1.9),	SR physician diagnosed point prevalence in 12 years children: 1.4% (1.1–1.9), Hazelnut: 1.6% (1.2–2.0) Almonds: 0.8% (0.5–1.1) Other nuts: 0.9% (0.7–1.3)	SR physician diagnosed point prevalence in 12 years children: 0.4% (0.2–0.6)		Data from Clausen et al. 2017 were extracted from a thesis. The data here reported were extrapolated by reporting the sum of possible FA and probable FA in Table 2 of the thesis. For the outcomes reported, data were included in the thesis from Clausen et al.
De Jong et al. 2019, The Netherlands[17]	Point prevalence at 10 years SPT: 3.2% (2.7–3.8); SR physician diagnosed: 2.0% (1.6–2.4)	Point prevalence at 10 years Hazelnut: SPT: 4.1% (3.5–4.7) Cashew nut: SPT: 1.3% (1–1.7); SR physician diagnosed: Cashew nut: 1.4% (1.1–1.8)			The authors also reported about peach allergy.
Depner et al. 2012, Austria, Finland, France, Germany, and Switzerland[18]		Data on sIgE positivity to hazelnut are presented in a bar graph for children aged 0–12 months			The authors measured sIgE for hen's egg, cow's milk, hazelnut, carrot and wheat flour. Data on FA as defined by sIgE at birth and/or at 12 months are presented in bar graphs figures in the paper (for all centres and for each separate centre), but it is not possible to extract a precise value.
Dereci et al. 2016; Turkey[19]		Estimates in school-age children (6–18 years) SR lifetime prevalence hazelnut allergy: 0.2% (0.2–0.3) Point prevalence SPT hazelnut allergy: 0.1% (0.1–0.16); DBPCFC 0.0% (0.0–0.1); OFC: 0%			Data on nut allergy were specifically reported in Dereci et al. 2016
Diwakar et al. 2017, United Kingdom[20]		Prevalence trend between 2000 and 2015 increased by 275% (1.2 to 4.5 per 1000 children aged 0–17 years).			Data were extracted from a conference abstract. The author reported about prevalence increased trend for any FA, egg and nut allergy.
Doğruel et al. 2016; Karakoc et al. 2015, Turkey[21,127]	No data on sIgE positivity available		No data available on sIgE positivity available		The authors also reported about cow's milk, hen's egg, soy, chicken meat, beef and banana allergy. Specifically, for fish, peanut and soy, the authors mention sIgE were measured, but no data were reported.
Du Toit et al. 2008, United Kingdom and Israel[22]	At 4–18 years: SR point prevalence 1.9% (1.5–2.3) in United Kingdom History or OFC: 0.4% (0.3–0.6) in United Kingdom	At 4–18 years: SR point prevalence 2.0% (1.6–2.5) b SR point prevalence 2.0% (1.6–2.5)			
Dubakiene et al. 2012, Lithuania[23]	Point prevalence at 6 months: History + sensitization 0.1% (0.0–0.4); Point prevalence at 12 months: History + sensitization 0.1% (0.0–0.5)		Point prevalence at 12 months: History + sensitization 0.1% (0.0–0.0)		

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Eggesbø et al. 2003, 2001a and 2001b, Norway[25–27]		Data not shared	Data not shared		
Eller et al. 2009, Kjaer et al. 2008, Johnke et al. 2006, Denmark[28–30]	Point prevalence: At 3 months: sIgE 0.2% (0.0–1.3) At 6 months: sIgE 1.6% (0.7–3.3) At 12 months: sIgE 1.6% (0.7–3.3) At 18 months: sIgE 1.2% (0.5–3.1) At 6 years by OFC/DBPCFC: 0.5% (0.1.-1.8) Cumulative incidence by 18 months: sIgE 1.8% (1.0–3.4)	Data not shared	Data not shared	At age 6 by OFC/DBPCFC: 0.0% (0.0–0.9)	
Erhard et al. 2021, Germany[31]	SPT and or sIgE point prevalence in school-age children (8–9 years): 11.5% (8.2–15.9)	Lifetime prevalence of SR hazelnut allergy in school-age children (8–9 years): 1.9% (1.1–2.9) Point prevalence hazelnut allergy in school-age children (8–9 years): SPT and/or sIgE: 17.6% (13.5–22.7); DBPCFC: 0.4% (0.1–2.1)	SPT point prevalence in school-age children (8–9 years): White fish: 1.5% (0.6–3.9); Oily fish: 0.4% (0.1–2.1)	SPT point prevalence in school-age children (8–9 years): Crustaceous: 1.1% (0.4–3.3)	The authors also reported about cow's milk, wheat, hen's egg, soy allergy. The 'main outcome of the paper was hazelnut allergy in school-age children. For DBPCFC to hazelnut, only 2 of the eligible 11 subjects underwent the test. Estimate for SR hazelnut allegy was not reported for meta-analysis as they equal estimate reported by Grabenhenrich et al. on the same population (paper reporting on the same study)
Falcaõ et al. 2004, Portugal[32]			SR point prevalence in adults older than 39 years: 0.9% (0.4–2.0)	SR point prevalence in adults older than 39 years: 0.5% (0.2–1.3)	Types of shellfish studied were octopus and squid.
Fedorova et al. 2014a; 2014b; 2016, Russia[33–35]	Data available, but method of assessment not clarified	Data available, but method of assessment not clarified	Point prevalence in children aged 7–10 years: SR: 1.6% (1.4–1.9); History + SPT and/or sIgE positivity: 0.3% (0.2–0.4)		Data were extracted from a conference abstract. In Fedorova et al. 2014a, the authors claim to have investigated SR, sIgE and SPT positive allergy to hazelnut and peanuts. Contextually, the authors report that point prevalence allergy to peanut and to hazelnut is 0.1% and 0.1%, respectively, but do not specify if the record regards SR, sIgE or SPT positivity, or a combination of all.
Fox et al. 2009, United Kingdom[36]	Case–control study: frequency estimates not given				
Frongia et al. 2005, Italy[37]	Estimates not given in the paper				
Gaspar-Marques et al. 2014, Portugal[38]	SR point prevalence: All (0–6 years; mean age 3.5 years): 0.5% (0.2–1.1) At 0–3 years: N/A At 4–6 years: 0.8% (0.4–1.7)	SR point prevalence: All (0–6 years; mean age 3.5 years): 0.3% (0.1–0.8) At 0–3 years: N/A At 4–6 years: 0.5% (0.2–1.4)	SR point prevalence: All (0–6 years; mean age 3.5 years): 0.2% (0.1–0.7) At 0–3 years: 0.6% (0.2–1.9) At 4–6 years: N/A	SR point prevalence: All (0–6 years; mean age 3.5 years): 0.7% (0.4–1.4) At 0–3 years: 0.9% (0.3–2.2) At 4–6 years: 0.7% (0.3–1.5)	The authors also reported about chocolate, egg kiwi orange, strawberry, peach

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Gelincik et al. 2008, Turkey[39]	Point prevalence in adults: History + SPT 0.0% (0.0–0.1) History + sIgE 0.0% (0.0–0.1) DBPCFC 0.0% (0.0–0.0)	Point prevalence in adults: History + SPT (hazelnut) 0.0% (0.0–0.0) History + sIgE (hazelnut) 0.0% (0.0–0.0) DBPCFC (hazelnut) 0.0% (0.0–0.0) DBPCFC (walnut) 0.0% (0.0–0.0)	Data not shared		
Grabenhenrich et al. 2020, Iceland, United Kingdom, The Netherlands, Germany, Poland, Lithuania, Spain and Greece[41]	Estimates for school age children aged 6–10 years: Lifetime prevalence All centres: SR: 1.6% (1.3–1.9); SR physician diagnosed: 1.1% (0.9–1.4) Iceland: SR: 1.6% (0.96–2.6); SR physician diagnosed: 1.4% (0.8–2.3) United Kingdom: SR: 2.2% (1.2–4.0); SR physician diagnosed: 1.8% (0.9–3.4) The Netherlands: SR: 2.0% (1.2–3.4); SR physician diagnosed: 0.6% (0.2–1.6) Germany: SR: 1.4% (0.8–2.3); SR physician diagnosed: 1.2% (0.7–2.1) Poland: SR: 2.4% (1.6–3.7); SR physician diagnosed: 1.2% (0.7–2.2) Lithuania: SR: 1.0% (0.6–1.9); SR physician diagnosed: 0.6% (0.3–1.4) Spain: SR: 1.6% (0.9–2.8); SR physician diagnosed: 1.6% (0.9–2.8) Greece: SR: 0.5% (0.2–1.6); SR physician diagnosed: 0.4% (0.1–1.3) Point prevalence: SPT: 5.6% (4.7–6.6); DBPCFC: 0.1% (0.0–0.4)	Estimates for school age children aged 6–10 years: Lifetime prevalence hazelnut allergy: All centres: SR: 1.5% (1.2–1.8); SR physician diagnosed: 0.96% (0.7–1.2) Iceland: SR: 0.9% (0.5–1.8); SR physician diagnosed: 0.6% (0.3–1.4) United Kingdom: SR: 0.9% (0.3–2.2); SR physician diagnosed: 0.7% (0.2–1.9) The Netherlands: SR: 1.1% (0.5–2.2); SR physician diagnosed: 0.46% (0.16–1.3) Germany: SR: 1.9% (1.2–2.9); SR physician diagnosed: 0.8% (0.4–1.6) Poland: SR: 3.5% (2.5–5.0); SR physician diagnosed: 2.7% (1.8–4.0) Lithuania: SR: 1.3% (0.7–2.2); SR physician diagnosed: 0.8% (0.4–1.6) Spain: SR: 1.16% (0.6–2.3); SR physician diagnosed: 1.0% (0.5–2.1) Greece: SR: 0.2% (0.0–1); SR physician diagnosed: 0.2% (0.0–1) Point prevalence hazelnut SPT: 5.2% (4.4–6.2); DBPCFC: 0.3% (0.1–0.7) Lifetime prevalence nut (excluding hazelnut) allergy: 0.7% (0.5–0.9); SR physician diagnosed: All centres: 0.6% (0.46–0.9) Iceland: SR: 0.5% (0.2–1.2); SR physician diagnosed: 0.4% (0.16–1.1) United Kingdom: SR: 0.7% (0.2–1.9); SR physician diagnosed: 0.7% (0.2–1.9) The Netherlands: SR: 0.9% (0.4–2.0); SR physician diagnosed: 0.6% (0.2–1.6) Germany: SR: 0.8% (0.4–1.6); SR physician diagnosed: 0.8% (0.4–1.6) Poland: SR: 0.1% (0.0–0.7); SR physician diagnosed: 0.1% (0.0–0.7) Lithuania: SR: 0.1% (0.0–0.6); SR physician diagnosed: 0.1% (0.0–0.6) Spain: SR: 2.0% (1.2–3.4); SR physician diagnosed: 1.9% (1.1–3.2) Greece: SR: 0.7% (0.3–1.8); SR physician diagnosed: 0.7% (0.3–1.8)	Estimates for school age children aged 6–10 years: Lifetime prevalence white fish allergy: All centres: SR: 0.8% (0.6–1.0); SR physician diagnosed: 0.6% (0.4–0.8) Iceland: SR: 1.8% (1.1–2.9); SR physician diagnosed: 1.4% (0.8–2.3) United Kingdom: SR: 0.4% (0.1–1.6); SR physician diagnosed: 0% The Netherlands: SR: 0.6% (0.2–1.6); SR physician diagnosed: 0.3% (0.1–1.1) Germany: SR: 0.1% (0.0–0.6); SR physician diagnosed: 0.1% (0.0–0.6) Poland: SR: 0.6% (0.3–1.4); SR physician diagnosed: 0.2% (0.1–0.9) Lithuania: SR: 0.6% (0.3–1.4); SR physician diagnosed: 0.6% (0.3–1.4) Spain: SR: 1.0% (0.5–2.1); SR physician diagnosed: 0.7% (0.3–1.7) Greece: SR: 0.9% (0.4–2.1); SR physician diagnosed: 0.9% (0.4–2.1) Point prevalence white fish DBPCFC: 0.0% (0.0–0.3) Lifetime prevalence oily fish allergy: SR: 0.4% (0.3–0.6); SR physician diagnosed: 0.2% (0.1–0.4) Iceland: SR: 0.8% (0.4–1.7); SR physician diagnosed: 0.4% (0.16–1.1) United Kingdom: SR: 0.2% (0.0–1.2); SR physician diagnosed: 0% The Netherlands: SR: 0%; SR physician diagnosed: 0% Germany: SR: 0.4% (0.16–1.0); SR physician diagnosed: 0.2% (0.0–0.7) Poland: SR: 0.2% (0.1–0.9); SR physician diagnosed: 0% Lithuania: SR: 0.4% (0.16–1.1); SR physician diagnosed: 0.3% (0.1–0.9) Spain: SR: 0.7% (0.3–1.7); SR physician diagnosed: 0.3% (0.1–1.0) Greece: SR: 0.5% (0.2–1.6); SR physician diagnosed: 0.5% (0.2–1.6) Point prevalence oily fish DBPCFC: 0.0% (0.0–0.3)	Estimates for school age children aged 6–10 years: Lifetime prevalence crustaceous allergy: All centres: SR: 0.4% (0.3–0.6), SR physician diagnosed: 0.2% (0.1–0.4) Iceland: SR: 0.9% (0.5–1.8); SR physician diagnosed: 0.6% (0.3–1.4) United Kingdom: SR: 0.7% (0.2–1.9); SR physician diagnosed: 0.4% (0.1–1.6) The Netherlands: SR: 0.6% (0.2–1.6); SR physician diagnosed: 0% Germany: SR: 0.1% (0.0–0.6); SR physician diagnosed: 0% Poland: SR: 0%; SR physician diagnosed: 0% Lithuania: SR: 0.5% (0.2–1.2); SR physician diagnosed: 0.3% (0.1–0.9) Spain: SR: 0.4% (0.1–1.3); SR physician diagnosed: 0.4% (0.1–1.3) Greece: SR: 0.4% (0.1–1.3); SR physician diagnosed: 0% Point prevalence DBPCFC: 0.1% (0.0–0.3)	The author also reported lifetime prevalence of egg. Milk, wheat, soy, tomato, kiwi, strawberry, apple, citrus, fruit allergy. For other FA to specific allergens with SPT, positivity data are presented in a bar graph (Figure 3).

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Grimshaw et al. 2016, United Kingdom[42]	Clinical history or DBPCFC cumulative incidence by 2 years: 0.7% (0.1–1.3); DBPCFC and SPT and/or sIgE by 2 years: 0.6% (0.1–1.1)		Clinical history or DBPCFC cumulative incidence by 2 years: 0.1% (0.0–0.3) DBPCFC and SPT and/or sIgE by 2 years: 0.1% (0.0–0.4)		The author also recorded other FA such as lentil and broccoli
Grundy et al. 2002, United Kingdom[43]	Point prevalence at 3–4 years: SR: 1.0% (0.6–1.7) SPT 3.3% (2.4–4.4) OFC + history 1.4% (0.9–2.9) OFC 0.6% (0.3–1.3)				
Haftenberger et al. 2013, Germany[44]	sIgE point prevalence at age18-79 years: 8.0% (7.3–8.8) Recombinant peanut, 11.7% (10.7–12.7)	sIgE point prevalence at age 18–79 years: Hazelnut 15.7% (14.6–16.8) Almond 4.0% (3.5–4.6)		sIgE point prevalence at age 18–79 years: Shrimp: 7.1% (6.3–8.0); Recombinant shrimp 0.5% (0.3–0.7)	The author reported also IgE prevalence of cow's milk, wheat, soy, tomato, kiwi, strawberry, apple, celery, cherries, chickpea lupin seed, cherries chickpea, lupin seed
Hicke-Roberts et al., 2020, Sweden[45]	SR cumulative incidence by 8 years: 2.8% (1.9–4.0)	SR cumulative incidence by 8 years: Tree nuts: 2.3% (1.5–3.4)	SR cumulative incidence by 8 years: 1.1% (0.6–2.0)		The outcome investigated was SR FA or intolerance. The author also looked at cow's milk, hen's egg and cereal allergy.
Hourihane et al. 2007, United Kingdom[47]	Point prevalence at 4–5 years: SPT 2.7% (1.9–3.9) DBPCFC or history 1.9% (1.2–2.9) DBPCFC 1.4% (0.8–2.3)				
Ivakhnenko et al. 2013, Ukraine[49]			SR lifetime prevalence up to 24–30 months: 2% (1.3–3.1)		The author reported about cow's milk, hen's egg, citrus, fruit, vegetables, chocolate and others FA
Järvenpää et al., 2014, Finland[50]		SR point prevalence nut allergy at 6–7 years: 1.8% (1.3–2.6)	SR point prevalence at 6–7 years: 0.7% (0.4–1.3)		The author also looked at other food allergies such as łegumes, fruits, spices, vegetables, cow's milk, hen's egg, wheat and soy
Johansson et al. 2005, Sweden and Norway[51]	sIgE point prevalence in adults: Sweden 2.3% (1.5–3.4) Norway 0.6% (0.2–1.8) Sweden + Norway 1.7% (1.2–2.5)	sIgE point prevalence in adults: Sweden 3.5% (2.5–4.8) Norway 0.6% (0.2–1.8) Sweden + Norway 2.5% (1.9–3.5)	sIgE point prevalence in adults: Sweden 0.1% (0.0–0.6) Norway 0% Sweden + Norway 0.1% (0.0–0.4)		Type of fish studied was codfish.
Jorge et al. 2017, Portugal[52]		Nut allergy/sensitization among subjects with Q2-confirmed food reaction at 3–11 years: SR point prevalence 0.41% (0.22–0.75) sIgE point prevalence: 0.12% (0.04–0.36) SPT point prevalence 0.08% (0.02–0.3)	SR point prevalence among subjects with Q2-confirmed food reaction: 1.06% (0.72–1.55) sIgE point prevalence among subjects with Q2-confirmed food reaction: 0.69% (0.43–1.11) SPT point prevalence among subjects with Q2-confirmed food reaction: 0.49% (0.28–0.85)	Shellfish allergy/ sensitization among subjects with Q2-confirmed food reaction: SR point prevalence: 0.94% (0.62–1.4); sIgE point prevalence: 0.16% (0.06–0.42) SPT point prevalence: 0.12% (0.04–0.36)	176 out of 2474 subjects self-reported an adverse reaction to food (Q1), of whom 159 responded to a second questionnaire (Q2) which was used by authors to confirm food reaction. 115 subjects had a confirmed reaction. Only those who were positive to both Q1 and Q2 were then tested for IgE sensitization (positive sIge or SPT). Data on specific FA were therefore reported narratively, but not included in meta-analysis.

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Jürisson et al. 2015, Estonia[55]	SPT point prevalence: At 12 months: 0.4% (0.1–2.16) At 24 months: 0.4% (0.1–2.16)		SPT point prevalence codfish allergy: 0% at 6, 12 and 24 months		Data were extracted from a conference abstract.
Kaya et al. 2013, Turkey[56]	Point prevalence at school age (sixth to eighth grade): SPT: 0.1% (0.0–0.1); sIgE: 0.0% (0.0–0.1); DBPCFC: 0.0% (0.0–0.1)	SR lifetime prevalence tree nuts allergy at school age (sixth to eighth grade): 1.2% (1.0–1.4) Point prevalence at school age (sixth to eighth grade): Hazelnut: sIgE: 0.0% (0–0.1); OFC: 0.0% (0.0–0.1); DBPCFC: 0.0% (0–0.1) Walnut: SPT: 3% (2.1–4.2); sIgE: 0.0% (0.0–0.1); OFC: 0.0% (0–0.1); DBPCFC: 0.0% (0.0–0.1) Pistachio: SPT: 0.0% (0–0.1); sIgE: 0.0% (0–0.1)			The author also investigated milk, egg, kiwi, cocoa, honey, banana, sesame, black pepper, strawberry, tomato allergy. The author definition of 'tree nuts allergy' is 'hazelnut, peanuts, walnuts, pistachio'.
Kelleher et al. 2014, Ireland[57]	SPT was performed in children aged 0–24 months		SPT was performed in children aged 0–24 months		Data were extracted from a conference abstract. Food allergen measured by SPT: cow's milk, egg, peanut, codfish, wheat and soya. Estimates on specific foods allergy were not reported by the authors
Kotz et al. 2011, United Kingdom[58]	Data not shared				
Krause et al. 2002, Greenland[59]	sIgE point prevalence at 5–18 years: 1.2% (0.7–2.0)		sIgE point prevalence at 5–18 years: 0.7% (0.3–1.4)		
Kristinsdottir et al. 2011, Iceland[60]	Point prevalence at 1 year: History + SPT 0.2% (0.1–0.7) History + sIgE 0.7% (0.4–1.3) History + SPT or sIgE 0.7% (0.4–1.3) DBPCFC 0.1% (0.0–0.5)	Point prevalence at 1 year: SR 0.1% (0.0–0.4) History + SPT 0.1% (0.0–0.4)	Point prevalence at 1 year: SR 0.4% (0.2–0.9) History + SPT 0.1% (0.0–0.4) History + sIgE 0.1% (0.0–0.5) History + SPT or sIgE 0.1% (0.0–0.5) DBPCFC 0.2% (0.1–0.7)	SR point prevalence at 1 year: 0.1% (0.0–0.4)	Type of shell fish studied was shrimp.
Kurulaaratchy et al. 2005, Arshad et al. 2001, Tariq et al. 2000, United Kingdom[62–64]	SPT point prevalence at 4 years 1.1% (0.6–2.0)		Estimates given in a figure in the paper.		
Kvenshagen et al. 2009, Norway[65]	Point prevalence by Clinician history or OFC at 2 years: 1.0% (0.4–2.3)	Estimates not given in the paper.			
Le et, al. 2015, The Netherlands[66]	SR point prevalence at age 20–54 years: 0.7% (0.46–1.0) DBPCFC point prevalence 0.0% (0–0.1)	SR point prevalence at 20–54 years: Hazelnut: 0.6% (0.4–0.9) Walnut: 0.6% (0.4–0.9) DBPCFC point prevalence Hazelnut: 0.2 (0.1–0.4)	SR point prevalence at age 20–54 years: 1.6% (1.2–2.0)	SR point prevalence age 20–54 years: shrimp 0.9% (0.7–1.3)	Data are also reported for SR and IgE FA to apple, peach, kiwi, melon, banana, tomato, carrot and cow milk, hen

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Lozoya-Ibáñez et al. 2020, Portugal[67]	Peanut food reaction investigated by sensitization tests and OFC in adolescents (10–23 years)	Tree nuts food reaction investigated by sensitization tests and OFC in adolescents (10–23 years)	Seafood reaction investigated by sensitization tests and OFC in adolescents (10–23 years)	Seafood reaction investigated by sensitization tests and OFC in adolescents (10–23 years)	183 out of 1702 subjects completing a questionnaire reported ad adverse food reaction (phase 1). In 81 subjects, the adverse food reaction was confirmed by an allergist by phone (phase 2). These subjects were further investigated by performing IgE sensitization tests (sIgE and/or SPT) and oral food challenge (phase 3). Data on specific FA/sensitization are only shared for subject who participated to phase 3, but no sufficient data are available for narrative report of the prevalence estimates on each specific food.
Lyons et al. 2020, The Switzerland, Spain, Iceland, Lithuania, Bulgaria, Poland, Netherlands, Greece[68]	SR point prevalence FA in European children aged 7–10 years: 1.9% (1.7–2.1) sIgE point prevalence: Switzerland: 10.1% (8.8–11.3), Spain: 7.8% (6.4–9.3), Greece: 4.1% (3.2–5.0), The Netherlands: 6.2% (5.2–7.2), Lithuania: 2.6% (2.1–3.2), Poland: 4.8% (3.9–5.8), Iceland: 2.3% (1.7–2.9) Symptoms + sIgE positivity point prevalence: Switzerland: 0.4% (0.0–1.6), Spain: 0.9% (0.1–2.46), Greece: 0.3% (0.1–1.9), The Netherlands: 0.6% (0.1–1.7), Lithuania: 0.0% (0.0–0.9), Poland: 0.8% (0.16–1.9), Iceland: 0.5% (0.1–1.5) OFC point prevalence at age 7–10 years: 0.0% (0–0.0)	SR point prevalence FA in European children aged 7–10 years: not reported sIgE point prevalence: Hazelnut: Switzerland: 14.3% (12.9–15.8), Spain: 8.6% (7.1–10.1), Greece: 3.6% (2.8–4.5), The Netherlands: 9.5% (8.3–10.8), Lithuania: 6.8% (5.9–7.7), Poland: 7.6% (6.4–8.7), Iceland: 1.9% (1.3–2.4) *Walnut* sIgE point prevalence: Switzerland: 9.5% (8.3–10.7), Spain: 7.4% (6.0–8.9), Greece: 5.3% (4.3–6.4), The Netherlands: 3.5% (2.8–4.3), Lithuania: 2.3% (1.7–2.8), Poland: 3.6% (2.8–4.4), Iceland: 1.4% (0.9–1.8) Symptoms + sIgE positivity point prevalence: *Hazelnut*: Switzerland: 0.8% (0.1–2.3), Spain: 0.5% (0.0–1.8), Greece: 0.3% (0.1–1.9), The Netherlands: 0.7% (0.1–1.9), Lithuania: 2.1% (0.4–5.3), Poland: 0.8% (0.16–1.9), Iceland: 0.1% (0.0–0.6) *Walnut*: Switzerland: 0.3% (0.0–1.3), Spain: 0.5% (0.0–1.8), Greece: 0.6% (0.0–2.5), The Netherlands: 0.5% (0.1–1.5), Lithuania: 0.0% (0.0–0.9), Poland: 0.5% (0.0–1.4), Iceland: 0.0% (0.0–0.3)	SR point prevalence FA in European children aged 7–10 years: 3.6% (3.3–3.9) sIgE point prevalence: Switzerland: 0.5% (0.2–0.8), Spain: 0.9% (0.4–1.4), Greece: 0.2% (0.0–0.5), The Netherlands: 0.5% (0.2–0.8), Lithuania: 0.8% (0.4–1.1), Poland: 0.0% (0.0–0.3), Iceland: 0.4% (0.2–0.7) Symptoms + sIgE positivity point prevalence: Switzerland: 0.1% (0.0–0.7), Spain: 0.5% (0.0–1.8), Greece: 0.3% (0.1–1.9), The Netherlands: 0.1% (0.0–1.0), Lithuania: 0.0% (0.0–0.9), Poland: 0.0% (0.0–0.4), Iceland: 0.1% (0.0–0.8)	SR point prevalence FA in European children aged 7–10 years: not reported sIgE point prevalence: Shrimps: Switzerland: 3.7% (3.0–4.5), Spain: 2.7% (1.8–3.5), Greece: 1.0% (0.5–1.4), The Netherlands: 3.3% (2.6–4.1), Lithuania: 0.4% (0.1–0.6), Poland: 2.3% (1.7–3.0), Iceland: 0.9% (0.5–1.3) Symptoms + sIgE positivity point prevalence: *Shrimps* Switzerland: 0.0% (0.0–0.4), Spain: 0.7% (0.1–2.16), Greece: 0.0% (0.0–0.9), The Netherlands: 0.1% (0.0–1.0), Lithuania: 0.0% (0.0–0.9), Poland: 0.0% (0.0–0.4), Iceland: 0.3% (0.0–1.1) OFC point prevalence shrimp at age 7–10 years: 0.0% (0–0.0)	The authors also investigated milk, egg, wheat, soy, kiwi, peach, carrot, shrimps, celery, tomato, sunflower seed, banana, corn sesame seed, fish, mustard seed, honey. Data on population prevalence estimation were obtained by the authors using a weighting procedure fully explained in the paper online repository. Data on DBPCFC were not reported in meta-analysis as the authors claim that the number of subjects who agreed to be tested was too low to infer a valid population prevalence estimate on confirmed FA by DBPCFC
Majkowska-Wojciechowska et al. 2009, Poland[69]		SR lifetime prevalence 1.6% (1.2–2.3)			The type of tree nuts studied was not specified in the paper
Marklund et al. 2004, Sweden[70]	SR point prevalence at 13–21 years: 6.0% (4.9–7.3)	SR point prevalence at 13–21 years: Nuts 7.3% (6.1–8.8) Almond 4.1% (3.2–5.3)	SR point prevalence at 13–21 years: 1.0% (0.6–1.6)	SR point prevalence at 13–21 years: 1.7% (1.1–2.4)	These are indirect-recalculated estimates as the authors provided only the percentage estimates.

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Matsyura et al. 2017, Ukraine[72]	Point prevalence at mean age 1.2 years: 0.9% (0.51–1.6)				Data extracted form a conference abstract. Data on prevalence were obtained under the assumption that the subjects tested for sIgE positivity corresponded to the number of subjects reporting SR FA.
Mortz et al. 2013, Denmark[73]	Only data on concomitant sesame plus peanut allergy were available	Only data on concomitant sesame plus hazelnut allergy were available			The main focus of the study was sesame allergy. Contextually, the authors provide data on concomitant FA to sesame and hazelnut, and to sesame and peanut combined together.
Mustafayev et al., 2013, Turkey[75]	SPT positivity point prevalence at 10–11 years: 0.7% (0.5–0.9) SR point prevalence at 10–11 years: 1.4% (1.1–1.7); OFC point prevalence at 10–11 years: 0.0% (0–0.1)	Hazelnut: SPT positivity point prevalence at 10–11 years: 0.4% (0.3–0.6) SR point prevalence at 10–11 years: 1.5% (1.2–1.8); OFC point prevalence at 10–11 years: 0.0% (0–0.1) Walnut: SPT (reported by parents) lifetime prevalence up to 10–11 years: 4.5% (4.0–5.0) SR point prevalence at 10–11 years: 1.2% (1.0–1.5); OFC point prevalence at 10–11 years: 0.0% (0.0–0.16) Pistachio: SR point prevalence at 10–11 years: 0.8% (0.6–1.0)	SR point prevalence at 10–11 years: 2.3% (2.0–2.7)		Data are also reported for SR and OFC-confirmed FA to pistachio, walnut, peanut, hazelnut, fish. The author also reported data about OFC positivity to beef, peach, spinach, cheese, kiwi allergy
Nicolaou et al. 2010, United Kingdom[76]	SR lifetime prevalence at 8 years: 1.7% (1.0–2.6) Point prevalence at 8 years: sIgE 9.3% (7.2–11.9); SPT 5.1% (3.9–6.7); SPT or sIgE 11.8% (9.9–14.0); History + sIgE 8.6% (6.6–11.2); History + SPT 0.9% (0.4–2.0); History + SPT + sIgE 3.4% (2.2–5.2); History or DBPCFC 2.0% (1.3–3.2); DBPCFC 0.8% (0.4–1.5)	SR lifetime prevalence at 8 years: 1.0% (0.5–1.8)	SR lifetime prevalence at 8 years: 0.5% (0.2–1.1)		
Niggemann et al. 2011, Germany[77]	sIgE point prevalence in children <18 years: 10.9% (10.4–11.4)				These are indirect-recalculated estimates as the authors provided only the percentage estimates.
Orhan et al. 2009, Turkey[78]	SR lifetime prevalence at 6–9 years: 0.1% (0.0–0.3) Point prevalence at 6–9 years: History and SPT 0.1% (0.0–0.3) DBPCFC at 6–9 years: 0%	SR lifetime prevalence at 6–9 years: Hazelnut 0.3% (0.1–0.6) Walnut 0.1% (0.0–0.3) History and SPT point prevalence at 6–9 years: Hazelnut 0.1% (0.0–0.3) Walnut 0.1% (0.0–0.3) DBPCFC point prevalence at 6–9 years: Hazelnut 0% Walnut 0%	SR lifetime prevalence at 6–9 years: 0.3% (0.2–0.6) Point prevalence at 6–9 years: History and SPT 0.2% (0.1–0.4) DBPCFC at 6–9 years: 0.0% (0.0–0.2)		

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Östblom et al. 2008a, 2008b, 2008c and Almqvist et al. 2005, Sweden[79–82]	Estimates at 4 years: SR point prevalence 2.8% (2.3–3.3) sIgE point prevalence 5.4% (4.5–6.3)	Estimates at 4 years: SR point prevalence 2.7% (2.2–3.2)	Estimates at 4 years: SR point prevalence 1.1% (0.8–1.5) sIgE point prevalence 0.7% (0.5–1.2)		Estimates also available at 8 years but these were only presented in figures. Tree nut studied was almond. Estimates also available at 8 years but these were only presented in figures.
Osterballe et al. 2009, Denmark[83]	SR point prevalence at mean age 22 years: 5.3% (4.0–7.1) DBPCFC point prevalence at mean age 22 years: 0.6% (0.3–1.4)	SR point prevalence at mean age 22 years: Almond 0.2% (0.1–0.9) Brazil nut 2.7% (1.8–4.1) Hazelnut 6.6% (5.2–8.5) Walnut 0.5% (0.2–1.2)	SR point prevalence at mean age 22 years: 0.2% (0.1–0.9) DBPCFC point prevalence at mean age 22 years: 0.1% (0.0–0.7)	SR point prevalence at mean age 22 years: Octopus 0.4% (0.1–1.0) Shrimp 2.0% (1.3–3.2) OFC point prevalence at mean age 22 years: Octopus 0.1% (0.0–0.7) Shrimp 0.2% (0.1–0.9)	Type of wish studied was codfish.
Osterballe et al. 2005, Denmark[84]	History or SPT point prevalence: At <3 years 0%; at 3 years 1.6% (0.8–3.2); at >3 years 1.0% (0.3–2.9); All children 1.2% (0.7–2.2); Adults 1.2% (0.7–2.1) DBPCFC point prevalence: At <3 years 0%; at 3 years 0.2% (0.0–1.2); at >3 years 0%; All children 0.1% (0.0–0.6); Adults 0.4% (0.2–1.1)		History or SPT point prevalence: At <3 years 0%; at 3 years 0.8% (0.3–2.1); at >3 years 0.3% (0.1–1.9); All children 0.6% (0.2–1.3); Adults 0.6% (0.3–1.4) DBPCFC point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0%; All children 0%; Adults 0.2% (0.1–0.8)	History or SPT point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0.3% (0.1–19); All children 0.1% (0.0–0.6); Adults 1.1% (0.6–1.9) DBPCFC point prevalence: At <3 years 0%; at 3 years 0%; at >3 years 0%; All children 0%; Adults 0.3% (0.1–0.9)	Type of shellfish studied was shrimp. Type of wish studied was codfish.
Patelis et al. 2014, Sweden and Iceland[85]	SR lifetime prevalence (mean age 33.6 years): 5.8% (5.0–6.9)		SR lifetime prevalence (mean age 33.6 years): 4.2% (3.46–5.1)	See to the left	
Pawlińska-Chmara et al. 2015, Poland[86]		In children aged 7–10 years, 5.4% of the SR allergic symptoms occurred after nuts consumption			Data were also available for SR FA to any food, cow's milk, hen's egg's, strawberries, oranges, other milk derivates, nut, chocolate, other foods
Penard-Morand et al. 2005, France[87]	SR point prevalence at 9–11 years: 0.3% (0.2–0.5) SPT point prevalence at 9–11 years: 1.0% (0.8–1.3)	SR point prevalence at 9–11 years: 0.1% (0.1–0.3)	SR point prevalence at 9–11 years: 0.1% (0.1–0.3) SPT point prevalence at 9–11 years: 0.7% (0.5–0.9)	SR point prevalence at 9–11 years: 0.5% (0.4–0.7)	
Pereira et al. 2005, United Kingdom[88]	SR point prevalence: 11 years 1.8% (1.1–3.0) 15 years 2.5% (1.6–3.9) Both 2.2% (1.5–3.0) SPT point prevalence: 11 years 3.7% (2.6–5.4) 15 years 2.6% (1.6–4.2) Both 3.2% (2.4–4.3)	SR point prevalence: 11 years 1.2% (0.6–2.2) 15 years 2.1% (1.3–3.4) Both 1.6% (1.1–2.4)	SR point prevalence: 11 years 0.9% (0.4–1.9) 15 years 1.8% (1.1–3.1) Both 1.4% (0.9–2.1) SPT point prevalence: 11 years 1.3% (0.7–2.4) 15 years 1.4% (0.7–2.6) Both 1.3% (0.8–2.1)	SR point prevalence: 11 years 0.3% (0.1–0.9) 15 years 0.7% (0.3–1.5) Both 0.5% (0.2–0.9) DBPCFC point prevalence: 15 years 0.1 (0.0–0.7)	The type of shellfish studied with DBPCFC was shrimp.

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Pyrhönen et al. 2011 and 2009, Finland[90,91]		Lifetime prevalence at 0–4 years: SR parent-perceived 1.5% (1.1–2.0) SR physician diagnosed 0.2% (0.1–0.4) SR parent-perceived or physician diagnosed 1.7% (1.3–2.2)	Lifetime prevalence at 0–4 years: SR parent-perceived 4.0% (3.4–4.7) SR physician diagnosed 0.6% (0.4–0.9) SR parent-perceived or physician diagnosed 4.6% (3.9–5.4)		
Raciborski et al. 2012, Poland[94]		In children aged 6–8 years, 18.2% of the SR allergic symptoms occurred after nuts consumption			Data were also reported for SR FA to any food, dairy product, cocoa and chocolate
Rance et al. 2005, France[93]	SR lifetime prevalence for all children (mean age 8.9 years) 0.7% (0.5–1.1)	SR lifetime prevalence for all children mean age 8.9 years) 0.7% (0.4–1.1)	SR lifetime prevalence for all children mean age 8.9 years) 0.7% (0.4–1.1)	SR lifetime prevalence for all children mean age 8.9 years) 1.4% (1.0–1.9)	Lifetime prevalence estimates also given for age groups 2–5, 6–10, and 11–14 years, but only the point prevalence were given, no CI and the number of endpoints
Rentzos 2019 et al. Sweden[95]	SR point prevalence at age 17–78 years: 3.5% (2.4–4.6) sIgE point prevalence: 4.9% (3.5–6.2) Symptoms + sIgE positivity point prevalence: 0.5% (0.1–0.9)	Point prevalence at age 17–78 years: Hazelnut: *SR*: 8.9% (7.1–10.6); *sIgE positivity*: 13.3% (11.2–15.4); *Symptoms + sIgE positivity*: Chestnut: *SR*: 0.5% (0.1–0.9) Almond: *SR* 3.7% (2.5–4.8); *sIgE positivity*: 3.0% (1.9–4.0); *Symptoms + sIgE positivity*: 0.8% (0.2–1.3) Brazil nuts: *SR* 4.2% (3.0–5.4); *sIgE positivity*: 0.9% (0.3–1.5); *Symptoms + sIgE positivity*: 0.4% (0.0–0.8)	SR point prevalence at age 17–78 years: 0.3% (0.0–0.6) sIgE point prevalence: 0.0% (0.0–0.0) Symptoms + sIgE positivity point prevalence: 0.0% (0.0–0.0)	SR point prevalence at age 17–78 years: 3.5% (2.4–4.6)	
Roberts et al. 2005 and Lack et al. 2003, United Kingdom[96,97]	Point prevalence at 0–7 years: SR 0.4% (0.3–0.5) SPT 1.4% (1.2–1.7) History + SPT, 0.2% (0.2–0.3) DBPCFC, 0.2% (0.1–0.3)	SPT point prevalence a 0–7 years: Mixed tree nuts 1.0% (0.8–1.3) Almond 0.5% (0.2–0.9) Brazil nut 0.5% (0.3–0.9) Cashew nut 0.4% (0.2–0.8) Hazel nut 0.1% (0.0–0.4) Pecan nut 0.2% (0.1–0.4) Walnut 0.5% (0.3–0.9)	SPT point prevalence at 0–7 years: 0.0% (0.0–0.3)		Type of fish studied was codfish.
Rona et al. 2007, World-wide[98]	All ages groups: Pooled estimates for SR point prevalence: 0.7% (0.6–0.9) Range of estimates: SR 0% to 2%; sIgE <1% to 6%; SPT 1% to 6%; History + SPT or IgE 0.5% to 2.5%		All ages groups: Pooled estimates for SR: 0.6% (0.5–0.7) Range of estimates: SR 0% to 2%; sIgE ~0%; SPT ~0% to 2%; History + SPT or IgE ≤0.5%; OFC or DBPCFC ~0%	All ages groups: Pooled estimate for SR point prevalence: 1.1% (1.0–1.2) Range of estimates: SR 0% to 10%;SPT 2.5%; History + SPT or IgE 0% to 1.4%; OFC or DBPCFC ~0%	
Sandin et al. 2005, Sweden and Estonia[100]	Estimates for each specific not given in the paper	Estimates for each specific not given in the paper	Estimates for each specific not given in the paper		Specific foods studied in the paper but estimates for each food not given by the authors rather several foods were studied together
Schäfer et al. 2001, Germany[101]	SR lifetime prevalence in adults 1.3% SPT point prevalence in adults 6.8%	SR lifetime prevalence in adults 5.3% SPT point prevalence in adults (hazelnut) 11.3%	SR lifetime prevalence in adults 1.0% (fish and shellfish) SPT point prevalence in adults (mackerel) 1.8%	SR lifetime prevalence in adults 1.0% (fish and shellfish) SPT point prevalence in adults (crab) 1.9%	Estimates are weighted for the general population. The authors did not provide numbers used for weighting; hence, we were unable to recalculate the estimates.

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Schnabel et al. 2010, Germany[102]	SR point prevalence at 6 years: Doctor diagnosis 4.7% (3.6–6.1) New onset 3.1% (2.3–4.4) sIgE point prevalence: At 2 years 2.1% (1.4–3.2) At 6 years 5.2% (4.0–6.7)		sIgE point prevalence at 6 years 0.6% (0.3–1.3)		Type of fish studied for SPT was cod.
Skypala et al. 2013, United Kingdom[103]	SR lifetime prevalence in subjects aged 18–75 years: 3.5% (2.9–4.1)		SR lifetime prevalence in subjects aged 18–75 years: 4.0% (3.4–4.7)	See to the left	Estimates for SR lifetime prevalence for other foods are reported: fruits, vegetables, citrus fruit, non-citrus fruit, curry and spices, tomatoes, beans and lentils, seeds
Soost et al. 2009 and Zuberbier et al. 2004, Roehr et al. 2004, Germany[104-106]	History and SPT point prevalence 0–17 years 1.1% (0.5–2.1) Children and adults 2.4% (1.5–3.7)	SR lifetime prevalence 2.7% (1.8–4.1) History and SPT point prevalence: Hazelnut 0–17 years 2.0% (1.2–3.3) Children and adults 23.0% (20.2–26.0) Walnut 0–17 years 0.7% (0.3–1.6) Children and adults 7.1% (5.5–9.1) DBPCFC point prevalence of Hazelnut: 0–14 years 0.7% (0.3–1.7) 15–17 years 4.3% (2.0–9.0) All children 1.4% (0.7–2.5)	SR lifetime prevalence 0.5% (0.2–1.4) History and SPT point prevalence 0–17 years Mackerel 0.1% (0.0–0.8) Children and adults: Herring 0.5% (0.2–1.3) Mackerel 0.4% (0.1–1.1)	History and SPT point prevalence 0–17 years 0% (shrimp) Children and adults Crab 1.2% (0.7–2.3) Mussels 0.1% (0.0–0.7)	The type of tree nuts studied for lifetime prevalence not specified in the paper
Stefanki et al. 2018 Greece[107]	SR lifetime prevalence up to 4 years of age: 0.3% (0.1–0.9) SR-physician diagnosed lifetime prevalence up to 6 years of age: 0.8% (0.3–1.9)	SR lifetime prevalence up to 4 years of age: 0.3% (0.1–0.9)	SR lifetime prevalence up to 4 years of age: 1% (0.5–1.9) SR-physician diagnosed lifetime prevalence up to 6 years of age: 0.6% (0.2–1.6)		Data were extracted from a conference abstract. Data reported also for tomato, milk, egg.
Steinke et al. 2007, Europe[108]		SR point prevalence in subjects <18 years: Austria 7.1%; Belgium 9.3%; Denmark 13.6%; Finland 13.5%; Germany 19.0%; Greece 2.1%; Italy 9.1%; Poland 6.8%; Slovenia 9.3%; Switzerland 13.0%; All countries 9.7%	SR point prevalence in subjects <18 years: Austria 0%; Belgium 4.7%; Denmark 0%; Finland 19.8%, Germany 4.8%; Greece 8.3%; Italy 6.1%; Poland 1.1%; Slovenia 7.0%; Switzerland 17.4%; All countries 8.4%	SR point prevalence in subjects <18 years: Austria 0%; Belgium 2.3%; Denmark 4.5%; Finland 2.1%, Germany 4.8%; Greece 0%; Italy 3.0%; Poland 2.3%; Slovenia 4.7%; Switzerland 13.0%; All countries 3.0%	The numbers the authors used in making the calculation for the estimates were not given in the paper. Therefore, it was not possible to recalculate the estimates.
Sterner et al. 2019, Sweden[109]	sIgE tested in children ages 13–14 years	By component-resolved diagnostic in children ages 13–14 years	sIgE tested in children ages 13–14 years		The authors used a panel for sIgE testing which included egg, codfish, wheat, peanuts and soybean among the allergens tested, but the data on the positivity to each specific allergen were not reported

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Strinnholm et al. 2014; Winberg et al. 2015, Sweden[110,111]	SR point prevalence at age 7–8 years: 3.2% (2.6–4.0)	SR point prevalence at age 7–8 years: 3.6% (2.9–4.4) Almonds 2.0 (1.5–2.6)	SR point prevalence at age 7–8 years: 1.2% (0.9–1.7)		Estimates are also reported for SR FA to milk, egg, wheat, soy, fruits and kiwi, orange, apple, raw carrots, banana. DBPCFC to cow's milk, egg, wheat and codfish was offered to subjects with suspected FA. The result of the food challenge is reported for each patient in Table 3 of the paper from Winberg et al., although it was not possible to extract a valid data for DBPCFC positive FA to each specific food allergens.
Venkataraman et al. 2017, United Kingdom[113]	SR point prevalence At age 1 year 0.1% (0.0–0.4) At age 2 years 0.2% (0.0–0.6) At age 4 years 0.5% (0.2–1.1) At 10 years 0.4% (0.2–0.9) At 18 years 0.9 (0.5–1.6)	SR point prevalence At age 4 years 0.16 (0.0–0.6), At age 10 years 0.1 (0.0–0.5) At age 18 years 0.5 (0.3–1.1)	SR point prevalence At age 1 years 0.16% (0.0–0.6) At age 10 years 0.1% (0.0–0.5) At age 18 years 0.16 (0.0–0.6)	SR point prevalence At age 10 years 0.1 (0.0–0.5) At age 18 years: 0.2 (0.1–0.7)	Estimates given report FA according to restrictive criteria defined by authors Therefore, these estimates were not reported in meta-analysis. Estimates for SR point prevalence for other foods are reported: fruits, tomatoes, kiwi.
Venter et al. 2010, United Kingdom[114]	SPT point prevalence at 3–4 years: 2.0% (1.2–3.4) History or OFC 1.2% (0.7–2.2) OFC point prevalence at 3–4 years: 0.3% (0.1–1.0)		SPT point prevalence at 3–4 years: 0.5% (0.2–1.4)		Estimates based on the latest cohort in the study, i.e. Cohort C.
Venter al 2008; Dean et al. 2007; Venter et al. 2006, United Kingdom[115–117]	SPT point prevalence: At 1 year 0.4% (0.1–1.1) At 2 years 2.0% (1.1–3.4) At 3 years 2.0% (1.2–3.4) History or OFC point prevalence: At 3 years 1.2% (0.7–2.2) History or OFC cumulative prevalence at 3 years 1.1% (0.6–2.0) OFC point prevalence: At 3 years 0.3% (0.1–1.0)	History or OFC point prevalence: At 1 year Cashew nut 0.0% (0.0–0.4) Hazelnut 0.0% (0.0–0.4) At 2 years Cashew nut 0.0% (0.0–0.4) Hazelnut 0.0% (0.0–0.4) At 3 years Cashew nut 0.1% (0.0–0.6) Hazelnut 0.1% (0.0–0.6) History or OFC cumulative prevalence at 3 years Cashew nut 0.1% (0.0–0.6) Hazelnut 0.1% (0.0–0.6)	SPT point prevalence: At 1 year 0.3% (0.1–1.0) At 2 years 0.5% (0.2–1.3) At 3 years 0.5% (0.2–1.4) History or OFC point prevalence: At 1 year 0.1% (0.0–0.6) At 2 years 0.0% (0.0–0.4) At 3 years 0.0% (0.0–0.4) History or OFC cumulative prevalence at 3 years 0.1% (0.0–0.6) OFC point prevalence: At 3 years 0%		
Venter et al. 2006, United Kingdom[118]	SR point prevalence at 6 years: 1.9% (1.1–3.1) SPT point prevalence at 6 years: 2.6% (1.6–4.0) OFC point prevalence at 6 years: 0.3% (0.1–1.0)	SR point prevalence at 6 years: 1.4% (0.8–2.5)	SR point prevalence at 6 years: 0.3% (0.1–0.9) SPT point prevalence at 6 years: 1.0% (0.5–2.0) OFC point prevalence at 6 years: 0%		

(Continues)

TABLE 4 (Continued)

Reference, country	Estimates of the frequency of peanut allergy, Percentage (95% CI)	Estimates of the frequency of tree nut allergy, Percentage (95% CI)	Estimates of the frequency of fish allergy, Percentage (95% CI)	Estimates of the frequency of shellfish allergy, Percentage (95% CI)	Comment
Venter et al. 2016a and 2016b, United Kingdom[119,120]	SPT point prevalence: At age 1 years: 0.4% (0.1–1.1) At age 2 years: 2.0% (1.16–3.3) At age 3 years: 2.0% (1.2–3.4) At age 10 years: 2.4% (1.4–4.0) SPT lifetime prevalence for the past 10 years 3.2% (2.2–4.6); sIgE point prevalence at age 10 years: 11.8% (8.3–16.4) Clinical history or FC-confirmed allergy lifetime prevalence in children up to 10 years: 1.4% (0.8–2.4)		Data not shared		For this specific outcome, data were available from Venter et al. 2016a
von Hertzen et al. 2006, Finland and Russia[121]	SPT point prevalence in Finland Children (7–16 years): 8.2% (5.8–11.5) Mothers 10.1% (7.4–13.6)	SPT point prevalence in Finland Children (7–16 years): 6.3% (4.0–9.8) Mothers 11.3% (8.1–15.6)	SPT point prevalence in Finland Children (7–16 years): 0.3% (0.0–1.5) Mothers 2.8% (1.5–2.1)		Type of tree nut studied was hazelnut
Westerlaken van-Ginkel et al. The Netherlands[122]	SR point prevalence at mean age 47.5 years: 1.1% (1.1–1.2)	SR point prevalence at mean age 47.5 years: Almond 1.0% (0.9–1.1) Cashew 0.7% (0.6–0.8) Pistachio 0.5% (0.4–0.5) Walnut: 1.8 (1.7–1.9) Hazelnut: 2.1 (2.0–2.2)	SR point prevalence at mean age 47.5 years: 0.4% (0.4–0.5)	SR point prevalence at mean age 47.5 years: 1.16% (1.16–1.2)	The author also reported SR point prevalence, for kiwi, sesame, strawberry, cherry
Zuidmeer et al. 2008, World-wide[126]		SR pooled point prevalence for children 0.5% (0.2–0.8) Ranges for SR point prevalence: 0–6 years 0.0% to 0.2% 6–18 years 0.2% to 2.3% Adults 0.4% to 1.4% Range for SPT point prevalence for children 0.0% to 0.7%			

Note: The following records were extracted from conference abstracts (or posters), or from /Journals' letters: Diwaker et al., Jürisson et al., Karakoc et al., Kelleher et al., Stefanaki e al. and Clausen et al. data were extracted from a university thesis. Data recorded before September 2012 were reported as 'studies'; therefore, one row may combine data extracted from more than one paper. Data recorded from September 2012 have been reported using the principle one paper/abstract = one row. The following papers/abstracts reported about the same study population: Fedorova et al. 2014a, together with Fedorova et al. 2014b; Grabenhenrich et al. 2020, together with Erhard et al. 2021; Lyons et al. 2019, together with Burney et al. 2014, and Le et al. 2015; Strinnholm et al. 2014, together with Winberg et al. 2015.

Abbreviations: CI, confidence interval; DBPCFC, double-blind placebo-controlled food challenge; FA, food allergy; OFC, oral/open food challenge; sIgE, specific immunoglobulin E; SPT, skin prick test; SR, self-reported.

came from only one study (Figure S17). The point prevalence was highest in adults and those aged 6–17 years than in younger children (Figure S17). However, for point prevalence of sIgE positivity and lifetime prevalence of self-reported WA, only two estimates each were available for adults, while only one adult estimate was available for FC positive WA. No data on adults were available for lifetime prevalence of self-reported physician-diagnosed WA and for point prevalence of SPT positivity (Figures S19 and S20). No consistent pattern was seen across European regions (Figures S17–S23). Point prevalence of self-reported WA did not substantially change between 2000–2012 and 2012–2021 (1.5% to 1.3%), while lifetime prevalence decreased from 3.6% to 1.4% (Figure 2). Lifetime prevalence of self-reported physician-diagnosed WA and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT positivity decreased from 0.7% to 0.4%, but only one estimate out of five was available for 2000–2012. Point prevalence of sIgE sensitization increased from 3.9% to 7.4% (Figure 4). There was no study published for FC positivity and of FC positive or clinical history of WA during 2012–2012, hence comparison could not be made with estimates from studies published during 2000–2012 (Figure 6).

3.5 | Soy allergy

Soy allergy (SA) or sensitization was investigated in 36 studies. The overall lifetime and point prevalence of self-reported SA were 0.5% (95% CI 0.3–0.7) and 0.5% (95% CI 0.4–0.6), respectively (Figure 2). The overall point prevalence of self-reported physician-diagnosed SA was 0.3% (95% CI 0.1–0.5) (Figure 3). Point prevalence of sIgE positivity was 3.7% (95% CI 2.8–4.7), 0.2% (95% CI 0.01–0.7) for SPT positivity (Figure 4), 0.1% (95% CI0.03–0.1) for sIgE positivity plus symptoms (Figure 5) and 0.3% (95% CI 0.1–0.4) for FC positivity (Figure 6), while no data were available for FC positivity or clinical history.

The prevalence estimates for soy allergy or sensitization were generally higher in children than in adults (Figures S24, S25, S27, and S28) for all outcomes investigated, although for point prevalence of sIgE positivity and lifetime prevalence of self-reported SA, only two estimates each were available for adults (Figures S24 and S28). No data on adults were available for lifetime prevalence of self-reported physician-diagnosed SA (Figure S26). Moreover, for FC positivity or clinical history, data were only available from Western Europe. There was no consistent pattern across European regions (Figures S24–S28). Both point and lifetime prevalence of self-reported SA slightly decreased between 2000–2012 and 2012–2021 from 0.7% to 0.4% (Figure 2). Lifetime prevalence of self-reported physician-diagnosed SA, point prevalence of SPT sensitization and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figure 3-5). Point prevalence of sIgE positivity slightly increased from 3.2% to 3.9% (Figure 4). Point prevalence of FC positivity were only available in studies published during 2000–2012 (Figure 6). No studies were available for FC positivity or clinical history of SA (Figure 6).

3.6 | Peanut allergy

Peanut allergy (PA) or sensitization was investigated in 68 studies. The overall lifetime and point prevalence of self-reported PA were 1.5% (95% CI 1.0–2.1) and 2.1% (95% CI 1.7–2.5), respectively (Figure 2). The overall point prevalence of self-reported physician-diagnosed PA was 0.9% (95% CI 0.6–1.2) (Figure 3). Point prevalence of sIgE positivity was 5.6% (95% CI 3.4–7.8), 2.2% (95% CI 1.6–2.8)

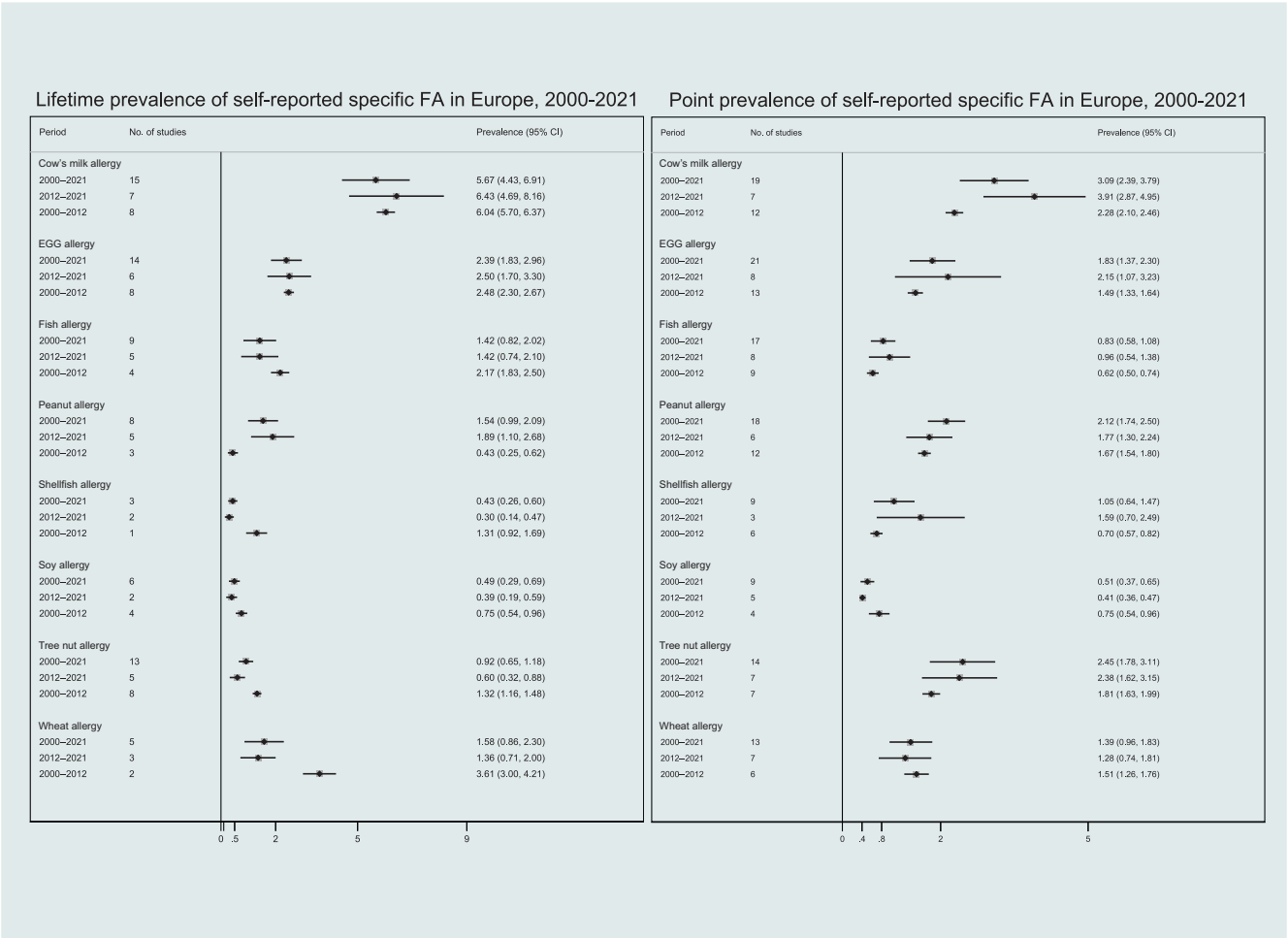

FIGURE 2 Pooled estimates for self-reported FA to the eight common foods in Europe for lifetime (left) and point prevalence (right) between 2000–2021, 2000–2012, and 2012–2021.

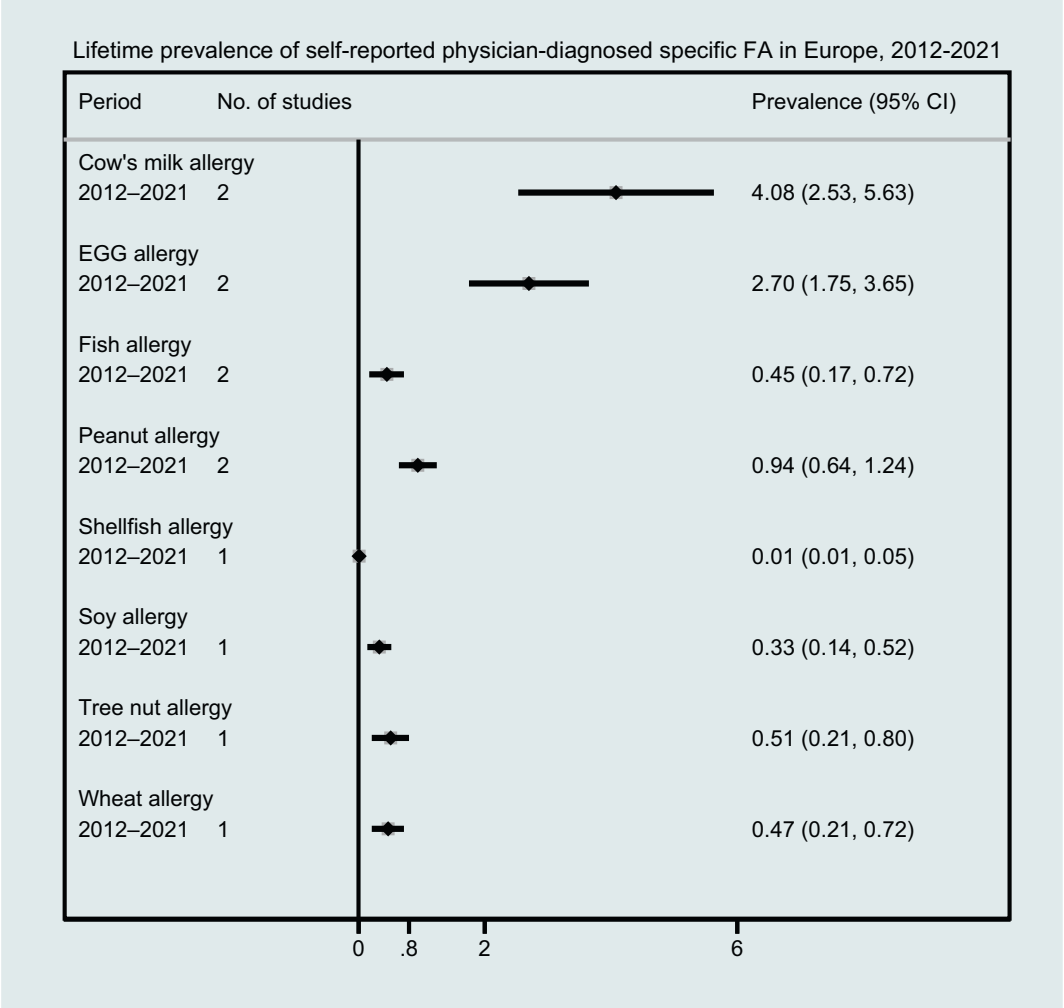

FIGURE 3 Pooled estimates for self-reported physician-diagnosed FA to the eight common foods in Europe for lifetime prevalence between 2012 and 2021.

for specific SPT positivity (Figure 4), 0.2% (95% CI 95% CI0.05–0.3) for sIgE positivity plus symptoms (Figure 5), 0.1% (95% CI 0–0.2) for FC positivity and 1.5% (95% CI 1.2–1.9) for FC positivity or clinical history (Figure 6).

In most cases, except for point prevalence of sIgE positivity plus symptoms, the estimates for peanut allergy or sensitization were higher in adults than in children (Figures S29, S30, and S33–S35). For point prevalence of sIgE positivity, only one estimate was available for adults (Figure S33), while no data on adults were available for point prevalence of SPT positivity, nor for lifetime prevalence of self-reported physician-diagnosed PA (Figures S31–S32). However, the prevalence of SPT positivity increased with increasing age, being lowest in the age group 0–1 year and highest in the age group 6–17 years (Figure S32) There was no consistent pattern across European regions (Figures S29–S35). Point prevalence of self-reported PA was unchanged between 2000–2012 (1.7%) and 2012–2021 (1.8%), while lifetime prevalence increased from 0.4% to 1.9% (Figure 2). Lifetime prevalence of self-reported physician-diagnosed PA and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT positivity did not substantially change between 2000–2012 (1.7%) and 2012–2021 (2.0%), while point prevalence of sIgE positivity decreased from 8.6% to 5.5% (Figure 4). Point prevalence of FC positivity decreased from 0.2% to 0.03%, although only a few studies were available for 2012–2021 (Figure 6). As for FC positivity or clinical history, only data published in 2000–2012 were available (Figure 6).

3.7 | Tree nut allergy

Tree nut allergy (TNA) or sensitization was investigated in 57 studies. The overall lifetime and point prevalence of self-reported TNA were 0.9% (95% CI 0.6–1.2) and 2.4% (95% CI 1.8–3.1), respectively (Figure 2). Lifetime prevalence of self-reported physician-diagnosed TNA was 0.5% (95% CI 0.2–0.8) (Figure 3). Point prevalence of sIgE positivity was 8.3% (95% CI 4.7–11.9), 4.9% (95% CI 2.9–7.0) for SPT positivity (Figure 4), 1.0% (95% CI 0.5–1.5) for sIgE plus symptoms (Figure 5), 0.04% (95% CI 0.02–0.1) for FC positivity and 0.05% (95% CI 0–0.2) for FC positivity or clinical history (Figure 6).

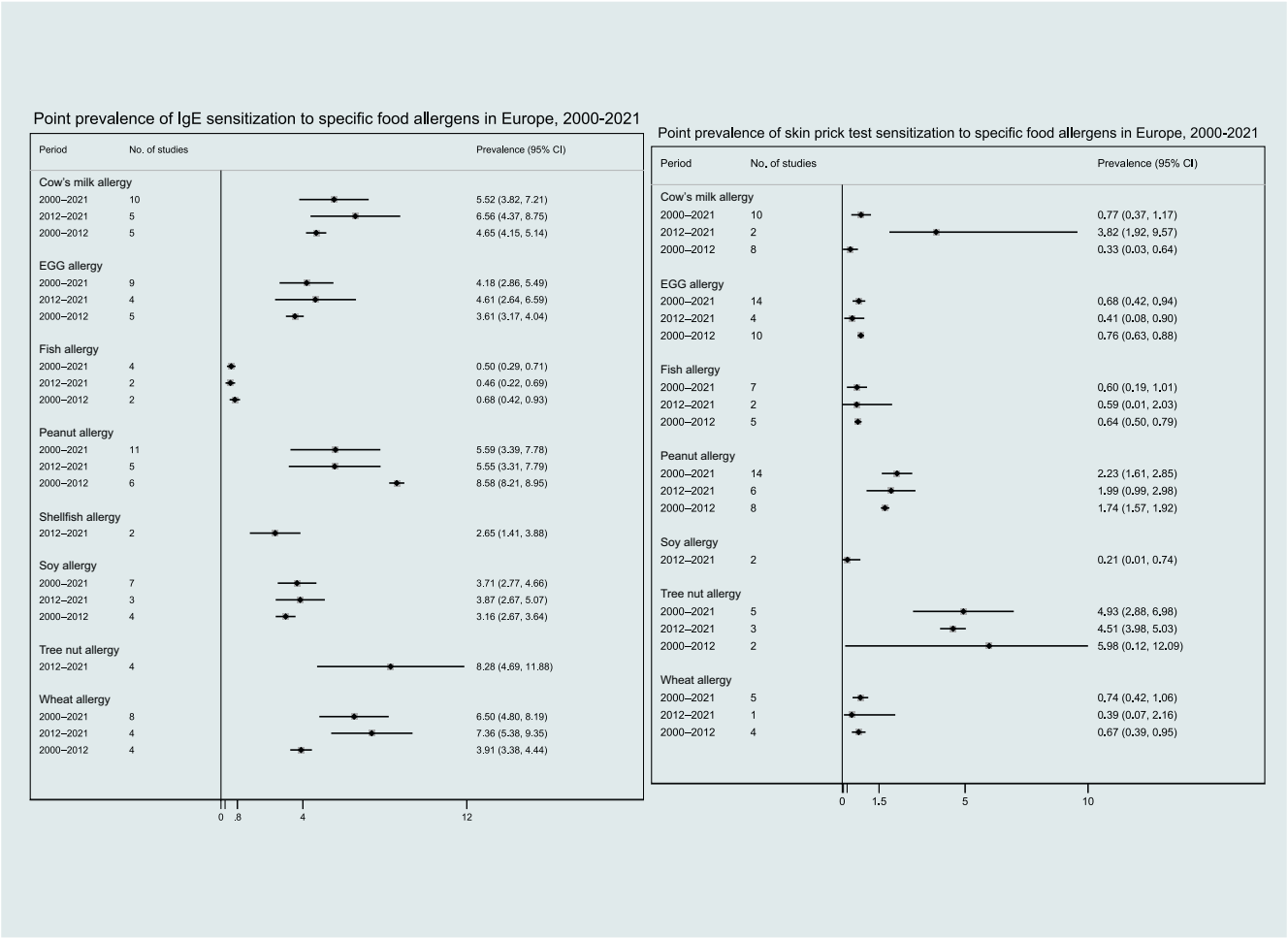

FIGURE 4 Pooled estimates for sIgE (left) or SPT (right) sensitization to the eight common foods in Europe between 2000–2021, 2000–2012 and 2012–2021.

The prevalence estimates of tree nut allergy or sensitization were generally higher in adults than in children (Figures S37 and S39–S42), except for lifetime prevalence of self-reported tree nut allergy, which was slightly higher in children than in adults (Figure S36). For point prevalence of sIgE positivity and FC positive TNA, only two estimates each were available for adults (Figures S40 and S42), while only one estimate out of six was from adults for SPT positive TNA (Figure S39) No data on the adults were available for lifetime prevalence of self-reported physician-diagnosed TNA (Figure S38). There was no consistent pattern across European regions (Figures S36–S42). Moreover, for SPT positivity, estimates were only available from Western and Southern European countries (Figure S39). Point prevalence of self-reported TNA slightly increased between 2000–2012 and 2012–2021 from 1.8% to 2.4%, while lifetime prevalence decreased from 1.3% to 0.6% (Figure 2). Lifetime prevalence of self-reported physician-diagnosed TNA, point prevalence of sIgE sensitization and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021, as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT positivity increased from 0.6% to 4.5% (Figure 4) Point prevalence of FC positivity decreased from 0.4% to 0.05%, while data on FC positivity or clinical history were only available for 2000–2012 (Figure 6).

3.8 | Fish allergy

Fish allergy (FHA) or sensitization was investigated in 60 studies. The overall lifetime and point prevalence of self-reported FHA were 1.4% (95% CI 0.8–2.0) and 0.8% (95% CI 0.6–1.1), respectively (Figure 2). Lifetime prevalence of self-reported physician-diagnosed FHA was 0.4% (95% CI 0.2–0.7) (Figure 3). Point prevalence of sIgE positivity was 0.5% (95% CI 0.3–0.7), 0.6% (95% CI 0.2–1.0) for SPT positivity (Figure 4), 0.03% (95% CI 0–0.1) for sIgE positivity plus symptoms (Figure 5), 0.02% (95% CI 0–0.1) for FC positivity and 0.05% (95% CI 0–0.2) for FC positivity or clinical history (Figure 6).

The prevalence estimates were slightly higher in children than in adults (Figures S43, S44, S48, and S49), except for lifetime prevalence of self-reported FHA (Figure S45). No data on adults were available for point prevalence of SPT or sIgE sensitization, nor for lifetime prevalence of self-reported physician-diagnosed FHA (Figures S45–S47). There was no consistent pattern across Europe (Figures S43–S49). Point prevalence of self-reported FHA only slightly changed between 2000–2012 and 2012–2021 (0.6% to 1.0%) while lifetime prevalence decreased from 2.2% to 1.4% (Figure 2). Lifetime prevalence of self-reported physician-diagnosed

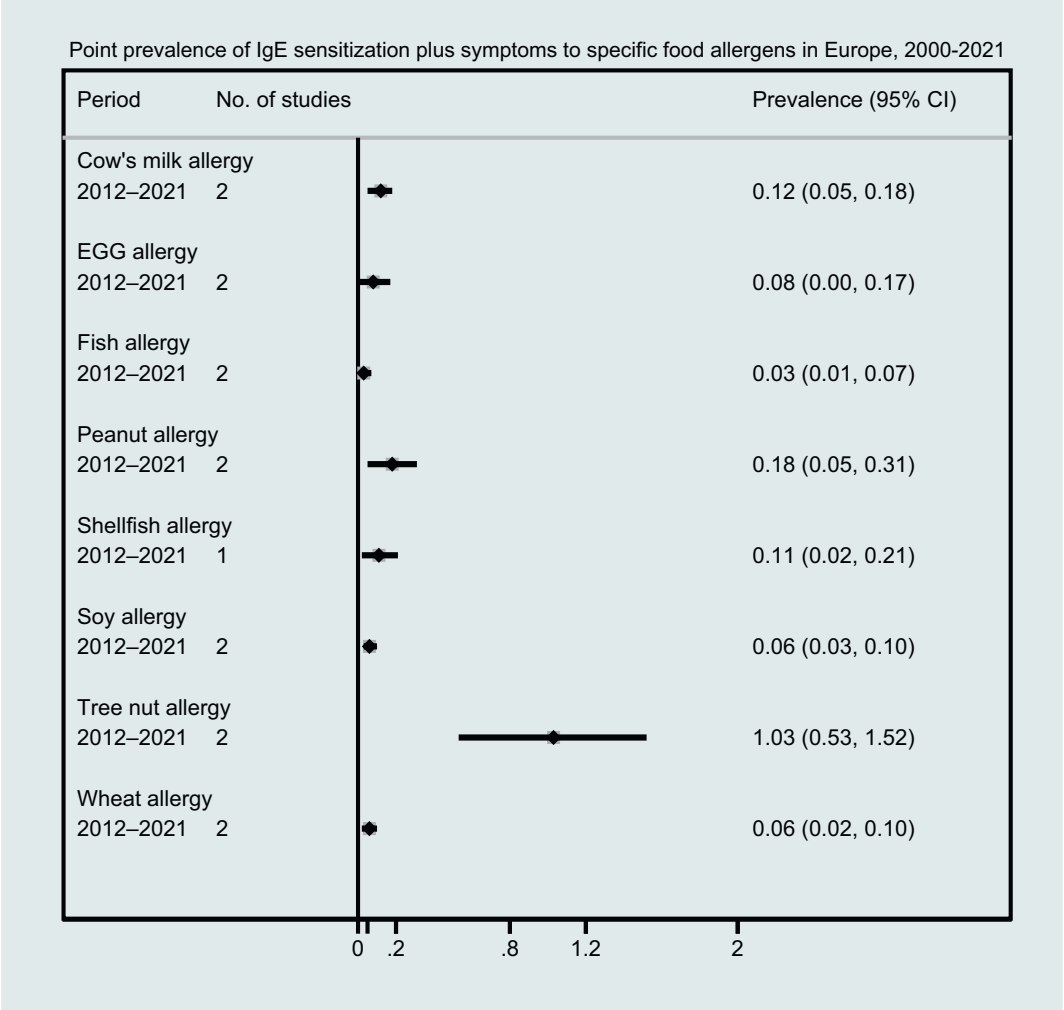

FIGURE 5 Pooled estimates for symptoms plus sIgE sensitization to the eight common foods in Europe between 2012 and 2021.

FHA and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012 and 2012–2021 as data were only available for 2012–2021 (Figures 3 and 5). Point prevalence of SPT (0.6%) and sIgE (0.7%) positivity did not change between 2000–2012 and 2012–2021, although for SPT positivity only one estimate out of seven was available for 2012–2021 (Figure 4). Point prevalence of FC positivity decreased from 0.2% to 0.03%, although only one estimate was available for 2012–2021 compared with seven estimates available for 2000–2012 (Figure 6). As for FC positivity or clinical history of FA, the only study available was published in 2000–2012 (Figure 6).

3.9 | Shellfish allergy

Shellfish allergy (SFA) or sensitization was investigated in 27 studies. The overall lifetime and point prevalence of self-reported SFA were 0.4% (95% CI 0.3–0.6) and 1.0% (95% CI 0.6–1.5), respectively (Figure 2). Lifetime prevalence of self-reported physician-diagnosed SFA was 0.01% (95% CI 0.01–0.05) (Figure 3). Point prevalence of sIgE positivity was 2.6% (95% CI 1.4–3.9) (Figure 4), 0.1% (95% CI 0–0.2) for sIgE positivity plus symptoms (Figure 5) and 0.1% (95% CI 0–0.2) for FC positivity (Figure 6). For SPT positivity, only one study was available, while no data were available for point prevalence of self-reported physician-diagnosed and FC positivity or clinical history.

The prevalence estimates of shellfish allergy or sensitization were higher in adults than in children (Figures S50, S51, and S53–S55), although for point prevalence of sIgE positivity and lifetime prevalence of self-reported SFA, only one study each was available for adults (Figures S50 and S53). Moreover, no data on adults were available for lifetime prevalence of self-reported physician-diagnosed SFA (Figure S52). For FC positivity, data were only available from Western European (Figure S55). There was no consistent pattern across European regions (Figures S50–S55). Point prevalence of self-reported SFA increased from 0.7% to 1.6% between 2000–2012 and 2012–2021, while lifetime prevalence decreased from 1.3% to 0.3% (Figure 2). However, for self-reported lifetime prevalence only two estimates out of nine were available for 2000–2012. Lifetime prevalence of self-reported physician-diagnosed SFA, point prevalence of sIgE sensitization and point prevalence of sIgE sensitization plus symptoms could not be compared between 2000–2012

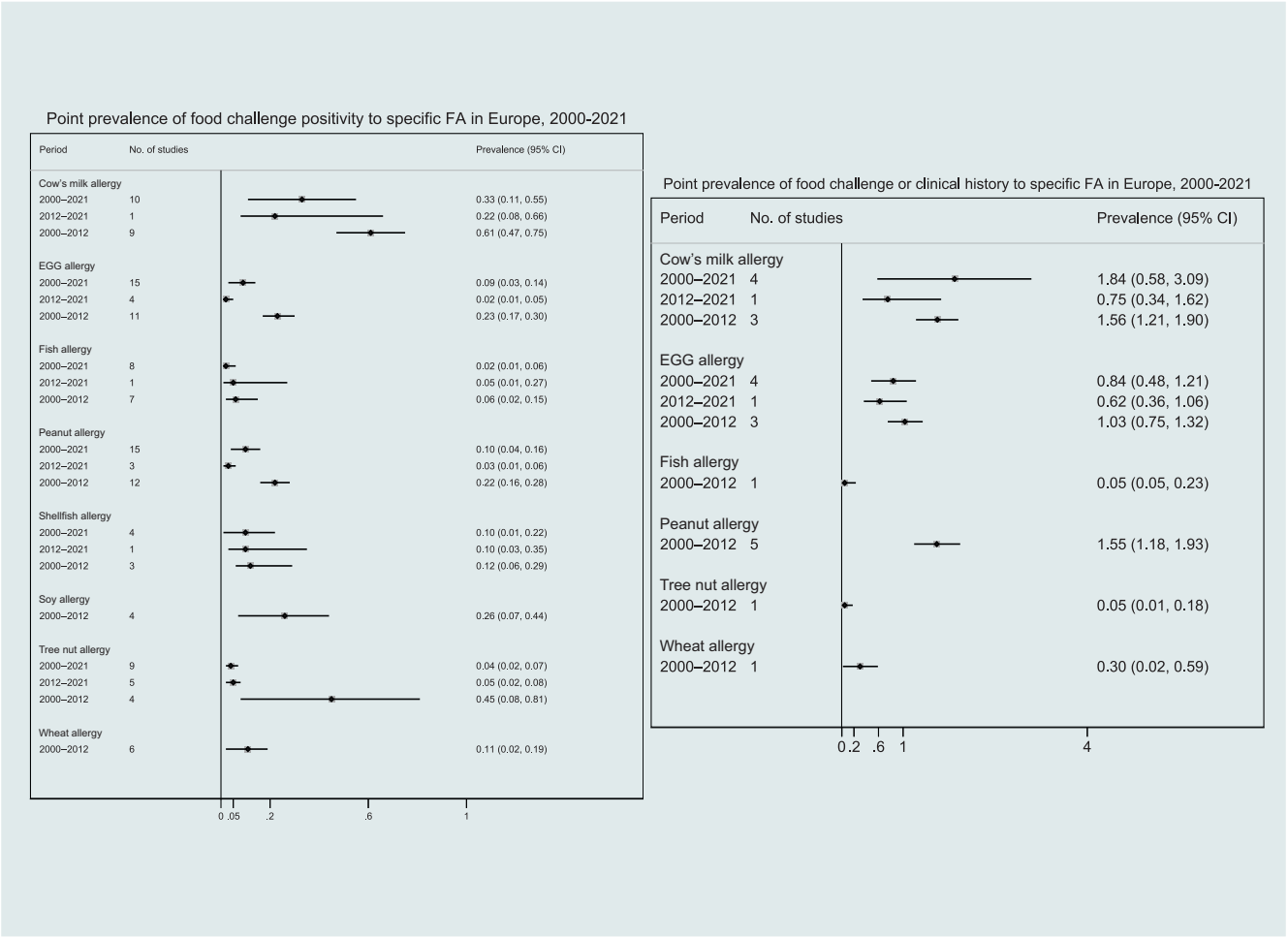

FIGURE 6 Pooled estimates for food-challenged verified FA to the eight common foods (left) and for clinical history or food challenge positive FA to the eight common foods (right) in Europe between 2000–2021, 2000–2012 and 2012–2021.

and 2012–2021 as data were only available for 2012–2021 (Figure 3-5). Point prevalence of FC positivity remained unchanged between 2000–2012 and 2012–2021 (both 0.1%), although only one estimate out of four was available for 2012–2021. No data were available for FC positivity or clinical history (Figure 6).

4 | DISCUSSION

4.1 | Statement of principal findings

This systematic review and meta-analysis presents the most updated and comprehensive estimates on the frequency of FA/FS to the eight big food allergens in Europe. Most studies were graded as at 'moderate' risk of bias. Most available studies were performed in children. The overall pooled lifetime prevalence of self-reported FA was highest for cow's milk (5.7%%, 95%CI 4.4–6.9) and lowest for soy (0.5%, 0.3–0.7) and shellfish allergy (0.4%, 0.3–0.6). Point prevalence of self-reported FA was also highest for cow's milk (3.1%, 2.4–3.8), and lowest for soy (0.5%, 0.4–0.6) and fish allergy (0.8%, 0.6–1.1). For lifetime and point prevalence SR FA, in the case of PA, TNA and FHA allergy, albeit illogical, the pooled estimate for lifetime prevalence was lower than point prevalence. However, the estimates for lifetime and point prevalence were not pooled from the same studies, which could explain the inconsistency. Point prevalence of sIgE (8.3%, 4.7–11.9) and SPT (4.9%, 2.9–7.0) positivity was highest for tree nuts and lowest for fish and soy allergy (0.5%. 0.3–0.7, and 0.6%, 0.2–1.0, for fish, and 3.7%, 2.8–4.7, and 0.2%, 0.0–0.7, for soy, respectively). Finally, the prevalence of FC (OFC or DBPCFC) confirmed FA was highest for cow's milk (0.3%, 0.1–0.5) and lowest for fish (0.02%, 0.0–0.1), while the prevalence of FC confirmed FA or clinical history of FA was highest for cow's milk (1.8%, 0.6–3.1) and lowest for fish and tree nut allergy (both 0.05%, 0.0–0.2). Cow's milk, egg, wheat, and soy allergy or sensitization were more common in children than in adults, while peanut, tree nuts, and shellfish allergy or sensitization were more common in adults than in children. The observed result is consistent with the fact that FA such as CMA, EA, WA and SA usually emerge earlier in life, and tend to resolve before adult life. On the contrary, FHA, SFA, PA and TNA usually emerge later and tend to remain through adulthood. Despite this information, the results obtained from age-stratification need to

be interpreted with caution as the estimates available for children were far more than the estimates from adults, which could potentially bias the results. As pointed out in the Results section, for some of the outcomes only one or two estimates were available from adults to perform age-stratified meta-analysis, which, in combination with the high heterogeneity across studies, limits the possibility to provide definitive conclusions on the differences between adults and children in respect to FA.

In these updated estimates, we observed no consistent patterns across European regions.

4.2 | Comparison between estimates from studies published during 2000–2012 vs. 2012–2021

Overall, there were no major changes in prevalence of FA to the eight common foods between 2000–2012 and 2012–2021, with some exception. One difference that all specific FA had in common is the fact that the prevalence of FC positivity and FC positivity or clinical history of FA decreased between 2000–2012 and 2012–2021, regardless of the definition of the outcomes. However, records on the prevalence of FC confirmed FA (the gold standard of FA diagnosis) were also fewer in 2012–2021 than in 2000–2012, as pointed out in the Result section.

For cow's milk, the biggest change was observed for SPT sensitization, which increased more than 10 times between 2000–2012 (0.3%) and 2012–2021 (3.8%). For wheat, the biggest changes were lifetime prevalence of self-reported FA, which decreased from 3.6% vs. 1.4%, and an increase in the prevalence of sIgE positivity to wheat (3.9% vs 7.4%). Perhaps, a possible explanation for the decrease in the frequency of lifetime prevalence of wheat allergy could be the recent gain of consciousness by the general population of the difference between a wheat allergy and a wheat intolerance (e.g. coeliac disease). It is also possible that improved diagnostic approaches to differentiate between a wheat allergy and a wheat intolerance (e.g. coeliac disease) could explain the observed differences.

For peanut, the biggest difference was the increase of lifetime prevalence self-reported FA from 0.4% to 1.9%. However, it is unclear whether this depended on an actual increase in food allergic subjects or rather on the fact that in 2000–2012 data on peanut allergy lifetime prevalence were only available for children, while in 2012–2021, both children and adults were represented, with the prevalence being higher in adults than in children (1.1% vs 3.3%). For tree nut, the biggest change was observed for point prevalence of SPT positivity, which increased in 2012–2021 (0.6% vs. 4.5%). Smaller differences were noted for all the other outcomes and food allergens.

The data on the potential difference between the prevalence of common FA in the last decade compared to 2000–2012 should be carefully interpretated. For some of the outcomes, the number of estimates available after dividing 2000–2012 from 2012–2021 was fewer than three estimate per period, which can result in a less accurate meta-analysis. In addition, the high heterogeneity already observed across studies published between 2000 and 2012 did not improve with newer studies. Indeed, we did not observed any improvements in terms of methodology, types of studies and sample sizes for the studies published between 2012 and 2021.

4.3 | Strengths and limitations of the current update

The current work followed a rigorous methodology, which included a comprehensive literature search in six major electronic databases, and a systematic approach to every stage of the review process. Compared to the 2014 review, two additional databases were included, and more keywords were employed in the database search to avoid missing any relevant studies. All methods of assessment or frequency occurrence measures were included; moreover, there was no restriction on language. Therefore, this review offers the most comprehensive and updated summary of the frequency of FA/FS to the eight big food allergens in Europe so far.

The quality of the work is, however, limited by the high heterogeneity between included studies, which has two possible explanations. First is that the observed heterogeneity is real, and as such indicates that the prevalence of common FA in Europe indeed varies greatly within and between European regions and age. Second, the observed heterogeneity could reflect methodological differences, for example regarding definition of FA, across Europe. In view of these two possible explanations, the pooled results of the meta-analysis presented in this review should be interpreted with caution. In future studies, active steps need to be taken to harmonize methodological aspects of studies, including in particular FA definitions, in order to minimize the high heterogeneity between studies. Moreover, most of the studies included did not distinguish between IgE and non-IgE FA, preventing the possibility to present the different FA outcomes by IgE-mediated or non-IgE-mediated phenotypes.

4.4 | Implications of the current update

The fact that most included studies were rated as moderate risk of bias suggests that the methodological quality of studies still needs to be improved and possibly standardized in future studies. Such consideration is even more meaningful considering that the current review also highlighted how FC was less employed during 2012–2021 when compared to 2000–2012, even though this was a key suggestion outlined in the 2014 EAACI review.

The different distribution of FA/FS to the eight big foods by age groups was confirmed in this updated review, while the regional differences which were observed in 2014 did not persist when additional data from 2012–2021 studies, which included more reported estimates from Southern and Eastern regions, were added to the analysis. Such observations indicate the importance of periodically

updating the frequency estimates of FA/FS with newer data, to minimize the selection of possible biases.

5 | CONCLUSIONS

With some exceptions, the prevalence of FA/FS to cow's milk, egg, wheat, soy, peanut, tree nuts, fish and shellfish has not substantially changed over the last decade. Even when changes (decrease or increase of FA/FS to the eight big foods) were noted, they did not seem to be consistent across all methods of assessments and definitions of each of these FA. This observation is in contrast with the recent published prevalence of 'any FA', which increased during the last decade.[3] This apparent discrepancy may be explained by the fact that, in recent years, more foods (beyond the eight specific foods included in the current review) have been studied as potential allergens in both children and adults. Attention needs to be given to these 'new' or 'emerging' FA, such as kiwi, peach, tomato, sesame, apple, banana, strawberry, chocolate, carrot, celery, lentils and beef, in order to appreciate their role in the overall burden of FA/FS in Europe.

AUTHOR CONTRIBUTIONS

BN and GR defined the research question and the search strategies with assistance from DL. DL with the assistance from BN developed the data extraction form. Screening, data extraction and narrative synthesis was done by GS, MA, SN, YA and BN. Manuscript writing was done by BN and GS. AM, AS, BVB, CV, EK, GR, MW and RvR were consulted concerning methodology and synthesis of the findings. All authors (AI, AM, AS, BN, BVB, CV, DL, EK, GR, GS, MA, MW, RvR, SN and YA) critically commented on drafts of the manuscript.

ACKNOWLEDGMENTS

BN acknowledges the support of Knut and Alice Wallenberg Foundation, the Wallenberg Centre for Molecular and Translational Medicine, University of Gothenburg, Sweden and the VBG Group Herman Krefting Foundation on Asthma and Allergy.

FUNDING INFORMATION

The study was funded through an unrestricted grant from DBV Technologies SA. The funders had no influence on the design of the study, interpretation of findings or the decision to publish.

CONFLICT OF INTEREST STATEMENT

Carina Venter reports: grants (Reckitt Benckiser, Food Allergy Research and Education, and National Peanut Board) and personal fees (Reckitt Benckiser, Nestle Nutrition Institute, Danone, Abbott Nutrition, Else Nutrition, Sifter and Before Brands). Ronald van Ree reports: consultancies (HAL Allergy BV, Citeq BV, Angany Inc., Reacta Healthcare Ltd., Mission MightyMe and AB Enzymes), speaker's fees (HAL Allergy BV, ThermoFisher Scientific and ALK) and stock options (Angany Inc.). Margitta Worm reports: grants and personal fees (Stallergens, HAL Allergie, Bencard Allergie, Allergopharma, ALK-Abello, Mylan Germany, Actelion Pharmaceuticals Deutschland, Biotest, AbbVie Deutschland, Lilly Deutschland Aimmune, DBV Technologies SA, Regeneron Pharmaceuticals, Sanofi Aventis, Leo Pharma, Novartis and Viatris) outside of the submitted work and being past WAO co-chair of the anaphylaxis committee and past chair of the food allergy interest group of EAACI. Berber Vlieg-Boerstra reports: personal fees (Marfo Food Group, Nestlé and Nutricia) and grants (Nutricia). Antonella Muraro reports: grants and speaker's fees (Aimmune), speaker's fees (DVB Technologies SA, Viatris [Mylan], ALK and Nestlé), and being member of the Executive Committee of GA2LEN and past president of EAACI. Graham Roberts reports grants (Asthma UK and National Institutes of Health Research). Bright Nwaru reports unrestricted grants and personal fees from DBV Technologies and AstraZeneca, respectively. Giulia C.I. Spolidoro, Yohannes Tesfaye Amera, Mohamed Mustafa Ali, Sungkutu Nyassi, Daniil Lisik, Athina Ioannidou report fee from ACT Institutet Sweden. The other authors report no conflicting interests related to this work. The funder played no role in the content and decision to submit this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Giulia C. I. Spolidoro https://orcid.org/0000-0002-3365-1171
Carina Venter https://orcid.org/0000-0002-7473-5355
Margitta Worm https://orcid.org/0000-0002-3449-1245
Berber Vlieg-Boerstra https://orcid.org/0000-0001-7962-5406
Graham Roberts https://orcid.org/0000-0003-2252-1248
Bright I. Nwaru https://orcid.org/0000-0002-2876-6089

REFERENCES

1. Nwaru BI, Hickstein L, Panesar SS, et al. The epidemiology of food allergy in Europe: a systematic review and meta-analysis. *Allergy*. 2014;69(1):62-75.
2. Nwaru BI, Hickstein L, Panesar SS, Roberts G, Muraro A, Sheikh A. Prevalence of common food allergies in Europe: a systematic review and meta-analysis. *Allergy*. 2014;69(8):992-1007.
3. Spolidoro GCI, Amera YT, Ali MM, et al. Frequency of food allergy in Europe: an updated systematic review and meta-analysis. *Allergy*. 2023;78(2):351-368.
4. Newcombe R. Two-sided confidence intervals for the single proportion: comparison of seven methods. *Stat Med*. 1998;17:857-872.
5. Baricic TV, Catipovic M, Cetinic EL, Krmek V, Horvat I. Parental perception, prevalence and primary care PHYSICIANS' knowledge on childhood food allergy in Croatia. *Children*. 2015;2(3):305-316.
6. Barlik F, Guner SN, Barlik M, Sugut A, Sancak R. Prevalence of food allergy in nursery and kindergarten children in Samsun. *Türk Pediatri Arşivi*. 2013;48(4):288-293.
7. Bröms K, Norbäck D, Eriksson M, Sundelin C, Svärdsudd K. Prevalence and co-occurrence of parentally reported possible asthma and allergic manifestations in pre-school children. *BMC Public Health*. 2013;13:764.
8. Burney P, Summers C, Chinn S, Hooper R, van Ree R, Lidholm J. Prevalence and distribution of sensitization to foods in the

European Community respiratory health survey: a EuroPrevall analysis. *Allergy*. 2010;65(9):1182-1188.
9. Woods RK, Abramson M, Bailey M, Walters EH. International prevalences of reported food allergies and intolerances. Comparisons arising from the European Community Respiratory Health Survey (ECRHS) 1991–1994. *Eur J Clin Nutr*. 2001;55(4):298-304.
10. Burney PG, Potts J, Kummeling I, et al. The prevalence and distribution of food sensitization in European adults. *Allergy*. 2014;69(3):365-371.
11. Lyons SA, Burney PGJ, Ballmer-Weber BK, et al. Food allergy in adults: substantial variation in prevalence and causative foods across Europe. *J Allergy Clin Immunol Pract*. 2019;7(6):1920-1928.e11.
12. Butiene I, Dubakiene R, Rudzeviciene O. Prevalence of sensitization to cow's milk in EuroPrevall Lithuanian birth cohort. *Clin Transl Allergy*. 2013;3(S3):O21.
13. Caffarelli C, Coscia A, Ridolo E, Povesi Dascola C, et al. Parents' estimate of food allergy prevalence and management in Italian school-aged children. *Pediatr Int*. 2011;53(4):505-510.
14. Chafen JJ, Newberry SJ, Riedl MA, et al. Diagnosing and managing common food allergies: a systematic review. *JAMA*. 2010;303(18):1848-1856.
15. Clausen I, Goksör E, Alm B, Wennergren G. *Food allergy at 12 years of age in western Sweden—risk factors and protective factors*. University of Iceland; 2017.
16. Goksör E, Lougheide-Camejo N, Göran Wennergren B. Cow's milk allergy from infancy to school age. *Clin Transl Allergy*. 2018;8(S2):O4.
17. de Jong NW, Elbert NJ, Mensink-Bout SM, et al. Parental and child factors associated with inhalant and food allergy in a population-based prospective cohort study: the generation R study. *Eur J Pediatr*. 2019;178(10):1507-1517.
18. Depner M, Ege MJ, Genuneit J, et al. Atopic sensitization in the first year of life. *J Allergy Clin Immunol*. 2013;131(3):781-788.
19. Dereci S, Koca T, Akcam M. The incidence and clinical characteristics of IgE-mediated hazelnut allergy in children living in the eastern Black Sea region of Turkey. *Pediatr Allergy Immunol Pulmonol*. 2016;29(1):24-28.
20. Diwakar L, Ryan R, Cummins C, Roberts T. Increasing prevalence of GP diagnosed childhood allergies in the United Kingdom: an analysis of the health information network (THIN) database. *Clin Exp Allergy*. 2017;47(12):1678-1721.
21. Dogruel D, Bingol G, Altintas DU, Yilmaz M, Guneser KS. Clinical features of food allergy during the 1st year of life: the ADAPAR birth cohort study. *Int Arch Allergy Immunol*. 2016;169(3):171-180.
22. Du Toit G, Katz Y, Sasieni P, Sasieni P, Mesher D, et al. Early consumption of peanuts in infancy is associated with a low prevalence of peanut allergy. *J Allergy Clin Immunol*. 2008;122(5):984-991.
23. Dubakiene R, Rudzeviciene O, Butiene I, Sezaite I, et al. Studies on early allergic sensitization in the Lithuanian birth cohort. *ScientificWorldJournal*. 2012;2012:909524.
24. Eckers N, Grabenhenrich L, McBride D, et al. Frequency and development of hen's egg allergy in early childhood in Germany: the EuroPrevall birth cohort. *Allergologie*. 2015;38(10):507-515.
25. Eggesbø M, Botten G, Halvorsen R, Magnus P. The prevalence of CMA/CMPI in young children: the validity of parentally perceived reactions in a population-based study. *Allergy*. 2001;56(5):393-402.
26. Eggesbø M, Botten G, Halvorsen R, Magnus P. The prevalence of allergy to egg: a population-based study in young children. *Allergy*. 2001;56(5):403-411.
27. Eggesbø M, Botten G, Stigum H, Nafstad P, Magnus P. Is delivery by cesarean section a risk factor for food allergy? *J Allergy Clin Immunol*. 2003;112(2):420-426.
28. Eller E, Kjaer HF, Høst A, Andersen KE, Bindslev-Jensen C. Food allergy and food sensitization in early childhood: results from the DARC cohort. *Allergy*. 2009;64(7):1023-1029.
29. Kjaer HF, Eller E, Høst A, Andersen KE, Bindslev-Jensen C. The prevalence of allergic diseases in an unselected group of 6-year-old children. The DARC birth cohort study. *Pediatr Allergy Immunol*. 2008;19(8):737-745.
30. Jøhnke H, Norberg LA, Vach W, Høst A, Andersen KE. Patterns of sensitization in infants and its relation to atopic dermatitis. *Pediatr Allergy Immunol*. 2006;17(8):591-600.
31. Erhard SM, Bellach J, Yurek S, et al. Primary and pollen-associated hazelnut allergy in school-aged children in Germany: a birth cohort study. *Allergol Int*. 2021;70:463-470.
32. Falcão H, Lunet N, Lopes C, Barros H. Food hypersensitivity in Portuguese adults. *Eur J Clin Nutr*. 2004;58(12):1621-1625.
33. Fedorova O, Fedotova M, Ogorodova L, et al. Fish allergy prevalence in children of West Siberia, Russia. *Allergy*. 2014;69:269.
34. Fedorova O, Fedotova M, Yazdanbakhsh M, et al. The prevalence of food allergy to hen's egg in schoolchildren in Western Siberia (Russian Federation). *Allergy*. 2016;71:300-389.
35. Fedorova O, Ogorodova L, Fedotova M, Evdokimova TA. The prevalence of food allergy to peanut and hazelnut in children in Tomsk region. *Vopr Pitan*. 2014;83(1):48-54.
36. Fox AT, Sasieni P, du Toit G, Syed H, Lack G. Household peanut consumption as a risk factor for the development of peanut allergy. *J Allergy Clin Immunol*. 2009;123(2):417-423.
37. Frongia O, Bellomo A, Di Giorgio G, Fiumalbi C, Frizza J, Maresca C. Food allergies and intolerance in infants and children. [Italian] Intolleranze e allergie alimentari nella prima infanzia. *Medico e Bambino*. 2005;24:533-538.
38. Gaspar-Marques J, Carreiro-Martins P, Papoila AL, et al. Food allergy and anaphylaxis in infants and preschool-age children. *Clin Pediatr*. 2014;53(7):652-657.
39. Gelincik A, Büyüköztürk S, Gül H, et al. Confirmed prevalence of food allergy and non-allergic food hypersensitivity in a Mediterranean population. *Clin Exp Allergy*. 2008;38(8):1333-1341.
40. Gómez-Galán C, Peña-Peloche M, Ferré-Ybarz L, et al. Incidence of Cow's Milk allergy in the first year of life in Central Catalonia. *Pediatr Catalan*. 2017;77(1):15-19.
41. Grabenhenrich L, Trendelenburg V, Bellach J, et al. Frequency of food allergy in school-aged children in eight European countries-the EuroPrevall-iFAAM birth cohort. *Allergy*. 2020;75(9):2294-2308.
42. Grimshaw KE, Bryant T, Oliver EM, et al. Incidence and risk factors for food hypersensitivity in UK infants: results from a birth cohort study. *Clin Transl Allergy*. 2015;6:1.
43. Grundy J, Matthews S, Bateman B, Dean T, Arshad SH. Rising prevalence of allergy to peanut in children: data from 2 sequential cohorts. *J Allergy Clin Immunol*. 2002;110(5):784-789.
44. Haftenberger M, Laussmann D, Ellert U, et al. Prevalence of sensitisation to aeraoallergens and food allergens: results of the German health interview and examination survey for adults (DEGS1). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*. 2013;56(5–6):687-697.
45. Hicke-Roberts A, Wennergren G, Hesselmar B. Late introduction of solids into infants' diets may increase the risk of food allergy development. *BMC Pediatr*. 2020;20(1):273.
46. Høst A, Halken S, Jacobsen HP, Christensen AE, Herskind AM, Plesner K. Clinical course of cow's milk protein allergy/intolerance and atopic diseases in childhood. *Pediatr Allergy Immunol*. 2002;13(s15):23-28.
47. Hourihane JO, Aiken R, Briggs R, et al. The impact of government advice to pregnant mothers regarding peanut avoidance on the prevalence of peanut allergy in United Kingdom children at school entry. *J Allergy Clin Immunol*. 2007;119(5):1197-1202.

48. Isolauri E, Huurre A, Salminen S, Impivaara O. The allergy epidemic extends beyond the past few decades. *Clin Exp Allergy*. 2004;34(7):1007-1010.
49. Ivakhnenko O, Nyankovskyy S. Nutritional status of babies and influence of unmodified cow's milk on allergic reactions according to the epidemiological study from Ukraine. *Pediatr Pol*. 2013;88(2):138-143.
50. Jarvenpaa J, Paassilta M, Salmivesi S, Sannisto T, Niitty S, Korppi M. Stability of parent-reported food allergy in six and 7-year-old children: the first 5 years of the Finnish allergy programme. *Acta Paediatr*. 2014;103(12):1297-1300.
51. Johansson SG, Nopp A, Florvaag E, et al. High prevalence of IgE antibodies among blood donors in Sweden and Norway. *Allergy*. 2005;60(10):1312-1315.
52. Jorge A, Soares E, Sarinho E, Lorente F, Gama J, Taborda-Barata L. Prevalence and clinical features of adverse food reactions in Portuguese children. *Allergy Asthma Clin Immunol*. 2017;13:40.
53. Julge K, Vasar M, Björkstén B. Development of allergy and IgE antibodies during the first five years of life in Estonian children. *Clin Exp Allergy*. 2001;31(12):1854-1861.
54. Vasar M, Julge K, Björkstö B. Development of atopic sensitization and allergic diseases in early childhood. *Acta Paediatr*. 2000;89(5):523-527.
55. Jurisson M, Julge K, Voor T, Vasar M, Rebane T, Vorobjov S. Trends of prevalence of atopic dermatitis and sensitization during the first two years of life in Estonian children. *Allergy*. 2015;70:507-526.
56. Kaya A, Erkocoglu M, Civelek E, Cakir B, Kocabas CN. Prevalence of confirmed IgE-mediated food allergy among adolescents in Turkey. *Pediatr Allergy Immunol*. 2013;24(5):456-462.
57. Kelleher M, Cullinane C, Dunn Galvin A, Murray D, Hourihane J. Prevalence of food allergy in Irish children during their first 2 years: results from the Cork BASELINE birth cohort study. *Allergy*. 2014;69:269-270.
58. Kotz D, Simpson CR, Sheikh A. Incidence, prevalence, and trends of general practitioner-recorded diagnosis of peanut allergy in England, 2001 to 2005. *J Allergy Clin Immunol*. 2011;127(3):623-630.e621.
59. Krause TG, Koch A, Poulsen LK, Kristensen B, Olsen OR, Melbye M. Atopic sensitization among children in an arctic environment. *Clin Exp Allergy*. 2002;32(3):367-372.
60. Kristinsdóttir H, Clausen M, Ragnarsdóttir HS, et al. Prevalence of food allergy in Icelandic infants during first year of life. *Laeknabladid*. 2011;97(1):11-18.
61. Kucukosmanoglu E, Yazi D, Yesil O, et al. Prevalence of egg sensitization in Turkish infants based on skin prick test. *Allergol Immunopathol*. 2008;36(3):141-144.
62. Kurukulaaratchy RJ, Matthews S, Arshad SH. Defining childhood atopic phenotypes to investigate the association of atopic sensitization with allergic disease. *Allergy*. 2005;60(10):1280-1286.
63. Arshad SH, Tariq SM, Matthews S, Hakim E. Sensitization to common allergens and its association with allergic disorders at age 4 years: a whole population birth cohort study. *Pediatrics*. 2001;108(2):E33.
64. Tariq SM, Matthews SM, Hakim EA, Arshad SH. Egg allergy in infancy predicts respiratory allergic disease by 4 years of age. *Pediatr Allergy Immunol*. 2000;11(3):162-167.
65. Kvenshagen B, Halvorsen R, Jacobsen M. Is there an increased frequency of food allergy in children delivered by caesarean section compared to those delivered vaginally? *Acta Paediatr*. 2009;98(2):324-327.
66. Le TM, van Hoffen E, Kummeling I, et al. Food allergy in The Netherlands: differences in clinical severity, causative foods, sensitization and DBPCFC between community and outpatients. *Clin Transl Allergy*. 2015;5:8.
67. Lozoya-Ibanez C, Morgado-Nunes S, Rodrigues A, et al. Prevalence and clinical features of adverse food reactions in Portuguese adolescents. *World Allergy Organ J*. 2020;13(8):100453.
68. Lyons SA, Knulst AC, Le T-M, et al. Prevalence of food sensitization and food allergy in children across Europe. *J Allergy Clin Immunol Pract*. 2020;8(8):2736.
69. Majkowska-Wojciechowska B, Wardzynska A, Luczynska M, Kowalski M, Makowska J, Kowalski M. Food hypersensitivity in the population of school children in Lodz—results of the "EuroPrevall" surveys. *Alerg Astma Immunol*. 2009;14:35-44.
70. Marklund B, Ahlstedt S, Nordström G. Health-related quality of life among adolescents with allergy-like conditions—with emphasis on food hypersensitivity. *Health Qual Life Outcomes*. 2004;2:65.
71. Matricardi PM, Bockelbrink A, Beyer K, et al. Primary versus secondary immunoglobulin E sensitization to soy and wheat in the multi-Centre allergy study cohort. *Clin Exp Allergy*. 2008;38(3):493-500.
72. Matsyura O, Lesya B. Food intolerance and food allergy in children in Lviv region (Ukraine). *Allergy*. 2017;72:770.
73. Mortz CG, Andersen KE, Bindslev-Jensen C. Allergy to sesame-prevalence in an unselected population and relation to pollen sensitisation. *Allergy*. 2013;68:146.
74. Mossakowska M, Pawlinska-Chmara R, Broczek KM. Asthma, allergy, and respiratory symptoms in centenarians living in Poland. *J Physiol Pharmacol*. 2008;59(Suppl 6):483-489.
75. Mustafayev R, Civelek E, Orhan F, Yuksel H, Boz AB, Sekerel BE. Similar prevalence, different spectrum: IgE-mediated food allergy among Turkish adolescents. *Allergol Immunopathol*. 2013;41(6):387-396.
76. Nicolaou N, Poorafshar M, Murray C, et al. Allergy or tolerance in children sensitized to peanut: prevalence and differentiation using component-resolved diagnostics. *J Allergy Clin Immunol*. 2010;125(1):191-197.e191-113.
77. Niggemann B, Schmitz R, Schlaud M. The high prevalence of peanut sensitization in childhood is due to cross-reactivity to pollen. *Allergy*. 2011;66(7):980-981.
78. Orhan F, Karakas T, Cakir M, Aksoy A, Baki A, Gedik Y. Prevalence of immunoglobulin E-mediated food allergy in 6-9-year-old urban schoolchildren in the eastern Black Sea region of Turkey. *Clin Exp Allergy*. 2009;39(7):1027-1035.
79. Ostblom E, Lilja G, Ahlstedt S, van Hage M, Wickman M. Patterns of quantitative food-specific IgE-antibodies and reported food hypersensitivity in 4-year-old children. *Allergy*. 2008;63(4):418-424.
80. Ostblom E, Lilja G, Pershagen G, van Hage M, Wickman M. Phenotypes of food hypersensitivity and development of allergic diseases during the first 8 years of life. *Clin Exp Allergy*. 2008;38(8):1325-1332.
81. Ostblom E, Wickman M, van Hage M, Lilja G. Reported symptoms of food hypersensitivity and sensitization to common foods in 4-year-old children. *Acta Paediatr*. 2008;97(1):85-90.
82. Almqvist C, Pershagen G, Wickman M. Low socioeconomic status as a risk factor for asthma, rhinitis and sensitization at 4 years in a birth cohort. *Clin Exp Allergy*. 2005;35(5):612-618.
83. Osterballe M, Mortz CG, Hansen TK, Andersen KE, Bindslev-Jensen C. The prevalence of food hypersensitivity in young adults. *Pediatr Allergy Immunol*. 2009;20(7):686-692.
84. Osterballe M, Hansen TK, Mortz CG, Høst A, Bindslev-Jensen C. The prevalence of food hypersensitivity in an unselected population of children and adults. *Pediatr Allergy Immunol*. 2005;16(7):567-573.
85. Patelis A, Gunnbjornsdottir M, Borres MP, et al. Natural history of perceived food hypersensitivity and IgE sensitisation to food allergens in a cohort of adults. *PLoS One*. 2014;9(1):e85333.

86. Pawlińska-Chmara R, Teul I. Food hypersensitivity in the population of school children in Opole. *Pomeranian J Life Sci*. 2015;61(1):120-123.
87. Pénard-Morand C, Raherison C, Kopferschmitt C, et al. Prevalence of food allergy and its relationship to asthma and allergic rhinitis in schoolchildren. *Allergy*. 2005;60(9):1165-1171.
88. Pereira B, Venter C, Grundy J, Clayton CB, Arshad SH, Dean T. Prevalence of sensitization to food allergens, reported adverse reaction to foods, food avoidance, and food hypersensitivity among teenagers. *J Allergy Clin Immunol*. 2005;116(4):884-892.
89. Protudjer JLP, Olen O, Vetander M, et al. Milk-related symptoms and immunoglobulin E reactivity in Swedish children from early life to adolescence. *Nutrients*. 2018;10(5):651.
90. Pyrhönen K, Hiltunen L, Kaila M, Näyhä S, Läärä E. Heredity of food allergies in an unselected child population: an epidemiological survey from Finland. *Pediatr Allergy Immunol*. 2011;22(1 Pt 2):e124-e132.
91. Pyrhönen K, Näyhä S, Kaila M, Hiltunen L, Läärä E. Occurrence of parent-reported food hypersensitivities and food allergies among children aged 1-4 yr. *Pediatr Allergy Immunol*. 2009;20(4):328-338.
92. Pyziak K, Kamer B. Natural history of IgE-dependent food allergy diagnosed in children during the first three years of life. *Adv Med Sci*. 2011;56(1):48-55.
93. Rancé F, Grandmottet X, Grandjean H. Prevalence and main characteristics of schoolchildren diagnosed with food allergies in France. *Clin Exp Allergy*. 2005;35(2):167-172.
94. Raciborski F, Samel-Kowalik P, Tomaszewska A, et al. Food allergy in children aged 6-8 years in Poland. *Allergy*. 2012;67:610-611.
95. Rentzos G, Johanson L, Goksor E, Telemo E, Lundback B, Ekerljung L. Prevalence of food hypersensitivity in relation to IgE sensitisation to common food allergens among the general adult population in West Sweden. *Clin Transl Allergy*. 2019;9:22.
96. Roberts G, Peckitt C, Northstone K, et al. Relationship between aeroallergen and food allergen sensitization in childhood. *Clin Exp Allergy*. 2005;35(7):933-940.
97. Lack G, Fox D, Northstone K, Golding J. Factors associated with the development of peanut allergy in childhood. *N Engl J Med*. 2003;348(11):977-985.
98. Rona RJ, Keil T, Summers C, et al. The prevalence of food allergy: a meta-analysis. *J Allergy Clin Immunol*. 2007;120(3):638-646.
99. Ronchetti R, Jesenak M, Trubacova D, Pohanka V, Villa MP. Epidemiology of atopy patch tests with food and inhalant allergens in an unselected population of children. *Pediatr Allergy Immunol*. 2008;19(7):599-604.
100. Sandin A, Annus T, Björkstén B, et al. Prevalence of self-reported food allergy and IgE antibodies to food allergens in Swedish and Estonian schoolchildren. *Eur J Clin Nutr*. 2005;59(3):399-403.
101. Schäfer T, Böhler E, Ruhdorfer S, et al. Epidemiology of food allergy/food intolerance in adults: associations with other manifestations of atopy. *Allergy*. 2001;56(12):1172-1179.
102. Schnabel E, Sausenthaler S, Schaaf B, et al. Prospective association between food sensitization and food allergy: results of the LISA birth cohort study. *Clin Exp Allergy*. 2010;40(3):450-457.
103. Skypala IJ, Bull S, Deegan K, et al. The prevalence of PFS and prevalence and characteristics of reported food allergy; a survey of UK adults aged 18-75 incorporating a validated PFS diagnostic questionnaire. *Clin Exp Allergy*. 2013;43(8):928-940.
104. Soost S, Leynaert B, Almqvist C, Edenharter G, Zuberbier T, Worm M. Risk factors of adverse reactions to food in German adults. *Clin Exp Allergy*. 2009;39(7):1036-1044.
105. Roehr CC, Edenharter G, Reimann S, et al. Food allergy and non-allergic food hypersensitivity in children and adolescents. *Clin Exp Allergy*. 2004;34(10):1534-1541.
106. Zuberbier T, Edenharter G, Worm M, et al. Prevalence of adverse reactions to food in Germany—a population study. *Allergy*. 2004;59(3):338-345.
107. Stefanaki E, Margetaki A, Roumeliotaki T, Chatzi L. Incidence of parent reported food hypersensitivity in Greek children at 4 and 6 years of age: results from a birth cohort study in Crete. *Clin Transl Allergy*. 2018;8(S2):118.
108. Steinke M, Fiocchi A, Kirchlechner V, et al. Perceived food allergy in children in 10 European nations. A randomised telephone survey. *Int Arch Allergy Immunol*. 2007;143(4):290-295.
109. Sterner T, Uldahl A, Svensson A, et al. IgE sensitization in a cohort of adolescents in southern Sweden and its relation to allergic symptoms. *Clin Mol Allergy*. 2019;17:6.
110. Strinnholm A, Winberg A, West C, Hedman L, Ronmark E. Food hypersensitivity is common in Swedish schoolchildren, especially oral reactions to fruit and gastrointestinal reactions to milk. *Acta Paediatr*. 2014;103(12):1290-1296.
111. Winberg A, West CE, Strinnholm A, Nordstrom L, Hedman L, Ronmark E. Assessment of allergy to Milk, egg, cod, and wheat in Swedish schoolchildren: a population based cohort study. *PloS One*. 2015;10(7):e0131804.
112. Van Den Hoogen SCTA, Van De Pol AC, Meijer Y, Toet J, Van Klei C, De Wit NJ. Suspected cow's milk allergy in everyday general practice: a retrospective cohort study on health care burden and guideline adherence. *BMC Res Notes*. 2014;7(1):507.
113. Venkataraman D, Erlewyn-Lajeunesse M, Kurukulaaratchy RJ, et al. Prevalence and longitudinal trends of food allergy during childhood and adolescence: results of the Isle of Wight birth cohort study. *Clin Exp Allergy*. 2018;48(4):394-402.
114. Venter C, Hasan Arshad S, Grundy J, et al. Time trends in the prevalence of peanut allergy: three cohorts of children from the same geographical location in the UK. *Allergy*. 2010;65(1):103-108.
115. Dean T, Venter C, Pereira B, et al. Patterns of sensitization to food and aeroallergens in the first 3 years of life. *J Allergy Clin Immunol*. 2007;120(5):1166-1171.
116. Venter C, Pereira B, Grundy J, et al. Incidence of parentally reported and clinically diagnosed food hypersensitivity in the first year of life. *J Allergy Clin Immunol*. 2006;117(5):1118-1124.
117. Venter C, Pereira B, Voigt K, et al. Prevalence and cumulative incidence of food hypersensitivity in the first 3 years of life. *Allergy*. 2008;63(3):354-359.
118. Venter C, Pereira B, Grundy J, Clayton CB, Arshad SH, Dean T. Prevalence of sensitization reported and objectively assessed food hypersensitivity amongst six-year-old children: a population-based study. *Pediatr Allergy Immunol*. 2006;17(5):356-363.
119. Venter C, Maslin K, Arshad SH, et al. Very low prevalence of IgE mediated wheat allergy and high levels of cross-sensitisation between grass and wheat in a UK birth cohort. *Clin Transl Allergy*. 2016;6:22.
120. Venter C, Maslin K, Patil V, et al. The prevalence, natural history and time trends of peanut allergy over the first 10 years of life in two cohorts born in the same geographical location 12 years apart. *Pediatr Allergy Immunol*. 2016;27(8):804-811.
121. von Hertzen L, Mäkelä MJ, Petäys T, et al. Growing disparities in atopy between the Finns and the Russians: a comparison of 2 generations. *J Allergy Clin Immunol*. 2006;117(1):151-157.
122. Westerlaken-Van Ginkel CD, Sprikkelman AB, Koppelman GH, Dubois AEJ, Vonk JM, Flokstra-De Blok BMJ. Likely questionnaire-diagnosed food allergy in 78, 890 adults from the northern Netherlands. *PLoS One*. 2020;15(5):e0231818.
123. Xepapadaki P, Fiocchi A, Grabenhenrich L, et al. Incidence and natural history of hen's egg allergy in the first 2 years of life-the EuroPrevall birth cohort study. *Allergy*. 2016;71(3):350-357.
124. Zeyrek D, Cakmak A, Koruk I, Kara B, Demir C. Prevalence of IgE mediated cow's milk and egg allergy in children under 2 years of age in Sanliurfa, Turkey: the city that isn't almost allergic to cow's milk. *Minerva Pediatr*. 2015;67(6):465-472.
125. Zivic H, Strizic H. Prevalence of cow's-milk protein allergy in a primary paediatric practice in Croatia. *J Pediatr Gastroenterol Nutr*. 2018;66:403.
126. Zuidmeer L, Goldhahn K, Rona RJ, et al. The prevalence of plant food allergies: a systematic review. *J Allergy Clin Immunol*. 2008;121(5):1210-1218.e4.

127. Karakoc G, Karagoz D, Altintas D, Yılmaz M, Duyuler G, Kont A. Natural course of food allergy at the end of the 4 years of age: results of birth cohort study from Turkey. *Allergy*. 2015;70(1477):527-613.

How to cite this article: Spolidoro GCI, Ali MM, Amera YT, et al. Prevalence estimates of eight big food allergies in Europe: Updated systematic review and meta-analysis. *Allergy*. 2023;00:1-57. doi:10.1111/all.15801

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

APPENDIX 1

TABLE A1 Geoscheme of European countries by UN.

Eastern Europe	Northern Europe	Southern Europe	Western Europe
Belarus	Åland[a]	Albania	Austria
Bulgaria	Channel Islands (Guernsey, Jersey, Sark)	Andorra	Belgium
Czech Republic	Denmark	Bosnia and Herzegovina	France
Hungary	Estonia	Croatia	Germany
Poland	Faroe Islands	Gibraltar	Liechtenstein
Moldova	Finland	Greece	Luxembourg
Romania	Iceland	Holy See (Vatican City)	Monaco
Russia	Ireland	Italy	Netherlands
Slovakia	Isle of Man	Kosovo[a]	Switzerland
Ukraine	Latvia	Malta	
	Lithuania	Montenegro	
	Norway	(North) Macedonia	
	Svalbard and Jan Mayen Islands[a]	Portugal	
	Sweden	San Marino	
	UK (England, Scotland, Wales, and Northern Ireland)	Serbia	
		Slovenia	
		Spain	
		Turkey[a]	
		Yugoslavia (historical)[a]	

Note: Adapted version from https://cies2018.org/wp-content/uploads/List-of-Countries-by-Region-UN-Annex-II.pdf.

[a]Appended.