





# Feeding difficulties in children with food allergies: An EAACI Task Force Report

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## Abstract

The term “feeding difficulties” refers to a spectrum of phenotypes characterized by suboptimal intake of food and/or lack of age-appropriate eating habits. While it is evident that feeding difficulties are prevalent within healthy children, no consensus has been reached for those with food allergies. The aim of this study was to systematically review all the available literature reporting the prevalence of feeding difficulties within food allergic children. We searched eight international electronic databases for all published studies until June 2022. International experts in the field were also contacted for unpublished and ongoing studies. All publications were screened against pre-defined eligibility criteria and critically appraised by established instruments. The substantial heterogeneity of included studies precluded meta-analyses, so narrative synthesis of quantitative data was performed. A total of 2059 abstracts were assessed, out of which 21 underwent full-text screening and 10 studies met the study criteria. In these, 12 different terms to define feeding difficulties and 11 diagnostic tools were used. Five papers included data of feeding difficulty prevalence in children with food allergies, ranging from 13.6% to 40%. Higher prevalence was associated with multiple food allergies. The current literature suggests that feeding difficulties are prevalent within food allergic children, particularly those with multiple food allergies. However, the heterogeneity of terminologies and diagnostic tools makes drawing conclusions challenging. Consensus guidelines for the diagnosis and management of feeding difficulties within food allergic children and further research

**Abbreviations:** ARFID, avoidant restrictive food intake disorder; BPFAS, Behavioural Paediatrics Feeding Assessment Scale; CEBQ, Child Eating Behaviour Questionnaire; CMPA, Cow's Milk Protein Allergy; EGID, Eosinophilic Gastrointestinal Disorder; EoE, Eosinophilic Oesophagitis; EPHPP, Effective Public Health Practice Project; FPI, Food Preference Index; FPIES, Food Protein-Induced Enterocolitis Syndrome; FSQ, Food Situation Questionnaire; HCPs, Healthcare Professionals; HRQoL, Health-Related Quality of Life; OFC, Oral Food Challenge; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; QoL, Quality of Life.

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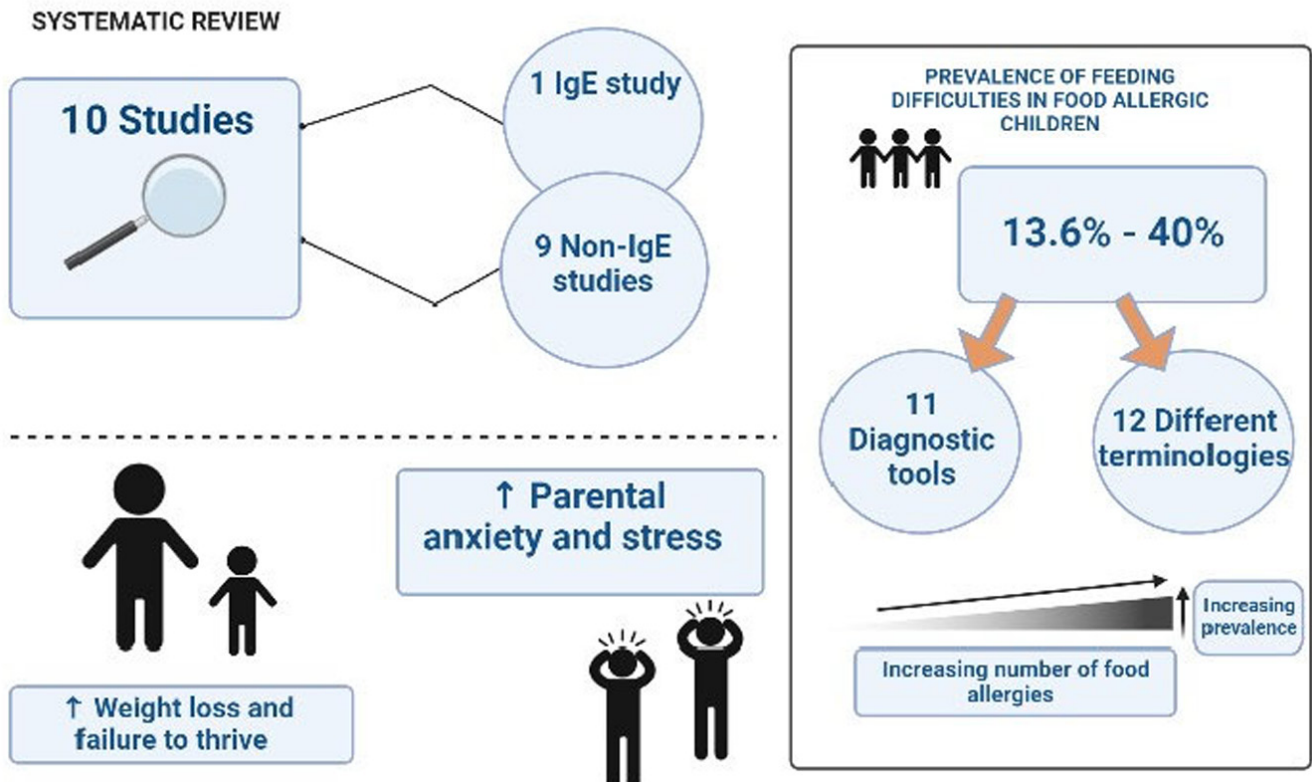
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on the development and perpetuation of feeding difficulties are needed to appropriately manage such patients.

**KEYWORDS**

eating difficulties, feeding difficulties, food allergy, prevalence, systematic review

## The prevalence of feeding difficulties in food allergic children



### GRAPHICAL ABSTRACT

Graphical abstract summarising the key findings of this systematic review.

## 1 | INTRODUCTION

Feeding difficulties is an umbrella term encompassing a spectrum of phenotypes, characterized by suboptimal intake of food and/or lack of age-appropriate eating habits.<sup>1</sup> Classifications of these phenotypes have been suggested in the literature, based upon three principal concerns of parents: eating too little, selective intake, and fear of feeding.<sup>2,3</sup> Feeding difficulties range in severity with the majority of children presenting with mild feeding difficulties and, more rarely, severe medical, nutritional/feeding and psychological concerns, which are classified as feeding disorders.<sup>3-7</sup> Feeding disorders can have long-lasting adverse impacts beyond childhood on various

### Key message

Feeding difficulties are prevalent within food-allergic children, particularly those with multiple food allergies. There is no consensus on how to assess feeding difficulties in food-allergic children and great heterogeneity of definitions and diagnostic criteria was found to assess feeding difficulties. Future work should focus on developing such tools to harmonize clinical outcomes and advance the field through prospective research.

physical, social, and emotional factors including: growth, cognitive function, parent-child and peer relations, parent and child anxiety and quality of life (QoL).<sup>7-12</sup> A glossary of different feeding difficulty terminologies is included in [Table 1](#).

Feeding disorders may present as disruptive mealtime behavior, food selectivity or a negative association with feeding due to discomfort, pain, or a previous traumatic event, such as an allergic reaction and therefore a learned aversion to food.<sup>11,13-15</sup> In children with food allergies, the limited exposure to different flavors and textures due to the elimination diet<sup>16</sup> limits the development of the appropriate oral-motor and sensory functions needed for feeding.<sup>7,17,18</sup>

Determining the true prevalence of feeding difficulties is challenging due to the heterogeneous nature of the pediatric population and the lack of consensus regarding terminologies, definitions, and diagnostic criteria. A significant proportion of healthy young children experience periods of food refusal as they become more autonomous and food neophobia is part of the normal development of all omnivores.<sup>17,19</sup> Available research indicates that feeding difficulties

are seen in 25%–45% of the general pediatric population, in 80% of children with developmental disabilities, and in 40%–70% of children with chronic medical conditions.<sup>7</sup> The occurrence of feeding difficulties within food-allergic children is also becoming increasingly recognized, but reported ranges, using different feeding difficulty terminologies, vary significantly.<sup>16,20,21</sup>

While guidelines exist for the management of feeding difficulties and disorders in the general pediatric population,<sup>3,7</sup> there are no consensus guidelines specific for those with food allergy, which may lead to misdiagnosis and mismanagement. In addition, parents often receive insufficient support, which may contribute to the reported decreased health-related quality of life (HRQoL) in families living with food allergy.<sup>7,22-24</sup>

In this work, we propose the first systematic review of all the available literature on feeding difficulties within food-allergic children and adolescents (up to 18 years of age) in order to determine whether the prevalence is higher than that in the general population.

**TABLE 1** Glossary of terms for the feeding difficulties included in this systematic review.

| Feeding difficulty                                | Definition   |
|---|--|
| Adaptive feeding                                  | Caregiver use of different strategies to improve the child's nutritional status; these can be functional or maladaptive  |
| Avoidant/restrictive food intake disorder (ARFID) | A recognized feeding disorder since 2013. It is a severe feeding disorder where patients have a very limited diet, typically consisting of <20 foods   |
| Aversive/avoidant eating                          | Strategies of eating resulting from repeated experiences of physical or emotional pain or discomfort during feedings, to avoid the aversive feeding situations   |
| Behavioral feeding difficulty                     | Broad term used to describe a variety of problematic mealtime behaviors including, among others: throwing food, refusal to sit at a table and screaming to avoid the meal  |
| Eating too little/no appetite                     | Lack of hunger resulting in eating too few calories for age/size/reliance on enteral feeding for appropriate calorie intake  |
| Fear of food                                      | Irrational fear of eating that prevents enjoyment of food and affects daily life; it can be specific to one type of food or many   |
| Feeding difficulties/problems/dysfunction         | Generic terms, characterized by suboptimal intake of food and/or lack of age-appropriate eating habits (includes all feeding difficulty phenotypes)  |
| Food aversion                                     | Refusal of foods that are presented to the child despite being developmentally appropriate   |
| Food neophobia                                    | Reluctancy or unwillingness to eat new foods; this is often seen in normal child development   |
| Food refusal                                      | Refusal by individual to eat all/most foods presented to them; failure to ingest adequate nutrition to maintain appropriate weight for age/size  |
| Fussy eating                                      | Often used interchangeably with picky eating. inadequate variety/quantity of foods through rejection of both familiar and unfamiliar foods, often in an inconsistent pattern   |
| Maladaptive feeding                               | Caregiver use of inappropriate strategies to improve the child's nutritional status, which perpetuate/worsen malnutrition and other manifestations of feeding dysfunction  |
| Pediatric feeding disorder (PFD)                  | An umbrella term defining impaired oral intake that is not age-appropriate and is associated with medical, nutritional, feeding skill, and/or psychosocial dysfunction. It can only be diagnosed in the absence of body image disturbances. Can be diagnosed as acute (<3 months in duration) or chronic (>3 months in duration) |
| Picky eating                                      | Often used interchangeably with fussy eating. eating a limited variety of foods/unwilling to try new foods, despite the ability to eat a broader diet, as well as strong food preferences  |
| Selective eating                                  | Strict rules on the color, texture, taste and the way the food is cooked   |
| Slow eater  | Mealtime duration >30 min  |
| Unspecified/generic feeding difficulty            | Could be one or a combination of picky/fussy eating, food neophobia, selective eating, little appetite, aversive eating, avoidant eating   |

## 2 | METHODS

### 2.1 | Search strategy

This systematic review was performed in line with the updated PRISMA guideline<sup>25</sup> (Figure 1). The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO): <http://www.crd.york.ac.uk/prospero/> (registration number: CRD42022338649).

Relevant articles were selected through searching the following electronic databases until June 2022 of: AMED, CAB International, CINAHL, EMBASE, Global Health, ISI Web of Science, MEDLINE, Psych INFO, as well as the databases of the proceedings of international conferences, such as ISI Conference Proceedings Citation Index and ZETOC (British Library). Appendix S1 contains the search strategies developed for MEDLINE and EMBASE, which was adapted to search other databases. Snowballing was used to

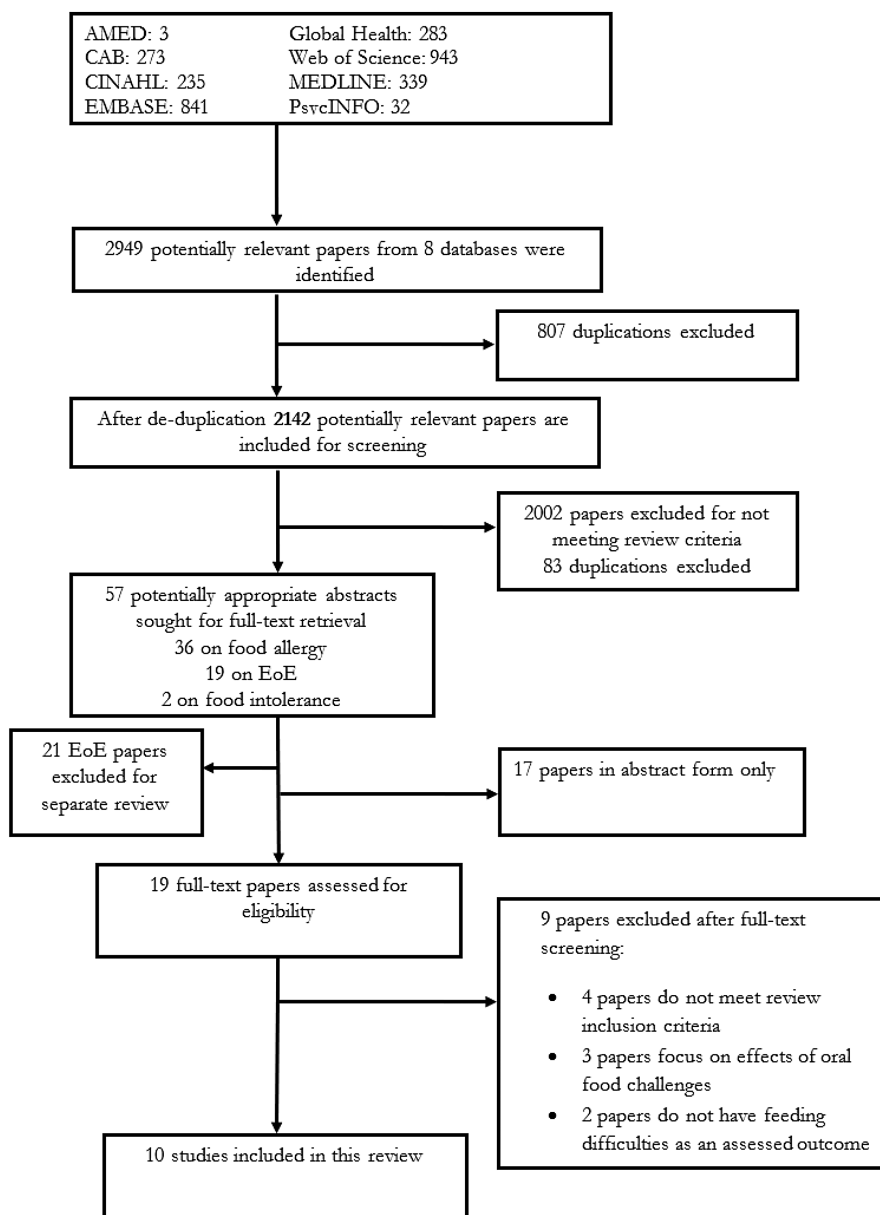
identify further references cited in identified papers and international experts in the field of research were contacted for unpublished and ongoing studies. No restrictions on the language or year of publication were set.

### 2.2 | Study eligibility

The PICOS<sup>26</sup> framework was used to design the study eligibility criteria as follows:

#### 2.2.1 | Population

Studies of children and adolescents up to 18 years of age with IgE, non-IgE, or mixed IgE and non-IgE-mediated food allergy, diagnosed by a



**FIGURE 1** PRISMA flow diagram of screening and selection of studies for qualitative analysis.<sup>25</sup> PRISMA methodology was used to guide the reporting of this systematic review. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

healthcare professional (HCP) were included. Publications involving children with eating disorders (e.g., anorexia nervosa) were excluded, as were papers on cohorts of children with organic disorders that have been linked to high incidences of feeding difficulties, for example, autism spectrum disorder (ASD). Publications focusing on eosinophilic oesophagitis (EoE) were syphoned to be reviewed separately in order to distinguish papers that described feeding difficulties as opposed to dysphagia and food impaction, which are direct presentations of the disease. The assessment of feeding difficulties in EoE is currently underway as a separate publication in a follow-up to this publication.

### 2.2.2 | Interventions/conditions

All types of feeding difficulties were included in this review.

### 2.2.3 | Outcome

The primary outcome of this systematic review was to establish the prevalence of feeding difficulties (Table 1) within the population of children with food allergies; therefore, studies that did not include quantitative prevalence data were excluded. The prevalence and any definitions and diagnostic criteria of the feeding difficulties were noted. Any impacts of feeding difficulties on growth, HRQoL, mental health, and school/work absenteeism in children and/or their parents, if investigated, were also reported.

### 2.2.4 | Study design

All types of studies: randomized-controlled, non-randomized, cross-sectional, case-controlled, cohort, and case series (defined as five or more case reports) were included. Animal studies, review papers, case reports, studies in abstract-form only, and qualitative papers were excluded.

## 2.3 | Screening of studies

Two independent reviewers (SH, UN) first screened the abstracts of retrieved articles, followed by the full text of potentially relevant papers. Any discrepancies were resolved by consensus and a third reviewer (RM) arbitrated any disagreements at each stage. Studies referencing food intolerances were screened beyond the abstract to determine whether they were describing non-IgE-mediated food allergy and were to then be included.

## 2.4 | Data extraction and reporting

Two reviewers independently extracted relevant information and study data onto a customized data extraction sheet (Appendix S2).

Descriptive tables were used to summarize the literature and characteristics of studies contributing to the overall evidence.

## 2.5 | Quality assessment and risk of bias

Two reviewers (SH, UN) independently assessed the methodological quality of eligible studies and the potential for risk of bias using the Effective Public Health Practice Project (EPHPP).<sup>27</sup> Any discrepancies, if encountered, were arbitrated by a third reviewer (RM). Overall grading for each observational study as well as component-specific measures were assessed, including suitability of the study design for the research question; risk of selection bias; and outcome assessment.

## 2.6 | Data syntheses

All data were qualitatively analyzed.

# 3 | RESULTS

## 3.1 | Search results

A preliminary search of all eight databases yielded 2949 potentially eligible papers. After the removal of duplicates and screening the abstracts of the remaining publications, 21 papers underwent full-text screening (Figure 1). Eleven of these were excluded (Table S1),<sup>28-36</sup> and 10 papers containing quantitative data on feeding difficulties were included in our systematic data analysis (Figure 1).<sup>9,16,37-44</sup> We found no interventional studies in this systematic review. The 10 observational studies comprised of two retrospective medical chart reviews, four cohort and four cross-sectional case-control studies.

The results of this systematic review have been divided into two sections: five papers including absolute values of the prevalence of feeding difficulties and five papers including quantitative data only on the mean/median feeding difficulty scores of a cohort of food allergic children.

## 3.2 | Characteristics of included papers

Across the 10 analyzed publications, 11 different diagnostic tools and 12 different terminologies of feeding difficulties were used (Tables 2 and 3). Some of the included studies assessed multiple feeding difficulty phenotypes and therefore used different terminologies. Seven of these publications used only one diagnostic tool, two of which both used the CEBQ, therefore accounting for six of the different diagnostic tools reported in this systematic review. Despite only one diagnostic tool being used, only four of these papers used one feeding difficulty term, whereas Maslin et al.<sup>41</sup> used two, and Polloni et al.<sup>39</sup>

TABLE 2 The characteristics of the five studies that contain prevalence data on feeding difficulties within food-allergic children.<sup>9,16,36-38,45</sup>

| First author and year of publication | Study design                 | Location         | Size of study | Median age at time of study (years) | Type of food allergy      | ≥2 food allergies (%) | Feeding difficulty terminology  | Means of diagnosing feeding difficulty   | Means of recruitment of patients into the study          |
|--------------------------------------|------------------------------|------------------|---------------|-------------------------------------|---------------------------|-----------------------|---|--|--|
| Maslin 2015                          | Cross-sectional case-control | UK/Isle of Wight | 66            | 1.08                                | CMPA                      | 28.8                  | Fussy/picky eating<br>Feeding difficulties<br>Avoidant eating                         | Picky eater questionnaire<br>Montreal Children's Hospital Feeding Difficulties questionnaire                           | Direct tertiary clinic referral                          |
| Meyer 2014                           | Retrospective chart review   | UK               | 437           | 8                                   | Non-IgE and mixed         | 94.3                  | Avoidant eating behavior  | Wright et al. criteria   | Direct tertiary clinic referral                          |
| Polloni 2017                         | Cohort                       | Italy            | 81            | 6.5                                 | IgE                       | 66.7                  | Lack of interest in trying new foods<br>Monotony of diet<br>Food introduction failure | Own survey of nutritional behavior and attitudes in food allergic kids   | Direct tertiary clinic referral                          |
| Rodrigues 2021                       | Cross-sectional case-control | Brazil           | 146           | 3.3                                 | CMPA                      | 63                    | Picky eating<br>Avoidant eating<br>Feeding problems<br>Food refusal/inappetence       | Picky eater questionnaire <sup>a</sup><br>Avoidant eating score<br>Montreal Children's Hospital Feeding Scale          | Advertisement/outreach via online groups and conferences |
| Su 2014                              | Retrospective chart review   | USA              | 203           | NR                                  | FPIES (non-IgE and mixed) | 18.2 <sup>a</sup>     | Food aversion   | Reluctance, avoidance, fear of eating/drinking documented by pediatric clinicians in EMRs (no specific criteria given) | Direct tertiary clinic referral                          |

Abbreviations: CMPA, Cow's Milk Protein Allergy; FPIES, food protein-induced enterocolitis syndrome.

<sup>a</sup>Three or more food allergies.

**TABLE 3** The characteristics of the five studies that contain quantitative data on the feeding difficulty scores of a cohort of food allergic children.<sup>13,39-43</sup>

| First author and year of publication | Study design                 | Location | Size of study | Median age at time of study (years) | Type of food allergy | Feeding difficulty terminology                           | Means of diagnosing feeding difficulty | Means of recruitment of patients into the study          |
|--------------------------------------|------------------------------|----------|---------------|-------------------------------------|----------------------|--|--|--|
| Ercan 2022                           | Cohort                       | Turkey   | 62            | 2.67                                | CMPA                 | Fussy eating<br>Food avoidance<br>Satiety responsiveness | CEBQ                                   | Direct tertiary clinic referral                          |
| Herbert 2017                         | Cohort                       | USA      | 74            | 3.57                                | IgE                  | Mealtime behavioral feeding difficulty                   | BPFAS                                  | Direct tertiary clinic referral                          |
| Maslin 2016                          | Cross-sectional case-control | UK       | 101           | 0.22                                | CMPA                 | Food neophobia   | Child food neophobia scale             | Direct tertiary clinic referral                          |
| Maslin 2016                          | Cohort                       | UK       | 101           | 11.5                                | CMPA                 | Fussy eating<br>Avoidant eating behavior                 | CEBQ                                   | Direct tertiary clinic referral                          |
| Rigal 2016                           | Cross-sectional case-control | France   | 45            | 7.17                                | Unspecified          | Food neophobia   | FSQ<br>FPI                             | Advertisement/outreach via online groups and conferences |

Abbreviations: BPFAS, Behavioural Paediatrics Feeding Assessment Scale; CEBQ, Child Eating Behaviour Questionnaire; CMPA, Cow's Milk Protein Allergy; FPI, Food Preference Inventory; FSQ, Food Situation Questionnaire.

used three different terminologies, respectively. Maslin et al.<sup>9</sup> used three different feeding difficulty terms, while Rigal et al.<sup>44</sup> used only one, despite both using two different diagnostic tools. Rodrigues et al.<sup>38</sup> used three different diagnostic tools and four different feeding difficulty terms. Tables 2 and 3 show the characteristics of the studies containing prevalence and quantitative data, respectively.

### 3.3 | Quality appraisal of included studies

The global quality rating of the studies considered five studies to be strong, one moderate and four weak (Table S2). Of these four weak studies: two were retrospective chart reviews, one of which disregarded confounders, and one had no validated data collection method; two were case-control studies with a high number of unexplained patient dropouts and either no mention of confounders or a high selection bias.

### 3.4 | Prevalence data

Five of the included studies<sup>9,16,37-39</sup> reported the prevalence of feeding difficulties in children with food allergies, ranging from 13.6% to 40% (Table 4). Only one of these five papers focused on a cohort of children with IgE-mediated food allergy,<sup>39</sup> recording a 19% prevalence of feeding difficulties. Out of the remaining four papers: two focused on cohorts of children with non-IgE-mediated food allergies and reported a prevalence of feeding difficulties ranging between 21.7% and 30%; two focused on children with Cow's Milk Allergy (CMA), the underlying etiology of which was not included, recording the prevalence of feeding difficulties to range between 13.6% and 40%.

Rodrigues et al.<sup>38</sup> reported the prevalence of three different feeding difficulty phenotypes: 35.4% prevalence of picky eating in the CMA group, which comprised of children with both IgE and non-IgE-mediated CMA, compared to 23.3% of their control group; 32.1% prevalence of feeding problems, which was non-significantly different than their control group (28.4%), and 23.9% prevalence of avoidant eating behavior. Conversely, using the same questionnaire to investigate the latter two forementioned phenotypes, Maslin et al.<sup>9</sup> reported 13.6% prevalence of feeding difficulties, compared to 1.6% in their control group, and 40% prevalence of avoidant eating behavior in their CMA group, which also included children with both IgE and non-IgE mediated CMA; these were both the lowest and highest reported prevalence of feeding difficulties found in this systematic review.

Two of the papers were retrospective chart reviews of non-IgE mediated food allergies, with patient records sourced directly from tertiary clinics.<sup>16,37</sup> The reported frequency of the respective feeding difficulties ranged from 21.7% to 40.2%.

Meyer et al.<sup>16</sup> (UK) retrospectively reviewed 437 cases of non-IgE-mediated allergies. 40.2% of parents recalled avoidant eating behaviors; 75% of these cases were supported by medical records, concluding a 30% prevalence. Su et al.<sup>37</sup> (USA) reported food aversion in 21.7% of Food Protein-Induced Enterocolitis Syndrome (FPIES) cases, with no restriction on diagnostic criteria.



TABLE 4 The terminologies, diagnostic criteria and prevalence's of each reported feeding difficulty.<sup>9,16,36–38,45</sup>

| First author and year of publication | Size of study | Means of diagnosing feeding difficulty   | Feeding difficulty terminology             | Prevalence of feeding difficulty (%)       |
|--------------------------------------|---------------|--|--|--|
| Maslin <sup>a</sup> 2015             | 66            | Picky eater questionnaire  | Fussy/picky eating                         | NR   |
|                                      |               | Montreal Children's Hospital Feeding Difficulties questionnaire  | Feeding difficulties                       | 13.6 <sup>b</sup>                          |
|                                      |               |  | Avoidant eating                            | 40   |
| Meyer 2014                           | 437           | Wright et al. criteria   | Avoidant eating behavior                   | 30 (medical report)/40.2 (parental report) |
| Polloni 2017                         | 81            | Own survey of nutritional behavior and attitudes in food allergic kids   | Lack of interest in trying new foods       | 19   |
|                                      |               |  | Monotony of diet                           | 15   |
|                                      |               |  | Food introduction failure                  | 11.1                                       |
| Rodrigues <sup>a</sup> 2021          | 146           | Picky eating questionnaire <sup>c</sup>  | Picky eating                               | 35.4 <sup>b</sup>                          |
|                                      |               |  | Avoidant eating score                      | 23.9                                       |
|                                      |               |  | Montreal Children's Hospital Feeding Scale | 32.1                                       |
|                                      |               |  | Food refusal/inappetence                   | 27.1                                       |
| Su 2014                              | 203           | Reluctance, avoidance, fear of eating/drinking documented by pediatric clinicians in EMRs (no specific criteria given) | Food aversion                              | 21.7                                       |

Abbreviations: EMR, electronic medical records; NR, not reported.

<sup>a</sup>Case-control studies.

<sup>b</sup>Prevalence is significantly higher than control group result.

<sup>c</sup>The 75th percentile score of the control group was used as a cutoff score for picky eating in the food allergic group.

### 3.5 | Quantitative data

Five of the included papers<sup>40–44</sup> report quantitative data relating to feeding difficulties in food allergic children (Table 5). Again, only one of these five studies focused on a cohort of children with IgE-mediated food allergies,<sup>42</sup> and reported significantly increased scores assessing behavioral feeding difficulties (BPFAS), in their food-allergic group compared to healthy controls.

Two studies investigated feeding difficulties (CEBQ) in CMPA children.<sup>41,43</sup> Maslin et al.<sup>41</sup> (UK) reported a 7.8% increase in prevalence of feeding difficulties when comparing the CMPA and control group, whereas Ercan and Tel<sup>43</sup> (Turkey) reported mixed results.

Mixed results for food neophobia were also found: Rigal et al.<sup>44</sup> reported significantly increased scores in food-allergic children when compared to their non-allergic siblings, whilst Maslin et al.<sup>41</sup> reported non-significant differences in scores between the CMA and non-allergic control group.

### 3.6 | Associations

Four papers<sup>16,37,39,41</sup> reported an increased association with the presence/severity of feeding difficulties and the number of foods

eliminated from the diet. Sub-group analysis by Su et al.<sup>37</sup> showed the prevalence of food aversion to be significantly different in those eliminating one/two foods, due to acute FPIES, compared to three or more: 16.9% and 43.2% respectively. One of the included papers found a younger patient age to be associated to stronger avoidant eating behaviors.<sup>38</sup> The number of food allergy symptoms, including vomiting, diarrhea and constipation<sup>16,38,41</sup> and extra-intestinal manifestations such as headaches, night sweats, lethargy and joint pain<sup>16</sup> and colic and dry cough at night<sup>9</sup> were also associated to increased prevalence/severity of feeding difficulties. A family history of food allergy was also associated with an increased food aversion score.<sup>37,38</sup> Parental trait and state anxiety scores were also found to negatively correlate to the change in nutritional habits after an oral food challenge (OFC).<sup>39</sup>

No associations between country of study, race, gender, or study design and the prevalence of feeding difficulties were made apparent.

### 3.7 | Impacts

Two of the included studies which focused on children with CMA showed the long-term effect of cow's milk elimination diets within the first 2 years of life on persisting avoidant feeding behavior 7–10 years later,<sup>41</sup> and altered nutritional habits at age 2–6,<sup>43</sup> respectively.



TABLE 5 The studies quantifying the median/mean feeding difficulty scores of the food allergic group versus the control group.<sup>13,39–43</sup>

| First author and year of publication | Size of study | Means of measuring feeding difficulty | Feeding difficulty terminology         | Measure outcomes                 | Median/Mean scores: food allergic group vs. control group |
|--------------------------------------|---------------|---------------------------------------|--|----------------------------------|---|
| Ercan 2022                           | 62            | CEBQ                                  | Fussy eating                           | Emotional over-eating            | 4 vs. 7   |
|                                      |               |                                       |  | Slowness in eating               | 7 vs. 10  |
|                                      |               |                                       | Food avoidance                         | Food fussiness                   | 7 vs. 12  |
|                                      |               |                                       | Satiety responsiveness                 | Food avoidance                   | 59 vs. 53   |
|                                      |               |                                       |  | Satiety responsiveness           | 25 vs. 20   |
| Herbert 2017                         | 74            | BPFAS                                 | Mealtime behavioral feeding difficulty | Child problem behavior frequency | 51.61 vs. 45.6 <sup>c</sup>                               |
|                                      |               |                                       |  | Total frequency                  | 70.93 vs. (NR)  |
| Maslin 2016                          | 101           | Child food neophobia scale            | Food neophobia                         | Food neophobia                   | 36 vs. 34 <sup>b</sup>                                    |
| Maslin 2016                          | 101           | CEBQ                                  | Fussy eating                           | Fussy eating                     | 18 vs. 15 <sup>b</sup>                                    |
|                                      |               |                                       | Avoidant eating behavior               | Avoidant eating behavior         | 7.8 <sup>a</sup>  |
| Rigal 2016                           | 45            | FSQ<br>FPI                            | Food neophobia                         | Food neophobia                   | 6.8 vs. 6.0   |

Abbreviations: BPFAS, Behavioural Paediatrics Feeding Assessment Scale; CEBQ, Child Eating Behaviour Questionnaire; FPI, Food Preference Inventory; FSQ, Food Situation Questionnaire; NR, not reported.

<sup>a</sup>7.8% increase in prevalence of avoidant eating behavior in the food allergic group compared to healthy control group; no absolute prevalence values available.

<sup>b</sup>Not statistically significant.

<sup>c</sup>This number refers to published data from typically developing children.

One study reported unaffected growth,<sup>9</sup> whereas four studies reported either a higher number of underweight children and reduced growth,<sup>41</sup> weight loss/poorer weight gain<sup>16,37</sup> or failure to thrive<sup>45</sup> in the presence of feeding difficulties. Anxiety in the patient and anxiety or stress in the parents were also reportedly higher in those affected by feeding difficulties.<sup>13,39,45</sup>

## 4 | DISCUSSION

To the best of our knowledge, this is the first systematic review on the prevalence, terminology (definitions), and outcomes of feeding difficulties in food-allergic children. This review demonstrates the sparsity of publications and lack of consensus on terminology and diagnostic criteria specifically in relation to food allergy.

The primary objective was to establish the prevalence of feeding difficulties in food-allergic children. Across six studies, using a variety of criteria, this prevalence ranged from 13.6% to 40%. This increased to 40.2% when including parental recall reports of feeding difficulties; however, studies have shown the lack of accuracy with parental recall of dietary habits in children.<sup>44</sup>

Within the literature, with the use of different diagnostic questionnaires and criteria, the prevalence of feeding difficulties in healthy children has been reported in the range of 20%,<sup>20</sup> 25%–30%<sup>3,46</sup> and even up to 45%.<sup>7,47</sup> Picky eating in healthy children has been reported to range between 14% and 50%.<sup>19,48</sup> As a result of this significant range of prevalence (14%–50%), it is challenging to ascertain which figure should be referenced when comparing healthy and food-allergic children.

Maslin et al.<sup>9</sup> and Rodrigues et al.<sup>38</sup> used the same diagnostic tool in children with CMPA but reported a prevalence of 13.6% and 32.1% of feeding difficulties/problems, respectively. This may be explained by the difference in the proportion of children eliminating two or more foods: 28.8% in the study by Maslin et al.<sup>9</sup> compared to 63% in the study by Rodrigues et al.<sup>45</sup> Also, while the age of food allergy onset was similar, the age at time of study was significantly different: 13 months and 3.3 years. Two published studies included in this review indicated a peak prevalence around age 3,<sup>41,43</sup> which has previously been hypothesized in the literature.<sup>38,49,50</sup> It is worth noting, however, that none of the included papers reported the age of feeding difficulty onset or diagnosis.

Out of the two retrospective chart reviews, Meyer et al.<sup>16</sup> reported the highest prevalence of feeding difficulties (30% as assessed by HCPs) in a population of non-IgE-mediated allergic children. The patients in this study were recruited from a tertiary referral center that specializes in gastroenterology, with 78.7% of included children eliminating three or more foods, as opposed to only 18.2% in the retrospective analysis by Su et al.<sup>37</sup> (21.7% prevalence). The predominance of acute FPIES (88.7%) in the review by Su et al.,<sup>37</sup> compared with the more diverse cohort of non-IgE-mediated allergies in the review by Meyer et al.,<sup>16</sup> may also contribute to this difference in prevalence, with chronic phenotypes more strongly associated with learned feeding aversions. The study by Meyer et al.<sup>16</sup> may therefore be representative of a specific, more severe, allergic phenotype. In addition, while the Wright et al.<sup>20</sup> criteria had been used in a healthy UK population before, behaviors such as closing mouth or turning head when food is offered are commonly seen in normal developing toddlers,

thereby potentially contributing to an over-reporting of feeding difficulties by Meyer et al.<sup>16</sup>

Repeated, extended episodes of discomfort and pain from feeding are often experienced by patients with non-IgE-mediated food allergy for an extended period of time as a result of delayed trigger identification or lack of symptom resolution despite food avoidance.<sup>51</sup> Non-IgE-mediated food allergies are therefore thought to have a stronger association with feeding difficulties than IgE-mediated allergies. Only one identified paper reported the prevalence of feeding difficulties in IgE-mediated food-allergic children (19%). Only 28.4% of the assessed cohort had more than two food allergies. In addition, many different feeding difficulties, such as food refusal, selective eating, food neophobia and lack of appetite, as well as parental misperception, could have contributed to the “lack of interest in new foods” and “monotony of diet” that was reported by their own investigative tool. It is therefore difficult to compare the results of this study to others. One of the other included papers reported the behavioral feeding difficulty scores<sup>52</sup> of IgE-mediated food allergic children with feeding difficulties, which, although was found to be statistically higher than that of typically developing children, did not compare to children with non-IgE-mediated allergy.<sup>42</sup> This systematic review is therefore unable to conclude any specific comparative data on non-IgE and IgE-mediated allergies.

Food allergy management relies on strict adherence to elimination diets and emergency treatment in the event of allergen exposure when reactions occur. Four of the studies reported an association between increased number of eliminated foods and the presence and severity of feeding difficulties.<sup>16,37,39,41</sup> This, coupled with the long-term persistence of feeding difficulties shown in children up to 10 years after food allergy remission,<sup>41,43</sup> highlights the potential effects of the elimination diets themselves or the resultant anxiety or fear from a perception of greater risk. Further examples of this have been described in case reports in the literature.<sup>21</sup>

One of the secondary objectives of this systematic review was to identify the different definitions used for feeding difficulties. Out of the 10 included studies, 11 different diagnostic tools and 12 different terminologies for feeding difficulties were used (Table 1). Different terminology and diagnostic criteria have been used in the literature dependent on the type of food allergy, and therefore account for the expected direct presentations of the disease, feeding difficulty phenotype and the age groups being assessed, due to different expected developmental milestones with regard to oral-motor skills and self-feeding ability. Multiple tools exist for assessing feeding difficulties in pediatrics but consensus in the literature for the best validated tools for food-allergic children, stratified by population subsets, does not exist. The studies included in this systematic review therefore use criteria that either the authors themselves had used before, either in clinical practice or research, or had been used in similar populations in the literature. It is therefore not possible, based on the publications included in this systematic review, to suggest a most appropriate specific terminology and specific tool

for the assessment of feeding difficulties in food-allergic children. However, Godday et al.<sup>7</sup> published a consensus definition and diagnostic criteria for pediatric feeding disorder in 2019, which may be useful in future studies assessing feeding difficulties in food allergic children.

Furthermore, this systematic review also aimed to assess the impact of feeding difficulties. Meyer et al. reported faltering growth in 67.6% of children with non-IgE-mediated food allergies with feeding difficulties, compared to 45.8% in those without and Mukkada et al. reported failure to thrive in 21% of those with feeding difficulties. Previous publications in the literature have suggested faltering growth, which is a relatively common finding in food allergic children,<sup>2,16,53</sup> to be a trigger for the development of feeding difficulties.<sup>54,55</sup> Herbert et al.<sup>41</sup> associated the decreased HRQoL in food allergic individuals, that has been commonly reported in the literature, with the presence of mealtime behavioral problems; however, there is no HRQoL questionnaire specific to feeding difficulties in food allergy.<sup>8,9,56,57</sup>

#### 4.1 | Limitations

This systematic review has limitations. Most notably, the conclusions of this systematic review are limited by the methodological heterogeneity of the available literature and limited number of eligible studies. Comparison of data from different countries is challenging, with the prevalence of different food allergies varying by geography,<sup>58</sup> as well as eating habits, parenting styles and healthcare systems. The majority of patient samples and papers were from Caucasian populations. Other factors, such as patient age and type of food allergy, may further contribute to the heterogeneity of results due to their vastly different clinical presentations. Also, while all studies contained children with food allergies diagnosed by a HCP, oral food challenges, the gold standard for diagnosis, were performed on all patients in only two studies.<sup>43,44</sup>

While Ercan et al.<sup>43</sup> and Maslin et al.<sup>41</sup> have suggested that there is a persistence of the feeding difficulty phenotype many years after the resolution of food allergy, none of the included studies contained long-term follow-up data on the development and evolution of feeding difficulties within this population. The high number of cross-sectional studies in this review therefore does not allow us to exclude transient feeding difficulties, such as selective eating, food refusal, or food neophobia phenotypes, which are often seen in healthy children.<sup>2</sup> Information on supportive interventions such as dietitian access was also not included in any of the publications. Therefore, the potential effects such support may have had on the development and/or persistence of feeding difficulties also cannot be assessed.

Nine of the included studies relied on direct tertiary clinic recruitment of patients, which may indicate a more complex, severe, or persistent profile warranting such referral. These studies may

therefore only be representative of the more challenging end of the food allergy spectrum. This suggests that feeding difficulties might be more prevalent in specific subsets of food-allergic children.

The increased parental anxiety<sup>3,8,13,39</sup> and attention on feeding and mealtime behavior<sup>11</sup> in parents of food allergic children is likely to lead to an inherent bias in the reporting of feeding difficulties. The amplified state of vigilance, to avoid accidental food allergen exposure, has been shown to increase within food allergic children as they age.<sup>10,59</sup> Misconceptions among parents and HCPs on what constitutes “normal” feeding development, and which feeding difficulties require further evaluation, monitoring, and management, may have influenced the data. What may be regarded as dysfunctional feeding, may actually be necessary adaptation to living with food allergy.

## 4.2 | Strengths of the study

The comprehensive review of eight international electronic databases with high methodological rigor increases the strength of the conclusions of this systematic review.

Future studies that could address the knowledge gaps identified in this systematic review are summarized in Appendix S3.

## 5 | CONCLUSION

This systematic review supports the idea of feeding difficulties being common in food-allergic children, particularly those with multiple food allergies. Great heterogeneity in definitions and diagnostic criteria was identified. Given the increasing prevalence of food allergies, this highlights the need for consensus-based definitions and diagnostic tools for feeding difficulties in food allergy to ensure early recognition and optimal management by multidisciplinary teams. This Task Force aims to conduct a Delphi Consensus exercise to reach agreement on which tools and terminology should be used to assess feeding difficulties in children with food allergies. Prospective, long-term follow-up data in this area are needed to understand long-term patterns as well as the potential underlying pathologic mechanisms and risk factors linking food allergy to the development of feeding difficulties.

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### CONFLICT OF INTEREST STATEMENT

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### PEER REVIEW

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#### SUPPORTING INFORMATION

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

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