

ORIGINAL ARTICLE

Gastroenterology

Esophageal food bolus impaction in children: A 15-year experience and a review

Roberto Privato¹  | Francesco Pezzoli¹ | Simona Barni² | Sara Renzo³ | Monica Paci³ | Jacopo Barp³ | Mattia Giovannini^{1,2} | Benedetta Pessina¹ | Leonardo Tomei² | Luca Scarallo^{3,4} | Paolo Lionetti^{3,4} | Francesca Mori²

¹Department of Health Sciences, University of Florence, Florence, Italy

²Allergy Unit, Meyer Children's Hospital IRCCS, Florence, Italy

³Gastroenterology and Nutrition Unit, Meyer Children Hospital IRCCS, Florence, Italy

⁴Department of NEUROFARBA, University of Florence, Florence, Italy

Correspondence

Roberto Privato, Department of Health Sciences, University of Florence, Viale Pieraccini 24, 50139 Florence, Italy.
Email: roberto.privato@unifi.it

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Abstract

Objectives: We aimed to analyze the episodes of esophageal food bolus impaction (EFI) occurred over a time of 15 years in children admitted to a large pediatric emergency department (PED), documenting their clinical presentation, underlying pathology, management, biopsy rate, and follow-up visits. Additionally, to combine our institutional experience with the existing literature, a comprehensive review was conducted.

Methods: We reviewed the medical records of all children presenting to our PED with EFI from 2010 to 2024. The comprehensive review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement for systematic reviews. Electronic databases including PubMed/Medline and EMBASE were screened. The data obtained was synthesized to map out the actual status and current literature on pediatric EFI.

Results: We identified 54 cases of EFI. Overall, 22 patients (41%) had underlying pathology. Previous episodes were reported in 14 cases (26%). Urgent endoscopy was performed in 31 cases (57%). The presence of underlying pathology was associated with the need for endoscopic removal ($p = 0.013$), as well as the history of previous episodes ($p = 0.016$). Biopsies were performed in 14 cases (26%). Pediatric gastroenterologists showed a higher rate of performed biopsies compared to surgeons, as well as higher rate of follow-up visits. An underlying disease was found during later clinical follow-up in 5 out of 54 cases of EFI (9%). A comprehensive review of 16 studies revealed high rates of underlying pathology and low rates of biopsies and follow-up visits among children with EFI.

Conclusion: Increased vigilance in identifying underlying pathologies in children with EFI is crucial. The importance of performing biopsies, regardless of prior anatomical conditions, and the need for ongoing follow-up to ensure timely and accurate diagnoses should be addressed through shared protocols.

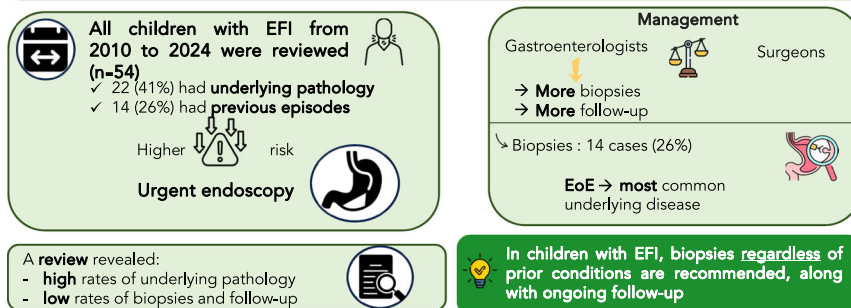
Roberto Privato and Francesco Pezzoli are co-first authors.

[Correction added on 26 November 2024, after the first online publication: the affiliation of Simona Barni has been revised.]

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EFI may be a serious event and require urgent
Following the rising incidence of eosinophilic esophagitis (EoE), an increase of EFI in children is reported, but large data are lacking.



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endoscopy, eosinophilic esophagitis, foreign body, pediatric

1 | INTRODUCTION

According to literature,¹ esophageal food impaction (EFI) is the third most common nonbiliary gastrointestinal (GI) emergency among adults, after upper and lower GI bleeding. Most frequently, impacted food is meat.² The treatment for EFI is endoscopic removal (ER) of impacted bolus, which should be performed as soon as possible to avoid complications, such as esophageal bleeding or perforation.³

Unlike inorganic foreign body obstruction, EFI unfrequently occurs in patients without an underlying esophageal pathology.⁴ EFI is frequent in the fourth or fifth decades of life.^{5,6} Nevertheless, literature is showing an increase in incidence among young people as a consequence of the rising incidence of eosinophilic esophagitis (EoE),⁷ a chronic T helper 2-mediated inflammatory disease characterized clinically by symptoms of esophageal dysfunction and histologically by the presence of eosinophilic infiltration, as described by recently published guidelines.⁸ However, data concerning the incidence of EFI in children are lacking, and research focusing on the epidemiological and clinical patterns of pediatric EFI is limited. Previous literature has shown high rates of potentially treatable underlying pathology (such as EoE or strictures) in children with EFI.⁹ Therefore, researchers recommend performing biopsies in all pediatric patients with EFI undergoing ER.¹⁰ Nonetheless, studies show variable biopsy rates and follow-up visits.

We aimed to analyze the EFIs occurred over a time of 15 years in children admitted to a pediatric emergency department (PED), documenting clinical presentations, underlying diseases, management, biopsy rate, and follow-up visits. Aiming to map out the actual status and current literature, a comprehensive review of pediatric EFI was also conducted.

What is Known

- Epidemiological data on the incidence of esophageal food impaction (EFI) in the pediatric population are lacking.
- Studies show variable biopsy rates and heterogeneous follow-up visits among children with EFI.

What is New

- Patients with underlying pathology have a higher risk of urgent endoscopic removal, as well as children with a history of previous episodes.
- There are differences in the rates of biopsies performed and follow-up visits between different subspecialties.
- Biopsies are rarely performed in children with known anatomical conditions, potentially missing or delaying diagnosis of eosinophilic esophagitis.

2 | METHODS

2.1 | Retrospective review of our data

This is a retrospective study conducted at a third-level pediatric hospital (Meyer Children's Hospital IRCCS) in Florence. The PED database was screened for all children presenting with EFI from January 1, 2010 to May 31, 2024. We examined the outpatient clinic records for all instances of specific and nonspecific

codes related to EFI as per the International Classification of Disease, Ninth Revision (ICD-9). These included codes for dysphagia (7872 and 43,882), esophageal foreign bodies (9351), and other related codes (53,012 for acute esophagitis, 5303 for esophageal stricture, 30,750 for unspecified feeding disorder). Data collected included age, sex, day of the week and time of PED admission, type of food ingested, clinical features, management strategies, subspecialty performing the ER, underlying pathologies, biopsy results, and follow-up visits.

At our institution, the pediatric gastroenterology or surgery service, per a predetermined schedule, is consulted by the PED to manage EFI patients. From 2010 to 2019, there were two pediatric gastroenterologists qualified to perform endoscopies, while from 2020 onwards there have been three; the number of qualified surgeons has varied during the observation period but has consistently been higher than three. Each of the gastroenterologists and surgeons performed at least one procedure during the observation period. Unlike pediatric gastroenterologists, surgeons were on call at night and during weekends. The decision to schedule follow-ups was entirely based on the clinician's judgment. Quantitative variables were portrayed as medians and interquartile ranges (IQRs). Categorical variables were described as numbers (*n*) and percentages (%). Mann–Whitney *U* test was used to compare continuous-type patient characteristics. Analyses of statistical differences between categorical variables were carried out using the χ^2 or Fisher exact test. Univariate and multivariate binary logistic regression was performed aiming to identify predictors of upper GI endoscopy need. Hosmer and Lemeshow's test was used to assess the goodness of fit of the model. Unadjusted (uOR) and adjusted odds ratios (aOR) with their 95% confidence intervals (CIs) were reported. All statistical tests were two-sided and a $p < 0.05$ was considered as the statistically significant threshold.

All data were analyzed using the SPSS statistical package, release 21.0 (SPSS Inc.).

2.2 | Review of the literature

We followed the structure of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standards to report inclusion and exclusion decisions.¹¹ Guidelines for systematic reviews were followed.¹²

2.2.1 | Search strategy

A literature search was conducted in May 2024, using electronic databases to identify relevant texts including PubMed/Medline and EMBASE. We used the following

search terms: “food impaction children,” “pediatric food impaction,” “food bolus,” “esophageal impaction,” “esophageal bolus,” “esophageal obstruction,” “esophageal foreign body,” “foreign body ingestion.” We only included English language studies. No limitations were placed on the year of publication or study design. Two independent reviewers conducted the initial title and abstract screening using predefined inclusion and exclusion criteria. Full-text articles of potentially eligible studies were then assessed independently by the same reviewers. Discrepancies were resolved through discussion, and a third reviewer was consulted if consensus could not be reached.

2.2.2 | Inclusion and exclusion criteria

Inclusion criteria for this review included: research studies focusing on pediatric populations (ages 0–18 years); studies reporting at least three of the following: (1) rate of urgent ERs, (2) underlying etiologies of the EFI, (3) symptoms, (4) biopsy rate, and (5) follow-up rate.

Exclusion criteria included: (1) nonempirical study (e.g., clinical summary or review articles, opinion pieces, comments, editorials, or letters to the editor); (2) full-text version of the article not available; (3) study sample including both children and adults in which the results were not reported by age; (4) case series reporting less than 10 cases; and (5) conference abstracts and short communications.

3 | RESULTS

3.1 | Retrospective study

The selected ICD-9 codes yielded a total of 494 emergency department admissions; 54 were cases of EFI. Demographic and clinical characteristics of the population are summarized in Table 1. Median age of children presenting with EFI was 10 (IQR: 5–14) years. The most frequent presenting symptom was dysphagia (70%), followed by food-stuck sensation (39%), vomiting (31%), pain (22%), and drooling (20%). The most frequently impacted food was meat (52%), followed by candies (11%), bread (7%), and fresh fruit (5%). The trigger was unknown in 13 cases (25%). Previous episodes were reported in 14 cases (26%). Urgent endoscopy was performed in 31 cases (57%): in 25 (80%) cases by a pediatric surgeon and in six (20%) cases by a pediatric gastroenterologist. In all the procedures, the food boluses were seen and removed. Biopsies were performed in 14 cases (26%). Pediatric gastroenterologists showed a higher rate of performed biopsies (100%) compared to surgeons (32%). Follow-up visits were performed in 16 cases (30%). The group who underwent biopsies had higher rates of follow-up

TABLE 1 Demographic and clinical characteristics and clinical presentation of children presenting to the ED with EFI.

	Total EFI (n = 54)	EFI requiring endoscopy (n = 31)	EFI not requiring endoscopy (n = 23)	p
Age in years [median; (Q1–Q3)]	10 (5–14)	12 (5–15)	9 (4–12)	0.13 ^a
Males [n (%)]	32 (59)	17	15	0.40
Symptoms				
Dysphagia [n (%)]	38 (70)	24	14	0.29
FS sensation [n (%)]	21 (39)	14	7	0.40
Vomiting [n (%)]	17 (31)	7	10	0.17
Chest pain [n (%)]	12 (22)	5	7	0.40
Drooling [n (%)]	11 (20)	4	7	0.27
Underlying pathology	22 (41)	20	2	0.013
EoE [n (%)]	10 (18)	10	0	0.005
Anatomical esophageal conditions	10 (18)	10	0	0.003
Other [n (%)]	2 (4)			
Previous episodes	13 (24)	12	1	0.016
Urgent endoscopy [n (%)]	31 (57)			
Spontaneous [n (%)]	22 (41)			
Coca-cola [n (%)]	1 (2)			
Biopsy [n (%)]	14 (26)			
Follow-up [n (%)]	16 (30)	16	0	<0.001

Abbreviations: ED, emergency department; EFI, esophageal food bolus impaction; EoE, eosinophilic esophagitis; FS, food stuck.

^aMann–Whitney *U* test.

visits (100% vs. 9% odds ratio [OR]: 5.3 95% CI: 1.9–14.7, $p < 0.001$). An underlying disease was found during clinical follow-up in 5 out of 54 children (9%), all of whom were diagnosed with EoE. Pediatric gastroenterologists had a higher rate of follow-up visits compared to surgeons (100% vs. 52%).

Spontaneous resolution was obtained in 22 cases (41%). Coca-cola was administered in eight cases (15%), obtaining resolution in one (2%).

Overall, 22 patients (41%) suffered from underlying diseases: 10 (50%) EoE, 10 (50%) known anatomical conditions (including history of esophageal atresia [EA], history tracheoesophageal fistula [TEF] after surgical repair, and corrosive stricture), one achalasia, and one myotonic dystrophy. Only three (30%) patients with known anatomical conditions underwent biopsies.

In the univariate analysis, the presence of underlying diseases was associated with the need for ER ($p = 0.013$ unadjusted odds ratio [uOR]: 4.4, 95% CI: 1.3–14.7), as well as the history of previous episodes ($p = 0.016$ uOR: 6.3, 95% CI: 1.2–32.3). These two variables remained significant after the multivariate logistic regression (Table 2). The group with EoE was older than the rest of the study

TABLE 2 Univariate and multivariate logistic regression analysis of the need for urgent endoscopy in children with EFI.

	uOR	p	aOR	p
Age	1.09 (0.9–1.2)	0.22		
Male	0.5 (0.2–1.7)	0.33		
Meat bolus	3.4 (0.8–13.2)	0.08		
Underlying pathology	6.6 (1.8–24)	0.006	6.7 (1.7–27.3)	0.002
Previous episodes	6.3 (1.2–32)	0.017	8 (1.4–45)	0.03

Abbreviations: aOR, adjusted odds ratio; EFI, esophageal food bolus impaction; *p*, *p* value; uOR, unadjusted odds ratio.

population (13 years IQR: 10–15 vs. 9 years IQR: 4–13, $p = 0.018$).

3.2 | Review of the literature

The PRISMA diagram of the results of this search is shown in Figure 1. We identified 234 potentially eligible papers from the PubMed search and 562 from the

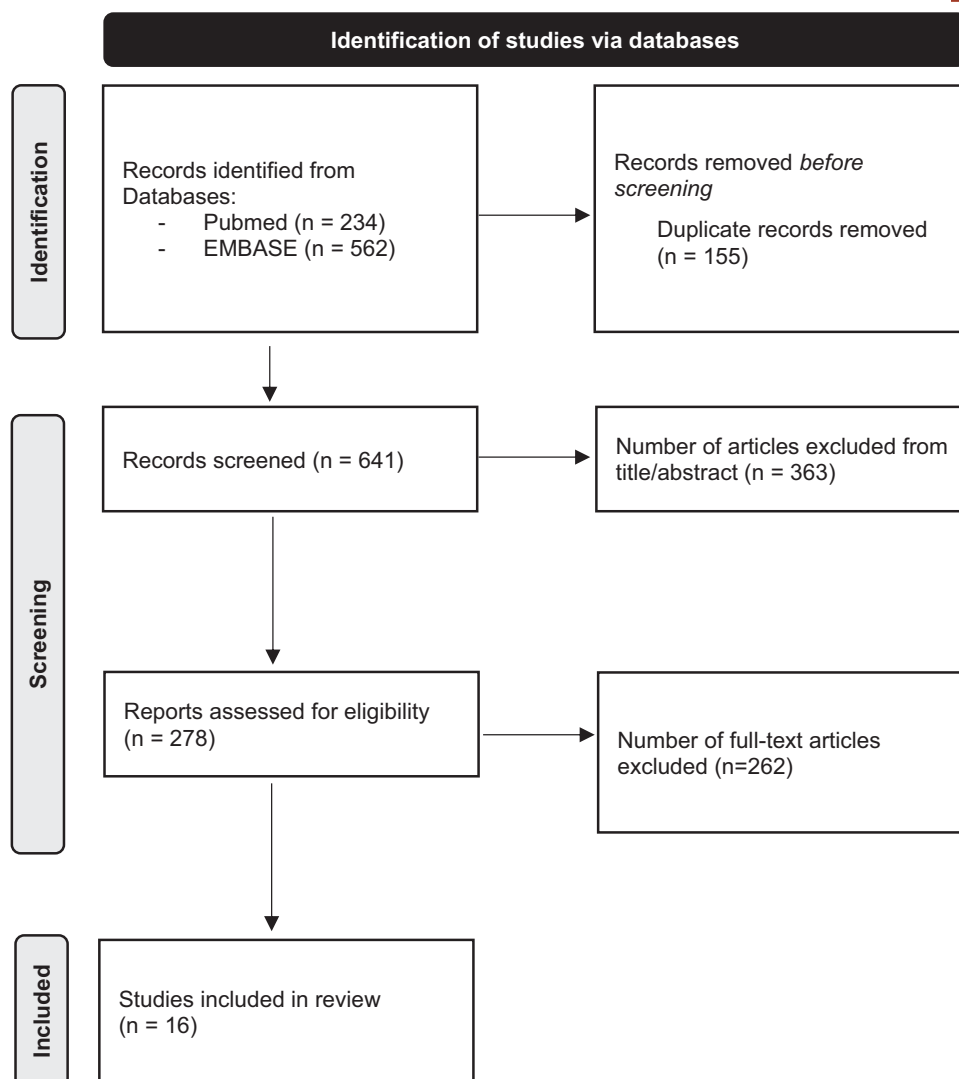


FIGURE 1 Path to study selection. *n* = number of records.

EMBASE database. After review of the titles and abstracts, we selected 278 papers for full-text review. After the removal of duplicates and the full-text review, 16 studies^{9,10,13–26} met the criteria for data charting and are discussed in this review (Table 3), including a total of 674 patients with EFI. Cohen's κ showed substantial agreement between the two reviewers ($0.68\ p < 0.05$).

3.2.1 | Underlying etiologies

Underlying etiologies were reported in all the included studies (Table 3). EoE and anatomical esophageal conditions (i.e., history of EA or TEF, strictures due to prior surgeries, corrosive strictures) were the main predisposing factors according to most studies. EoE was the most reported predisposing disease in 10/16 studies (62%) with 2/10 focusing only on EoE^{14,21} (Table 3). Lao et al.¹³ reported the histological

evidence of “esophagitis” as the main underlying condition but no patient had evidence of significant eosinophilia on esophageal biopsy to suggest EoE as the cause of EFI. In the study by Hurtado et al.,⁹ endoscopic morphologies of the esophageal mucosa were abnormal in 40/65 patients (82%) but only 15 patients fulfilled the criteria for EoE on histology.

In two studies,^{24,25} no cases of EoE were reported. Both studies documented the presence of anatomical esophageal conditions as the main underlying disease.

3.2.2 | Management

All the included papers described the management strategies of EFIs. ER was the most reported therapeutic approach across all the studies (Table 3). Six studies^{9,10,17,18,20,23} reported on the subspecialties performing the ER. According to the literature, readily available equipment for food bolus removal should

TABLE 3 Characteristics of studies included in the scoping review.

References	Population	Study type	Aim of the study	Symptoms	Underlying pathology	Biopsy rate	Follow-up	Urgent endoscopy
Lao et al. ¹³	12	R	- To review the clinical course of 12 pediatric patients with EFI over a 10-year period.	- Drooling and dysphagia, <i>n</i> = 11 - Choking and vomiting, <i>n</i> = 4 - Chest pain, <i>n</i> = 1 - Odynophagia, <i>n</i> = 1	- Prior TEF repair, <i>n</i> = 1 - Esophagitis, <i>n</i> = 5 - Nonspecific EMA, <i>n</i> = 4	7/12	10/12	11/12
Luis et al. ¹⁴	13	Case series	- To report EFI cases to point out the potential involvement of pediatric surgeons in diagnosis and treatment. - To report data on the motor function of the esophagus in children with EFI.	- Dysphagia, <i>n</i> = 9 - Pain, <i>n</i> = 3 - Vomiting, <i>n</i> = 2 - Heartburn, <i>n</i> = 1	- EoE, <i>n</i> = 13	Not described	All cases	7/13
Hurtado et al. ⁹	65 (72 events)	R	- To analyze the clinical course, management, and outcome of children with impacted esophageal FBs.	Not described	- Strictures, <i>n</i> = 13 - Esophagitis, <i>n</i> = 27	24/65	12/65	49/65
Antoniou et al. ¹⁵	35	R	- To report authors' experience and to evaluate the effectiveness of their protocol in the work-up and management of children with ingested FBs.	Reported for all foreign bodies, not specifically for food bolus	- Stricture post EA repair, <i>n</i> = 5 - EoE, <i>n</i> = 2 - Prior pyloric stenosis operation, <i>n</i> = 1	16/35	Not described	23/35
Diniz et al. ¹⁶	43	R	- To determine the frequency of the different causes of food impaction in patients who undergo an esophagram or upper GI examination.	Not described	- EoE, <i>n</i> = 23 (53%) - Prior EA repair, <i>n</i> = 11 (26%) - Prior Nissen fundoplication, <i>n</i> = 5 (12%)	27/43 (63%)	Not described	27/43
El-Matary et al. ¹⁷	18	R	- To analyze the clinical course, management, and outcome of children with impacted esophageal FBs	- Dysphagia, <i>n</i> = 4 - GERD-like symptoms, <i>n</i> = 1	- EoE, <i>n</i> = 7	20 out of total 140 FB impactions	Not described	All cases

TABLE 3 (Continued)

References	Population	Study type	Aim of the study	Symptoms	Underlying pathology	Biopsy rate	Follow-up	Urgent endoscopy
Williams et al. ¹⁰	19	R	- To assess the rate of esophageal biopsy at the time of EFI removal among different pediatric subspecialists - To determine the rate of treatable esophageal pathology identified by mucosal biopsy.	Not described	- Stricture, <i>n</i> = 11	9/19	Not described	All cases
Hiremath et al. ¹⁸	72 (95 events)	R	- To examine the relationship between EFI, EE, and EoE.	- Food stuck sensation, <i>n</i> = 35 - Vomiting, <i>n</i> = 26 - Odynophagia, <i>n</i> = 20 - Drooling, <i>n</i> = 14 - Choking, <i>n</i> = 14	- EoE, <i>n</i> = 8 - Narrowing/stricture at anastomotic site, <i>n</i> = 5 - Luminal stenosis, <i>n</i> = 4 - Rings, <i>n</i> = 6 - Unspecified anatomical comorbidities, <i>n</i> = 14	24 out of 33 requiring endoscopy	Not described	33/95
Kriem et al. ¹⁹	23 (39 events)	R	- Assessing the safety and efficacy of the push technique in managing pediatric EFI.	- Dysphagia, <i>n</i> = 22 - Drooling, <i>n</i> = 11 - Chest pain, <i>n</i> = 5 - Odynophagia, <i>n</i> = 3	- History of esophageal stricture, <i>n</i> = 10 - EoE, <i>n</i> = 8 - History of caustic injury, <i>n</i> = 1 - History of repaired TEF, <i>n</i> = 9 - Reflux esophagitis, <i>n</i> = 2 - Postsurgical stricture, <i>n</i> = 1 - Crohn's esophageal stricture, <i>n</i> = 1	10/23	Not described	All cases
Ettyreddy et al. ²⁰	35	R	- To describe the presentation, management, and outcomes associated with EFI. - To identify the key clinical features of pediatric EFI that are associated with a diagnosis of EoE.	- Dysphagia, <i>n</i> = 34 - Choking, <i>n</i> = 26 - Vomiting, <i>n</i> = 23 - Drooling, <i>n</i> = 23	- EoE, <i>n</i> = 26 (74%) - Neurologic impairment, <i>n</i> = 5 (15%) - Reflux esophagitis, <i>n</i> = 1 - Prior surgeries, <i>n</i> = 1	30/35	Not described	All cases
Gunasekaran et al. ²¹	30	R	- To compare clinical features, endoscopic findings, and esophageal histology including peak eosinophils and AHF, - to compare the outcomes of EoE patients with dysphagia presenting with and without EFI.	- Dysphagia, <i>n</i> = 30 - Heartburn, <i>n</i> = 3 - Regurgitation, <i>n</i> = 1 - Vomiting, <i>n</i> = 2 - GI bleeding, <i>n</i> = 1	- EoE, <i>n</i> = 30	All cases	All cases	All cases

(Continues)

TABLE 3 (Continued)

References	Population	Study type	Aim of the study	Symptoms	Underlying pathology	Biopsy rate	Follow-up	Urgent endoscopy
Le et al. ²²	101	R	- To determine the efficacy of MD for organic EFI in the pediatric population, especially in children with EoE.	Not described	- EoE, <i>n</i> = 27	Not described	58/101	77/101 ^a
Rosenwald et al. ²³	123 (127 events)	R	- To identify the factors associated with appropriate pediatric subspecialty follow-up post-EFI.	Symptom persistence after EFI was described.	- Previous esophageal stricture 17 (13%) - Previously diagnosed - EoE in 14/127 (11%) 72 had >15 eos/hpf on histology	95/127	63/123	All cases
Shafiq and Devarbhav ²⁴	11	R	- To report authors' experience with endoscopic management of FB ingestions in children.	- Reported for all foreign bodies, not specifically for food bolus.	- Corrosive stricture, <i>n</i> = 7 - Anastomotic stricture at the site of previous TEF surgery, <i>n</i> = 2	Not described	Not described	All cases
Raju et al. ²⁵	33 (86 events)	R	- To analyze the clinical course, management, and outcome of children with impacted esophageal foreign bodies.	- Reported for all foreign bodies, not specifically for food bolus.	- TEF with EA in 15 - Congenital esophageal stenosis in 1 - Other EA in 3 - Corrosive esophageal stricture in 9 - Miscellaneous in 2	1/33	All cases	All cases
Quitadamo et al. ²⁶	41	P	- To provide insights into EFI episodes in children.	- Drooling, <i>n</i> = 29 - Esophageal bolus sensation, <i>n</i> = 28 - Chest pain, <i>n</i> = 7 - Dysphagia, <i>n</i> = 6 - Vomiting, <i>n</i> = 3 - Food refusal, <i>n</i> = 1	- EoE, <i>n</i> = 20 - Strictures (on EA), <i>n</i> = 4 - Achalasia, <i>n</i> = 1 - Esophageal duplication, <i>n</i> = 1 - Strictureing peptic esophagitis, <i>n</i> = 1 - Strictureing caustic esophagitis, <i>n</i> = 1 - Esophageal congenital stricture, <i>n</i> = 1	All cases	Recorded only for patients receiving pharmacological therapy	All cases

Abbreviations: AHF, additional esophageal histological features; EA, esophageal atresia; EE, esophageal eosinophilia; EFI, esophageal food bolus impaction; EMA, esophageal motility abnormalities; EoE, eosinophilic esophagitis; eos/hpf, eosinophils per high power field; FB, foreign bodies; GERD, gastroesophageal reflux disease; GI, gastrointestinal; MD, medical disimpaction; P, prospective; R, retrospective; TEF, tracheoesophageal fistula.

^aEither during their initial presentation or as an outpatient.

include appropriately sized endoscopes, overtubes, accessories such as polypectomy snares, rat-tooth and alligator forceps, a Roth retrieval net, Dormia basket, and grasping forceps.²⁷ The endoscopist should select proper accessories based on the type of food and personal expertise. Complications during the procedure may occur, including esophagus laceration, perforation, and hematoma formation.²⁸ In our review, only a few studies reported detailed information regarding the type of endoscopy devices and accessories for removal. For example, in the study by Quitadamo et al.,²⁶ disimpaction was obtained using rat-tooth forceps or, in selected cases, with standard oval polypectomy snare. In the study by Ettyreddy et al.,²⁰ both flexible and rigid endoscopy were successful in relieving impaction. None of the studies reported complications during the procedures. One study¹⁹ compared the use of the pull (extraction) endoscopic technique with the push (advancement) technique in managing EFIs and concluded that both techniques are safe and effective in pediatric patients. As for nonendoscopic management, glucagon is the mainstay pharmacological treatment among adults, as it relaxes the esophageal smooth muscle and the lower esophageal sphincter, promoting the spontaneous passage of an impacted food bolus.²⁹ However, limited studies reporting on children are available. A medical disimpaction (MD) approach was described by Lee et al.,²² concluding that MD may be of help for symptom resolution in children without EoE. Attempts of disimpaction through administration of fizzy drinks were reported by Antoniou and Christopoulos-Geroulanos,¹⁵ resulting in the clearance of the bolus in 12/15 patients. Two studies investigated factors associated with spontaneous resolution.^{9,18}

3.2.3 | Biopsy rates

Biopsy rates were reported in 13/16 studies (Table 3). However, one of these reported the biopsy rate in the overall sample, which included both food and nonfood esophageal impactions.¹⁸ Few studies provided information about the sites and the number of esophagus biopsies. Rosenwald et al.²³ reported the highest number of biopsies overall. Five studies^{9,10,18,23} described differences in biopsy rates based on subspecialties performing the endoscopy and they all showed higher biopsy rates when the procedure was performed by gastroenterologists.

The factors influencing the decision to proceed with biopsies have been investigated by few authors. According to El-Matary et al.,¹⁷ 21 patients (92%) did not have biopsies taken on the basis of a normal-looking esophagus on endoscopy. In one study,¹³ five patients were not biopsied and four of those had a history of neurologic impairment that was attributed to the EFI

event. According to Rosewald et al.,²³ biopsied individuals were less likely to have previous esophageal stricture (8% vs. 28%, $p = 0.005$) but were more likely to have other endoscopic findings suggestive of EoE. In the study by Hurtado et al.,⁹ biopsies were performed on medical decision. In the study reporting the lowest number of biopsies,²⁵ no diagnosis of EoE was made.

3.2.4 | Follow-up

Information about follow-up was reported in 8/16 papers (Table 3). Raju et al.²⁵ reported the longest follow-up duration of at least 2 years. According to Rosenwald et al.,²³ individuals with follow-up visits were more likely to have had biopsies mainly by a gastroenterologist. Few studies reported the rate of diagnosis obtained through follow-up: Hurtado et al.⁹ reported that follow-up endoscopies in 12 children led to a diagnosis in nine, five of whom were found to suffer from EoE.

3.2.5 | Symptoms

Symptoms on admission for EFI were reported in eight studies and dysphagia was the most frequent one (see Table 3).

4 | DISCUSSION

Our data showed the presence of an underlying disease in 22/54 patients with EFI. Most studies show similar or higher rates (Table 3), suggesting that EFI in children should not be overlooked. In our sample, 31/54 (57%) required urgent ER. Patients with underlying pathology had a higher risk of urgent ER (aOR: 6.7, 95% CI: 1.7–27.3, $p = 0.002$). History of previous episodes correlated with the need of ER as well (aOR: 8, 95% CI: 1.4–45, $p = 0.03$). Hurtado et al.⁹ showed an even higher rate of underlying diseases among patients requiring ER. In their sample, demographic features of the group who required endoscopy were similar to the group who did not. This last result aligns with our data (Table 2).

Most papers included in our review reported EoE as the most common underlying disease. Only two studies have not reported cases of EoE; interestingly, one of them was the one reporting the lowest rate of performed biopsies.²⁵ Hiremath et al.¹⁸ evaluated the existing literature linking EoE and EFI up to July 2014, finding higher rates of EoE-attributable EFIs among those who were biopsied. However, their analysis found poor quality of the existing evidence, concluding that prospective studies are needed to better understand the relationship between EFI and EoE. In our sample, EoE was documented in 10/22 patients with

underlying pathology. Of those with underlying pathologies other than EoE, 10 had known anatomical conditions, including the history of EA, TEF after surgical repair, and corrosive stricture; only a few of these underwent biopsies (3/10). Presumably, physicians tended to consider EFI fully explained by the presence of known anatomical anomalies. In agreement with our findings, Rosenwald et al.²³ demonstrated that individuals with esophageal strictures were less likely to undergo biopsies in their sample (8% vs. 28%). Similarly, El-Matary¹⁷ showed that biopsies were frequently not taken when a normal esophagus macroscopic appearance was found on endoscopy. However, the literature shows that patients with the history of EA have a higher prevalence of EoE.³⁰ Moreover, recent literature has shown that a normal endoscopic appearance may be found at the onset of EoE and during follow-up, especially in young patients.³¹ Accordingly, Hiremath et al.¹⁸ highlights the importance of enhancing awareness among physicians to obtain biopsies irrespective of the past surgical history and the gross endoscopic findings. Indeed, the diagnosis of EoE in patients with known anatomical or neuromuscular conditions may be skipped or delayed.

Overall, biopsies were taken in 14/54 (26%) in our sample. The literature shows variable rates of performed biopsies (Table 3). Our analysis showed a 100% rate of biopsies when the endoscopy was performed by gastroenterologists. Several studies have reported similar results,^{9,10,18,23} suggesting a gap in awareness regarding EoE risk factors between different subspecialties. Hence, like Hiremath et al. point out,¹⁸ it is advisable to spread awareness among nongastroenterologists caring for children with EFI about the need for esophageal biopsies during the removal procedure of EFI.

Our data showed that performing biopsies is associated with a higher rate of follow-up visits (OR: 5.3, 95% CI: 1.9–14.7, $p < 0.001$), aligning with previous literature.²³ Follow-up correlates with a larger amount of diagnosis among children with EFI.⁹ In our population, 5/22 children with underlying diseases received the diagnosis of EoE during follow-up. The follow-up rate was higher when the endoscopy was performed by a gastroenterologist (100% vs. 52%), in agreement with previous reports.²³ Follow-up rate was reported in only 9/16 papers included in our review, reflecting scant attention to this aspect.

According to our analysis, meat bolus was the most impacted food (52%). The literature shows that underlying pathology is found more commonly in children with meat bolus impaction than in children with other foreign body ingestions.³² Accordingly, Williams et al.¹⁰ performed esophageal biopsies more frequently in children with meat bolus impactions than in children with inanimate foreign bodies, finding that mucosal pathology was more common in children with meat

bolus impaction. Therefore, they concluded that esophageal biopsy should be considered whenever meat is responsible for EFI.

As for clinical presentation, the literature shows that dysphagia, food stuck sensation, and drooling are the most common symptoms among children with EFI (Table 3). Dysphagia and food stuck sensation were the most reported in our sample as well, followed by vomiting, pain, and drooling (Table 1). Dysphagia was described in almost twice as many cases compared to food stuck sensation (70% vs. 39%). However, a potential overlap between the terms “food stuck sensation” and “dysphagia” should be considered. Although semantically distinct, these two terms are often used interchangeably. Moreover, children may struggle to distinguish food stuck sensation from difficulty swallowing. Accordingly, several studies included in our review did not mention food stuck sensation at all among the presenting symptoms; in these studies, “dysphagia” was almost always reported instead. Interestingly, the two most reported symptoms are highly subjective, which suggests the ability of most patients to verbalize personal discomfort. Indeed, EFIs more commonly occur during school age. In our study, the median age was 10 (IQR: 5–14) years, as similarly reported by other papers.^{9,26} Research focusing on nonfood esophageal impaction more commonly reported less subjective presentations (such as vomiting, drooling, or food refusal), reflecting a significantly lower mean age of the affected population.^{33,34} In our analysis, the group with EoE was older than the rest of the study population (13 years IQR 10–15 vs. 9 years IQR 4–13, $p = 0.018$), aligning with previous literature.²⁰ The non-EoE group includes children with strictures due to prior EA or TEF repair, who intuitively have earlier onset.

In our analysis, 32 patients required ER of EFI. Endoscopic management was the most performed across all the studies included in our review. Lee et al.²² described an MD approach, using glucagon injections and effervescent agents. They concluded that MD was ineffective in children with EoE but may be of help in children without EoE. According to Antoniou and Christopoulos-Geroulanos,¹⁵ carbonated and aerated drinks may successfully resolve EFI in a number of cases, as these drinks might penetrate and disintegrate the bolus by releasing carbon dioxide gas, which further distends the esophagus, facilitating the passage of the liquified bolus into the stomach. In our sample, Coca-cola was administered in eight cases (15%), obtaining resolution in one (2%). Despite the obvious advantages of medical strategies, including fewer sedations and less operating room usage, it should be considered that not performing endoscopy correlates with less biopsy diagnosis.

In summary, our findings advocate for increased vigilance in identifying underlying pathologies in

children with EFI, the importance of biopsies regardless of prior anatomical conditions, and the need for ongoing follow-up to ensure timely and accurate diagnoses. Enhanced awareness among healthcare providers, particularly nongastroenterologists, about the risks and management of EFI, including the necessity for biopsies, could improve patient outcomes significantly. However, larger and prospective studies on the prevalence and causes of EFI in children are needed for deeper insights into EFIs in this population.

Our retrospective study has limitations. First, as with all retrospective studies, there may have been inaccuracies in data collection and reporting, along with missing data. Second, detailed information about the sites in the esophagus where biopsies were performed and the number of biopsies taken at each site was not provided. Third, diagnoses of EoE in the group not requiring endoscopy may have been missed due to the lack of biopsies and follow-up. Moreover, organizational peculiarities of our institution may have impacted our results.

As for the review, the search strategy was limited to the two most relevant databases, therefore meaningful research published elsewhere may have been missed. Most studies were retrospective, with their intrinsic limitations. We limited our search to papers published in English, thus potentially missing relevant studies published in other languages. Moreover, a selection bias cannot be excluded, since papers reporting on a small number of cases were not included.

This paper also has several strengths. First, only few studies have provided information about clinical presentations, underlying diseases, management, biopsy rates, and follow-up rates in children with EFI. Second, the overall time of observation was 15 years long. Third, the retrospective analysis was performed on the PED database of a third-level pediatric hospital.

To the best of our knowledge, we also provided the first review focusing on EFI in pediatric patients.

In conclusion, shared protocols on when and how to perform biopsies in case of EFI should be published. The frequency of EoE has been increasing over the last years and EFI particularly by meat should be considered a mandatory event to investigate patients for suspected EoE. Even in those cases resolving with medical strategies and not requiring endoscopy a follow up should be planned to reach a confident diagnosis.

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CONFLICT OF INTEREST STATEMENT

M. G. reports personal fees from Sanofi.

ETHICS STATEMENT

The study was approved by the Ethics Committee of Meyer Children's Hospital IRCCS, code IR904-24-75921.

ORCID

Roberto Privato  <http://orcid.org/0009-0007-0352-161X>

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