Received: 2 December 2024 | Accepted: 3 April 2025

DOI: 10.1002/jpn3.70078

JPGN

REVIEW ARTICLE

Nutrition

Pediatric gastrostomy feeding tube weaning strategies: A scoping review

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Funding information

U.S. Department of Health and Human Services–Health Resources and Services Administration, Grant/Award Number: T73MC11047

Abstract

Pediatric feeding tubes (FTs) are used to support nutrition and hydration needs, but ought to be weaned when children are able to eat safely by mouth to maintain growth. We performed a scoping review of FT weaning interventions for children (<21 years) dependent on long-term FTs. Study design, patient characteristics, intervention strategies, setting, duration, interventionist(s), primary study measures, short-term and long-term outcomes are described. Two independent reviewers extracted all data and came to consensus using the Joanna Briggs Institute methodology; a third reviewer resolved discrepancies as needed. Forty-five articles met the inclusion criteria. Most interventions took place in outpatient or inpatient settings, although home, telemedicine, and school settings were also represented. The majority of interventions were led by interdisciplinary teams. Strategies varied and were used in combination, most commonly: parent training and/or education, hunger provocation, and behavioral approaches. Most interventions weaned a majority of children to oral feeding, often with additional success in follow-up; a handful of studies demonstrated that a minority of patients required resumption of FT after initially weaning. Successful programs weaning children from FTs to oral feeding have occurred across various environments involving heterogeneous teams and strategies. Nearly all interventions involve a combination of strategies, parent training and/or education, and three or more interventionists, demonstrating the complexity of weaning programs. To establish best practices for weaning children from FTs when medically safe to do so, future work ought to establish standard measurement tools for treatment outcomes.

KEYWORDS

feeding therapy, feeding tube dependence, interdisciplinary feeding programs, pediatric feeding disorders

1 | INTRODUCTION

A pediatric feeding disorder is defined as impaired oral intake that is not age-appropriate and is associated with medical, nutritional, feeding skill, and psychosocial dysfunction.[1] A minority of children who struggle with oral intake require long-term tube feeding to meet nutrition and hydration needs necessary for growth and development, an estimated prevalence of 2.7%–5.6%.[2] Despite long-term tube feeding being an efficient means of nutritional rehabilitation, one of the consequences is tube dependency, defined as the active refusal to eat or drink, or lack of motivation or ability to eat, which results in the child remaining dependent on the feeding tube (FT), although there are no medical indications for its continuation.[3]

Additionally, FTs may limit opportunities for socialization, incur medical complications, increase healthcare costs,[4,5] negatively impact child and family quality of life, and contribute to parental stress. Further, children with a history of unpleasant feeding experiences (i.e., coughing, gagging, reflux, and emesis) will often develop negative mealtime associations, which can further contribute to food aversions, defined as extreme and consistently negative reaction to oral fluids or diet, which interferes with nutrition requirements.[6–10] Thus, in children who have developed these associations, the transition from FTs to oral feeding may be met with resistance.

Despite the high prevalence of feeding difficulties in the pediatric care setting and the challenges that come with transitioning to oral feeds, there are no standard guidelines for gastroenterologists and other practitioners on who, when, where, or how to wean FTs. The first, and to our knowledge, only set of clinical practice recommendations for weaning children from FTs emerged in 2021 from the French Network of Rare Digestive Diseases (FIMATHO) and the French-Speaking Group of Paediatric Hepatology, Gastroenterology and Nutrition (GFHGNP). This multidisciplinary group included pediatricians, pediatric gastroenterologists, speech-language pathologists, psychologists, dieticians, and occupational therapists. They described eligibility criteria for weaning a child from FT to oral feeding if (i) the underlying disease is nonprogressive, (ii) the nutritional status is age appropriate or stable, (iii) the child demonstrates a functional and safe swallow, and (iv) the child and his/her parents are ready.[11]

The objective of this scoping review is to identify published long-term FT weaning strategies for pediatric populations. We aim to identify unifying characteristics of successful weaning strategies, defined as improvements in tube weaning and/or oral intake, and highlight gaps in consensus for future investigation.

What is Known

- Gastrostomy tube feeding has short-term and long-term consequences: interference with hunger regulation, potential dislodgement and infection, reduced opportunities for social engagement, greater caregiver burden, heightened parental stress, and increased healthcare costs.
- Although some children need feeding tubes (FTs) throughout their lifetime, many children who could be potentially weaned are continued to be fed via tube after resolution of underlying medical condition(s) due to lack of access to interdisciplinary weaning support, missed critical developmental windows, atypical hunger regulation, and/or acquired oral aversion.

What is New

- The majority of FT weaning interventions utilize parents as key interventionists.
- Interventions typically use hunger provocation and behavioral strategies, and most are in inpatient or outpatient settings.
- The majority of FT weaning interventions are successful during the intervention and cohorts demonstrate further gains in follow-up.

2 | METHODS

The Joanna Briggs Institute methodology and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Review (PRISMA-ScR) Checklist (Supporting Information S2: Appendix S2) were used to guide this review.[12] Our interdisciplinary research team consisted of a speech-language pathologist, pediatric nurse, clinical research coordinator, professional medical librarian, and developmental and behavioral pediatrician with expertise in feeding.

Search strategies were developed iteratively in consultation with a medical librarian. The search was conducted on August 2, 2023, across the following electronic databases: PubMed, Ovid Medline, CINAHL (EBSCO), Cochrane Library (Wiley), and Embase (Elsevier). An additional Google Scholar search was done via Harzing's Publish or Perish (limited to the first 200 results exported). The search included keywords and controlled vocabulary terminology, utilizing MeSH terms, Emtree terms, and CINAHL subject headings. The final search strategy is provided in Figure 1 with search queries provided in the Supporting Information S1: Appendices A–E.

Studies were included if: (1) published in an English-language peer-reviewed journal; (2) described a FT weaning intervention for children less than 21 years of age with a long-term FT; and (3) utilized an outcome measure related to tube weaning or oral feeding. In studies where participant age or FT type was not defined, authors were contacted to confirm eligibility. Studies in any setting (e.g., inpatient, outpatient, home, telemedicine, and school) were considered. Studies that included a majority pediatric population but had some adult participants were included. Studies that included a majority of long-term FTs, but also had participants with nasogastric tubes, were included. There was no publication date limit. No studies were excluded based on the study population's

racial, ethnic, or language characteristics. All publications utilizing qualitative, quantitative, or mixed methods were considered. Nonempirical studies, such as reviews or commentaries, published conference abstracts, or incomplete studies, were excluded. Case reports were excluded. Studies that solely focused on dietetic, pharmacological, or surgical interventions were excluded as well as studies focused on anorexia nervosa.

All citations retrieved from the databases were first imported into EndNote 20 (Clarivate) and then uploaded to Covidence (Veritas Health Innovation Ltd.) for deduplication and screening. Two reviewers (AG and MH) reviewed titles and abstracts against the selected criteria in a blinded process. The remaining citations were then reviewed as full-text articles for inclusion against the selection criteria. Discrepancies were resolved by reviewer consensus, and a third reviewer (SS) was consulted as needed. Data extraction was completed independently for each included study. Data discrepancies were resolved by reviewer consensus.

Variables in the data extraction included: title, author(s), publication year, study design, sample size, participant age, FT type, clinical characteristics, eligibility criteria, intervention strategies, setting, duration, interventionist(s), primary study measurements, and short-term and long-term outcomes. The study strategies were classified as either (a) parent training/education (parents or caregivers were involved in the intervention); (b) hunger provocation (a reduction in tube feedings used to induce appetite); (c) behavioral approach (reinforcers were used to promote or reduce specific feeding behaviors); (d) oral motor (a clinician engaged a child with specific therapy exercises to help the child gain oral motor skills); (e) sensory experience (intervention focused on helping a child gain familiarity with the sensory properties of food through child-directed food interactions at a meal or during play); and/or (f) play picnic (a child-led approach to introducing foods, specific to the Graz Method). Interventionists were noted, and when ≥3 disciplines involved were classified as multidisciplinary.

Extracted variables were categorized into two tables: (1) intervention characteristics and (2) intervention outcomes. Studies with ≥5 participants were included in the tables. Short-term outcomes refer to outcomes at the conclusion of the study intervention, regardless of intervention duration; long-term outcomes include those reported by study authors during the follow-up period, regardless of duration. Long-term outcomes were examined specifically relating to tube-weaning and oral intake. When these outcomes were not reported, but other data were tracked, those outcomes were reported. Blank cells for outcomes indicate that data were not reported in the publication.

3 | RESULTS

The search strategy identified 4619 unduplicated records (Figure 1). Titles and abstracts were screened, and 4406 records were excluded. Two hundred thirteen full-text studies were assessed for eligibility. Forty-five articles were included in this scoping review, with details outlined in Table 1.

3.1 | Design of study

Articles consisted of retrospective studies ($n = 21$), prospective interventions ($n = 12$), case series ($n = 10$), and quality improvement projects ($n = 2$). Articles were published between 1986 and 2023.

3.2 | Cohort characteristics

Study sample sizes varied from 2 to 378. Participants ranged in age from younger than 10 months to 24 years. Although each study included at least one child with a gastrostomy FT, a minority of participants had nasogastric, gastrojejunal, or jejunal FTs.

Clinical characteristics varied greatly. Some interventions focused on children with specific diagnoses, and others had diagnostic exclusions. Medical diagnoses commonly reported amongst study populations included children with reflux,[4,9,16–20,22,26,27,29,32,39,40,46,47] genetic disorders,[4,5,8–10,16,21,27,28,31,33,35,36,38,43] congenital heart defects,[4,5,9,10,15–17,26,27,30,31,33,40,43,46] prematurity,[4,5,8,10,18,20,26,28,31–33,35,37–39] neurological conditions,[5,9,10,16,21,27,28,30,31,33,35,41] history of failure to thrive,[5,8,18,20,22,24,26,35,39,40,43] respiratory diseases,[5,9,10,18,28,30,31,41,47] metabolic diseases,[5,9,21,30,31,35,38,41] cerebral palsy,[9,15,18,32,34,36,37,43] developmental delays,[14,20,35,38–41] chronic lung disease,[15,16,19,24,26,27,46] food allergies,[22,27,30,39,41,43,46] and history of cleft lip and/or palate.[8,32,37,47,48]

Some studies had exclusion criteria based on participant age, medical diagnosis, comorbidities, evaluations of swallow safety,[23,25,43,49] cognitive/developmental age,[7,8,14,17] measurements of FT dependency,[7,9,21,34,43] and history of failed attempts at weaning.[16,41,48,50] Because some interventions required parental involvement as core interventionists, some families were excluded if unable to fully engage in the intervention.[5,8,22,26,35,38,50]

3.3 | Intervention strategies

Nearly all interventions utilized parent education and/or training ($n = 42$). Next frequently used strategies included hunger provocation ($n = 29$), behavioral approach ($n = 29$), oral motor ($n = 14$), sensory

experience ($n = 11$), and a play picnic ($n = 8$). The vast majority of studies ($n = 43$) included a combination.

3.4 | Setting and duration

Studies took place exclusively in inpatient ($n = 14$), outpatient ($n = 12$), family home ($n = 2$), and school ($n = 1$) settings, with 16 studies looking at outcomes across multiple settings. Eight studies additionally incorporated telemedicine, but none utilized telemedicine alone. Intervention duration varied. Several studies shared results of longstanding clinical programs that followed patients over many years.

3.5 | Interventionist(s)

Most interventions involved interdisciplinary team members. Occupational therapists, psychologists, and speech-language pathologists were each included in at least 20 studies; social workers, parents/caregivers, gastroenterologists, nurses, and registered dietitians/nutritionists were each included in at least 10 studies. The most common physicians involved were pediatricians and gastroenterologists, who were sometimes consulted intermittently.

3.6 | Primary study measures

Common measurement outcomes included frequency of acceptance of oral trials, measurements of mealtime behaviors, amount of enteral and/or oral feeds, length of time taken to tube wean, change in anthropometric measurements (weight, height, or body mass index), calories consumed, acceptance of different textures, parental satisfaction, eating readiness skills, and cost. Less common measurements included tracking caregivers' feeding behaviors and questionnaire responses with standardized tools, for example, About Your Child's Health[41] and

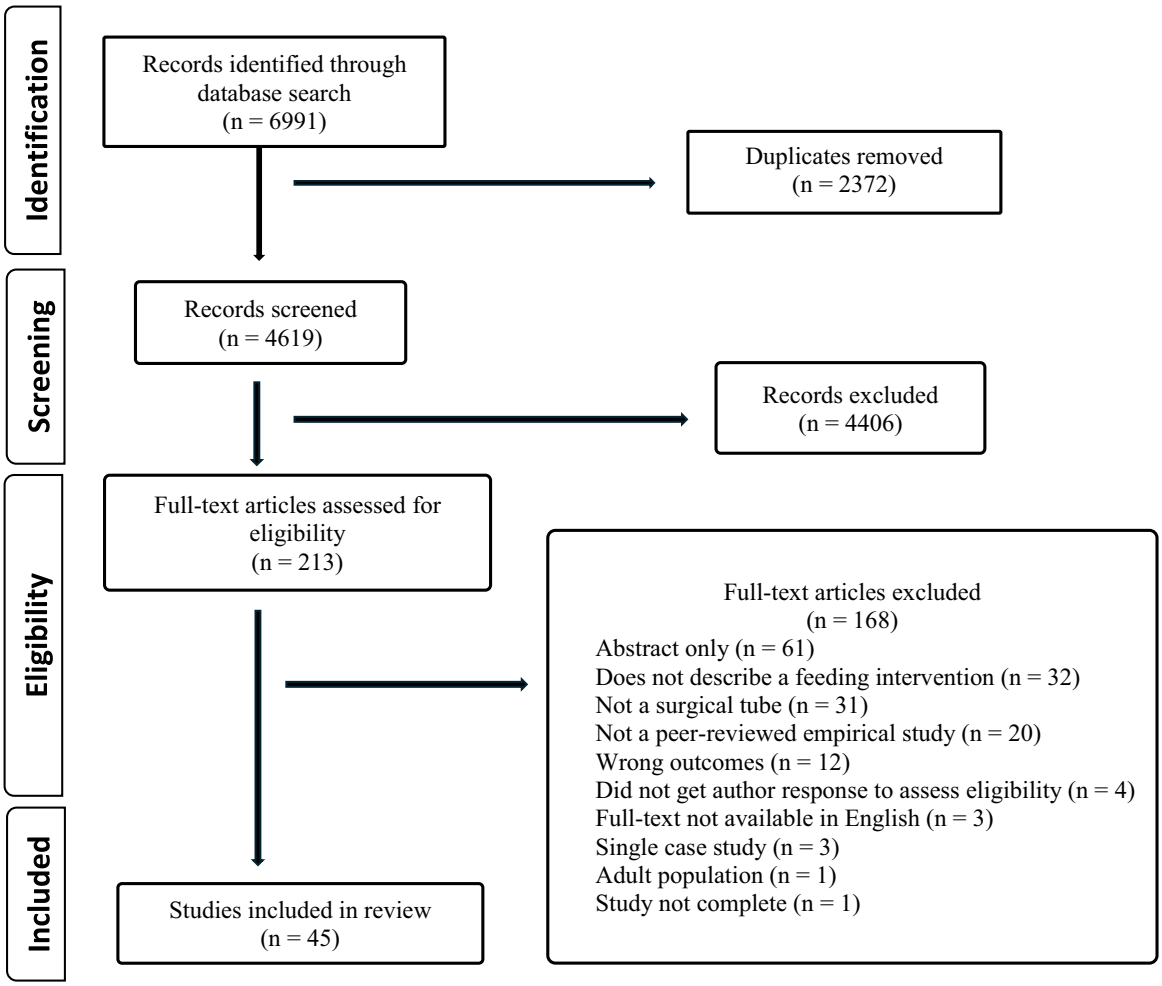

FIGURE 1 PRISMA flow diagram for the search and screening process. PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

TABLE 1 Characteristics of feeding tube weaning interventions for children included in scoping review with ≥5 participants ($n = 40$).

First author, year	Study design	Setting	*N*	Age	Cohort characteristics	Interventionist(s)	Intervention strategies	Intervention duration
Bandstra et al. 2020 [7]	Retrospective study	Outpatient	47	Orally averse group: *M* = 46.7 months, SD = 20 months Non-orally averse group: *M* (SD) = 45.5 (28.7) months	Feeding tube dependent children with and without oral aversion	Multidisciplinary[a]	Behavioral, sensory experience, oral motor, parent training/education	6–8 weeks, 3 daily treatment sessions
Benoit et al. 2000 [13]	Randomized controlled trial	Outpatient	64	Behavioral intervention: *M* (SD) = 17.4 (8.9) months Control group: *M* (SD) = 17 (8.8) months	Children fed by G or GJ tubes for ≥1 month and had resistance to feeding	Primary feeders, dietitians	Intervention: Behavioral, hunger provocation, parent training/education Control: Hunger provocation, parent training/education	7 weekly clinic visits + 4 follow-up visits
Blackman and Nelson, 1985 [14]	Case series	Inpatient or outpatient	17	<4 years	Children fed by G-tube with ability to orally feed, developmental level ≥6 months	Multidisciplinary	Behavioral, hunger provocation, parent training/education	Inpatient: 2–3 weeks Outpatient: up to 2.5 years
Blackman and Nelson, 1987 [15]	Case series	Inpatient	11	Range: 10–29 months	Children on prolonged tube feedings with ability to orally feed, developmental level ≥6 months	Multidisciplinary	Behavioral, hunger provocation, parent training/education	2–3 weeks
Brown et al. 2014 [16]	Retrospective study	Inpatient	30	*M* (SD) = 4 (1.3) years	G-tube dependent children with history of outpatient feeding therapy, developmental level >24 months	Multidisciplinary	Hunger provocation, behavioral, oral motor, sensory experience, parent training/education	19 days
Brown et al. 2003 [17]	Prospective clinical intervention	Inpatient	9	*M* (SD) = 3.1 (1.2) years	Children with G-tube dependence and feeding resistance	Multidisciplinary	Hunger provocation, behavioral, parent training/education	5–16 days
Chiatto et al. 2019 [6]	Retrospective study	Inpatient and outpatient	12	Median = 9 months Range: 6–16 months	Children affected by gastrointestinal disorders with FAs and history of intestinal resection	Multidisciplinary	Sensory experience, parent training/education	7–10 months, 2–3 sessions per week, 30-min sessions
Clawson et al. 2007 [18]	Prospective intervention study	Outpatient	8	*M* (SD) = 2.8 (1.2) years	Children with spastic diplegic cerebral palsy and feeding difficulties	Multidisciplinary	Oral motor, behavioral, parent training/education	29 days

(Continues)

TABLE 1 (Continued)

First author, year	Study design	Setting	*N*	Age	Cohort characteristics	Interventionist(s)	Intervention strategies	Intervention duration
Cornwell et al. 2010 [19]	Retrospective study	Inpatient	40	*M* (SD) = 47.9 (16.3) months	G-tube dependent children with co-occurring medical conditions	Multidisciplinary	Sensory experience, oral motor, behavioral, parent training/education	15–80 days, 5 sessions per day
de Moor et al. 2007 [20]	Case series	Outpatient and home	5	Range: 2.5–3.3 years	Children with developmental disabilities and severe food refusal	Therapist, parents	Hunger provocation, behavioral, parent training/education	4–8 months, 2–3 sessions per week
Dipasquale et al. 2021 [21]	Retrospective observational cohort	Inpatient or outpatient	94	*M* (SD) = 51 (40) months	Children on home enteral nutrition for ≥6 consecutive months, majority with gastrointestinal and genetic diseases	Multidisciplinary	Hunger provocation	Median = 5 months
Foy et al. 1997 [22]	Retrospective study	Inpatient and outpatient follow-up	19	Range: 9–51 months	Infants and toddlers with severe feeding refusal who were fed >95% by NG or G-tube at program entry	Multidisciplinary	Hunger provocation, behavioral, parent training/education	3 weeks
Grentz et al. 2022 [23]	Pilot study, retrospective data	Home, telemedicine	31	Range: 0–5 years	Infants and children with NG, G, or GJ-tubes who participated in prior treatment program	Multidisciplinary	Hunger provocation, parent training/education	38–80 days
Handen et al. 1986 [24]	Case series	Inpatient or outpatient	7	Range: 10–66 months	Children with severe congenital anomalies, diagnosis of food aversion, and dependent on central line or feeding tube	Trained staff and parents	Behavioral, parent training/education	Not specified
Horsley et al. 2022 [25]	Quality improvement	Outpatient, telemedicine	16	*M* = 7.6 months Range: 1–26 months	Infants and children with complex congenital heart disease who require enteral tube feeding	Multidisciplinary	Hunger provocation, parent training/education	Median weaning time was 12 days
Huynh et al. 2022 [26]	Pilot study	Outpatient, home, telemedicine	6	Range: 14 months to 8 years	Children with feeding tube dependency and prior unsuccessful attempts to tube wean	Multidisciplinary	Hunger provocation, behavioral, parent training/education	2 weeks, 2–3 sessions per day
Kim et al. 2021 [27]	Longitudinal observational study	Inpatient	50	*M* (SD) = 5.2 (2.6) years	Children with pediatric feeding disorders who are G-tube dependent	Multidisciplinary	Behavioral, oral motor, parent training/education	19 days

TABLE 1 (Continued)

First author, year	Study design	Setting	*N*	Age	Cohort characteristics	Interventionist(s)	Intervention strategies	Intervention duration
Krom et al. 2020 [28]	Retrospective cohort study	Inpatient	42	Median age = 19 months	Feeding tube-dependent children	Multidisciplinary	Hunger provocation, parent training/education, behavioral, oral motor	2–3 weeks
Lesser et al. 2022 [29]	Chart review	Inpatient	16	*M* = 11.5 years	Patients with a diagnosis of ARFID	Multidisciplinary	Behavioral, parent training/education	38 days Range: 14–63 days
Lively et al. 2019 [30]	Retrospective case-note audit	Home, inpatient, telemedicine	62	*M* (SD) = 2.4 (1.71) years	Tube-fed children with minimum of 93% of calories provided enterally for an extended period	Multidisciplinary	Hunger provocation, parent training/education	7 days
Marinschek et al. 2014 [5]	Retrospective study	Inpatient or outpatient versus telemedicine	378	Range: 0.2–23.7 years	Patients fed exclusively or predominantly via feeding tube	Multidisciplinary	Hunger provocation, play picnic, parent training/education	Onsite: 3 weeks Telemedicine: 35 days past last tube feed in stable weight and good condition
Marinschek et al. 2019 [31]	Case series	Outpatient or telemedicine	259	*M* = 2.24 years Range: 0.2–14.9 years	Formerly tube-dependent children 1–6 years after participation in tube weaning programs based on Graz model of tube weaning	Multidisciplinary	Hunger provocation, play picnic, parent training/education	35 days past last tube feed in stable weight and good condition
Marinschek et al. 2020 [32]	Retrospective study	Inpatient or outpatient, or telemedicine, or outpatient + telemedicine	64	Short gap tracheoesophageal fistula: Median = 1.04 years Long-gap esophageal atresia: Median = 1.39 years	Pediatric patients with feeding difficulty after repair of their esophageal atresia/tracheoesophageal fistula	Multidisciplinary	Hunger provocation, play picnic, parent training/education	Telemedicine: *M* (SD) = 96.5 (81.3) days Outpatient/telemedicine *M* (SD) = 184.7 (179.1) days
Mirete et al. 2018 [33]	Case series	Inpatient	37	*M* (SD) = 31.4 (21) months	Children requiring NG-tube or G-tube feeding and with history of failed weaning attempts or resistance in outpatient care	Multidisciplinary	Hunger provocation, sensory experience, parent training/education	2–3 weeks
Munakata et al. 2008 [34]	Preliminary study	Inpatient	10	*M* (SD) = 51 (26) months	Children with neurological disorders receiving long-term enteral nutrition	Not specified	Sensory experience, hunger provocation	3 months

(Continues)

TABLE 1 (Continued)

First author, year	Study design	Setting	*N*	Age	Cohort characteristics	Interventionist(s)	Intervention strategies	Intervention duration
Pahsini et al. 2023 [10]	Prospective case series study	Outpatient, followed by telemedicine	67	Median = 1.35 years Range: 4 months to 10 years	Infants with tube dependency	Multidisciplinary	Hunger provocation, play picnic, parent training/ education	2.4 months
Sadeh-Kon et al. 2020 [35]	Prospective study	Outpatient	58	Median = 2.8 years Range: 0.5–13 years	Children on long-term enteral nutritional support	Multidisciplinary	Hunger provocation, play picnic, parent training/ education	3 weeks
Schädler et al. 2007 [36]	Case series	Inpatient	86	Median = 2 years Range: 0–10 years	Ex-premature children with severe feeding disorders	Multidisciplinary	Behavioral, oral motor, parent training/education	60 days
Senez et al. 1996 [37]	Case series	Inpatient	19	Group 1: 2 months to 14 months Group 2: 2–15 years	Neonates and infants who have never been orally fed since birth and older children in posttraumatic or postsurgical periods who have fed before becoming ill	Mothers of the infant or substitutes	Sensory experience	Length of stay
Shalem et al. 2016 [38]	Retrospective study	Outpatient or inpatient	34	*M* = 4.3 years Range: 0.5–17.5 years	Children with severe selective eating with the necessary nutritional and oral skills for eating, as well as parent acceptance toward program	Multidisciplinary	Hunger provocation, play picnic, parent training/ education	3 weeks
Sharp et al. 2020 [39]	Retrospective study	Outpatient	81	*M* = 49 months Range: 10–230 months	Children with ARFID and chronic food refusal who are medically stable	Multidisciplinary	Behavioral, oral motor, parent training/education	38 ± 7 days, 5 days per week, 4 therapeutic meals per day
Sharp et al. 2022 [40]	Retrospective study	Outpatient	81	Range: 10–230 months	Children with ARFID and chronic food refusal who are medically stable	Multidisciplinary	Behavioral, oral motor, parent training/education	38 ± 7 days, 5 days per week, 4 therapeutic meals per day
Silverman et al. 2013 [41]	Retrospective study	Inpatient	77	*M* = 4.5 years Range: 2.3–6.7 years	Medically complex G-tube dependent (>1 year) children who had no clinical progress when treated in outpatient therapy	Multidisciplinary	Hunger provocation, behavioral, parent training/education	3 times per day for length of stay *M* = 10.9 days
Tarbell et al. 2002 [8]	Retrospective study	Outpatient	83	*M* = 2.7 years	Medically stable children with feeding tube dependency who can tolerate a bolus ≥4 ounces in 30 min, with	Multidisciplinary	Behavioral, sensory experience, oral motor, parent training/education	2–3 weeks

TABLE 1 (Continued)

First author, year	Study design	Setting	*N*	Age	Cohort characteristics	Interventionist(s)	Intervention strategies	Intervention duration
					cognitive skills ≥18 months, and parents who can participate			
Taylor et al. 2017 [42]	Retrospective study	Inpatient, outpatient, and combination	58	*M* (SD) = 69.5 (30.7) months	Children with cerebral palsy or autism spectrum disorder with G-tube dependence	Multidisciplinary	Behavioral, oral motor, parent training/education	46.8 ± 12 days
Taylor et al. 2019 [43]	Single-subject experimental design	Home, school	9	*M* = 7.9 years Range: 3.8–14.7 years	Children receiving 50% or more nutrition enterally for ≥6 months, with no medical conditions that could preclude safe oral feeding	Multidisciplinary	Behavioral, oral motor, parent training/education	1–2 weeks, 2–3 meal sessions per day
Trabi et al. 2010 [44]	Retrospective study	Inpatient	221	*M* (SD) = 793.5 (552.3) days	Children who had been fed exclusively by tube for >4 months before admission	Multidisciplinary	Hunger provocation, play picnic, parent training/ education	3 weeks
Wilken et al. 2013 [9]	Prospective study	Home	45	Median = 16 months Range: 5–57 months	Children with feeding tube dependency who received ≥50% of their nutrition via feeding tube for a minimum of 3 months	Multidisciplinary	Hunger provocation, behavioral, sensory experience, parent training/education	5-day hunger induction phase, intensive weaning phase for 4–10 days (3–6 home visits of 1–4 h duration at mealtimes)
Williams et al. 2017 [4]	Retrospective cohort-controlled study	Outpatient	45	IFT group: Median = 26 months Range: 19.5 – 33.5 months TT group: Median = 20 months Range: 18–35.3 months	Medically complex children with tube feeding dependency with history of feeding therapy	IFT: Multidisciplinary TT: SLP	IFT: hunger provocation, oral motor, sensory experience, behavioral. parent training/ education TT: hunger provocation, oral motor	IFT: 5 weeks, 5 days per week, 50-min sessions TT: up to 25 weekly visits, 50-min sessions
Wright 2013 [45]	Quality improvement	Outpatient	222	Median = 4 years	Children with complex feeding problems, either artificially fed or with severe nutritional problems	Multidisciplinary	Hunger provocation, behavioral, parent training/education	Up to 10 years

Abbreviations: ARFID, avoidant and restrictive food intake disorder; FA, food aversion; G, gastric; GJ, gastrojejunostomy; IFT, intensive feeding therapy; M, mean; NG, nasogastric; SD, standard deviation; SLP, speech-language pathologist; TT, traditional therapy.

[a]Intervention considered multidisciplinary if it includes ≥3 disciplines.

Pediatric Assessment Scale for Feeding Problems.[10]

3.7 | Short-term outcomes

Parent training/education contributed to improvements in FT weaning and/or oral intake. Parent training/education was implemented by various clinicians, who tasked parents with responsibilities such as using behavior modifications, changing language around mealtime, decreasing tube feeds, and engaging in messy food play. Parents were often given increased responsibility over the intervention. One study compared groups of patients, with one group including parents as interventionists and the other not; there were improved FT weaning outcomes in the parent-interventionist group.[4] We also noted that parents were involved in all study settings: outpatient ($n = 25$), inpatient ($n = 22$), telemedicine ($n = 8$), home ($n = 6$), and school ($n = 2$); 17 of the studies included multiple settings either through comparison or follow-up care.

A hunger provocation approach has been shown to be effective for FT weaning in multiple settings: inpatient ($n = 18$), outpatient ($n = 16$), telemedicine ($n = 8$), and home ($n = 3$); 11 of the studies included multiple settings. In hunger provocation interventions, the amount FTs were reduced by varied from 25% to greater than 50%. In a study that compared the effectiveness of the Graz method in-person versus telemedicine, telemedicine was demonstrated as slightly more effective (90.5% vs. 81.3% completely weaned off FTs).[5] Several hunger provocation studies looked at long-term outcomes following patients at least 1 year after treatment and found 83%–92% of patients continued to remain off FTs.[9,16,28,31]

Behavioral interventions typically consisted of an antecedent procedure, behavior, reinforcement, and extinction. Parents were often slowly integrated into these sessions (e.g., first observing sessions, then beginning to participate, and ultimately leading the sessions independently). The behavioral approach was demonstrated as effective across patient populations, particularly in picky eaters,[19] patients with avoidant and restrictive food intake disorder,[29] and children with oral aversions.[7] The behavioral approach was also tested in a variety of settings, including outpatient ($n = 17$), inpatient ($n = 14$), home ($n = 3$), school environment ($n = 2$), and telemedicine environments[1]; Eight of the studies included multiple settings in either a comparison or continuum of care. One inpatient study demonstrated success with FT weaning when including a cohort of patients who had participated in an outpatient setting and had not demonstrated previous progress.[41]

Oral motor interventions were always utilized in conjunction with either behavioral, sensory experience, and/or hunger provocation interventions. Oral motor interventions were utilized in the outpatient ($n = 8$), inpatient ($n = 6$), home ($n = 1$), and school ($n = 1$) environments; Two studies included multiple settings in a continuum of care.

Sensory experience strategies were also found to be effective across a variety of environments, including inpatient ($n = 6$), outpatient ($n = 5$), and home ($n = 1$); one study included multiple settings. A sensory experience intervention was solely utilized with parent involvement/coaching in patient populations with food aversions[6] and instances of children having never been orally fed or older children in a posttraumatic or post-surgical period who have fed before becoming ill.[37] Otherwise, sensory experiences were utilized in conjunction with behavioral approaches and hunger provocation approaches.

A play picnic was utilized as part of the Graz method of feeding.[5,10,32,35,38,50] A play picnic was utilized in the outpatient ($n = 6$), inpatient ($n = 5$), and telemedicine ($n = 4$) environments; Five studies included multiple settings. In these interventions, the clinicians were always part of a larger multidisciplinary team.

3.8 | Long-term outcomes

Thirty-three out of 45 studies reported long-term outcomes over variable time periods (2 weeks to 6 years) (Table 2). The vast majority of studies demonstrated decreased FT utilization, increased oral intake, and weight gain during follow-up. Fourteen out of 33 (42%) studies reported patients consuming all calories orally and/or having FT removed during follow-up.[8,17,21,22,24,26,29,30,33,39–41,43,44] One study reported patients showed improvements during follow up points of 4 months, 7 months, and 1 year except 1 month following discharge, suggesting an initial reduction in weight upon discharge from the intervention followed by weight gain.[18]

A minority of studies reported some completely weaned children required tube feeds during follow-up, demonstrating temporary weight loss, or had persistent issues with malnutrition.[16,27,28,35,36] While this was neither the majority of studies nor the majority of participants, it highlights the importance of individual factors to determine readiness to wean to oral feeds and the importance of continuing to follow intake and growth patterns.

4 | DISCUSSION

FT weaning interventions include heterogeneous studies and evaluation methods, which made determining consensus features of successful interventions difficult. However, we identified several common

TABLE 2 Outcomes of FT weaning interventions for children included in scoping review with ≥5 participants ($n = 40$).

First author, year	*N*	Primary study measure(s)	Short-term[a] outcomes	Long-term[b] outcomes
Bandstra et al. 2020 [7]	47	Rate of acceptance, maladaptive mealtime behavior, and tube utilization	Orally averse group: mealtime acceptance: 41% at baseline versus 97% at discharge ($p < 0.001$), Tube utilization: 98% at baseline versus 22% at discharge ($p < 0.001$) Nonorally averse group: mealtime acceptance: 61% at baseline versus 94% at discharge ($p < 0.001$), Tube utilization: 98% at baseline versus 34% at discharge ($p < 0.001$)	Orally averse group: mealtime acceptance: 89% at 2-week follow-up visit, Tube utilization: 11% between 6 and 12 weeks after discharge Nonorally averse group: mealtime acceptance: 99% at 2-week follow-up visit, Tube utilization: 25% between 6 and 12 weeks after discharge
Benoit et al. 2000 [13]	64	Tube weaning		47% in the behavioral group versus 6% in the control group no longer required FT at 14-week follow-up
Blackman and Nelson, 1985 [14]	17	Tube weaning	90% of children who completed the feeding program were weaned from FT	
Blackman and Nelson, 1987 [15]	11	Tube weaning	91% of patients transitioned to full oral feeding	
Brown et al. 2014 [16]	30	Caloric intake, tube weaning, and weight change	90% of patients had FT feedings completely discontinued at discharge	83% remained successfully off FT 1 year later
Byars et al. 2003 [17]	9	Tube weaning and oral intake	44% of children were weaned from FT feedings at discharge; mean oral intake increased 50% from pretreatment to posttreatment assessment	67% of children were weaned from FT, an average of 3.1 months after treatment
Chiatto et al. 2019 [6]	12	Weight and tolerance of oral feeds	Pureed food tolerance increased from 42% to 100%; Mashed, roughly mashed, and food with soft or hard separate lumps tolerance increased to 100%; Mixed textured foods tolerance increased to 92%	100% of children had tolerance to oral diet after MPT treatment at 39 (24–56) months follow-up
Clawson et al. 2007 [18]	8	Child feeding behaviors, caregiver feeding behaviors, weight and height, and nutrition data	FT decreased from 90% at admission to 62% at discharge	Long-term outcomes were presented as cohort means. At 1 month, mean weight percentile was less than at discharge, but was higher at 4 months, 7 months, and 1 year
Cornwell et al. 2010 [19]	40	Oral caloric intake and G-tube caloric intake	43% of children were fed completely orally	
de Moor et al. 2007 [20]	5	Food acceptance, frequency of vomiting, or gagging	100% of children had FT discontinued	100% of children remained off FTs at 3- to 12-month follow-up
Dipasquale et al. 2021 [21]	94	Tube weaning success per attempt, weight-for-age *z* score	70% of FT weaning attempts were successful	82% of FT weaning attempts were successful at 6-month follow-up
Foy et al. 1997 [22]	19	Oral caloric intake	21% of patients transitioned to full oral feeding within 1 month	Length of time taken to discontinue FT feedings ranged from 7.6 (1-23) months; 63% of patients

(Continues)

TABLE 2 (Continued)

First author, year	*N*	Primary study measure(s)	Short-term[a] outcomes	Long-term[b] outcomes
				achieved total oral feeding at follow-up, 16% achieved partial success
Grentz et al. 2022 [23]	31	Tube weaning, weight maintenance, and feeding practices	84% of children fully weaned from FT	93% of participants surpassed their pre-wean weight at 6-month follow-up
Handen et al. 1986 [24]	7	Oral intake	100% of patients established consistent oral intake, and 43% were removed from supplemental feeding sources after intervention	43% of patients continued to accept full oral feeds at 6- to 12-month follow-up; 2 additional patients were removed from supplemental feeding sources at 28-month follow-up.
Horsley et al. 2022 [25]	16	Oral intake and weight	94% of children were successfully weaned at home	100% of patients weaned at home did not require FT at 1-month follow-up
Huynh et al. 2022 [26]	6	Oral intake, weight, nutritional outcomes, parent satisfaction, and cost implications	83% of children completed the program	100% of children who completed the program had FTs removed by 6 months. No weight loss at 9-month follow-up.
Kim et al. 2021 [27]	50	Oral caloric intake, tube weaning, oral supplement intake, medication use, and BMI *z*-scores	81% were discharged without FT support	65% remained off FT support at 1-year follow-up
Krom et al. 2020 [28]	42	Tube weaning, anthropometrics, feeding behavior, and medical outcomes	86% of children were weaned from FTs during the program	78% were weaned at follow-up (median 67 months)
Lesser et al. 2022 [29]	16	Oral caloric intake, percentage of admission feeding goals met by discharge, and BMI	75% of participants met all their caloric needs orally at completion of treatment	100% of patients met all their caloric needs orally at ≥7-month follow-up
Lively et al. 2019 [30]	62	Time to wean, biological factors including weight, height, oral and mealtime behaviors	60% of children were fully weaned from FTs at completion of the intensive period	An additional 11% of children were fully weaned off FT at 3-month follow-up; a further 10% of children were fully weaned off FT at 10-month follow-up.
Marinschek et al. 2014 [5]	378	Tube weaning	91% of children fully weaned from FT in the telemedicine group versus 81% of onsite treatment group; Higher partial weaning rates were observed in the onsite group (15%) vs the telemedicine group (5%)	
Marinschek et al. 2019 [31]	259	Number of oral feeds and tube feeds		92% off FTs, 7% partially weaned from FT at 1–6 years follow-up
Marinschek et al. 2020 [32]	64	Tube weaning, weight	95% of patients completed the program by transitioning to exclusive oral intake; 5% of children were partially weaned	

TABLE 2 (Continued)

First author, year	*N*	Primary study measure(s)	Short-term[a] outcomes	Long-term[b] outcomes
Mirete et a. 2018 [33]	37	Tube weaning, anthropometric measures	30% of patients were weaned during hospitalization	22% of patients were additionally weaned at 3 months post-discharge; 22% of children were weaned with additional therapeutic services at 12-month follow-up
Munakata et al. 2008 [34]	10	Oral intake	50% of children increased oral intake with intervention	
Pahsini et al. 2023 [10]	67	PASSFP	Oral skills increased during tube weaning, PASSFP score of 24.76 (12.38) before intervention versus 47.97 (6.98) after program completion. Children were reported to have reduced oral aversion symptoms with increased food repertoire.	
Sadeh-Kon et al. 2020 [35]	58	Tube weaning, height/length, weight, BMI *z*-scores, caloric intake, protein intake	7% of children did not complete the program due to acute illness. Weaning was achieved in 83.3% of children: complete weaning in 40.7% and partial weaning in 42.6%	Among children weaned, 35.3% of the completely weaned children regressed to partial tube feeding; 30.8% of partially weaned children improved their eating skills and achieved 100% oral feeding at 6-month follow-up. These results were maintained at the 12-month follow-up.
Schädler et al. 2007 [36]	86	Tube weaning, feeding time, and avoidance behavior signs	62% of children responded to treatment (i.e., no feeding tube; feeding requires less than 30 min)	Success of therapy after discharge was maintained in 94%; however, 25% of the children with normal BMIs at discharge and sustained success of therapy fell below the third BMI percentile. Among the children who had been discharged still using tube feeds or still requiring >30 min for an average feed, 47% had converted to oral feeds and average feeding durations of less than 30 min.
Senez et al. 1996 [37]	19	Tube weaning time	Group 1: 89% of children completed weaning in 30–330 days, 11% of children failed to wean; Group 2: 100% of children completed weaning in 11–45 days	
Shalem et al. 2016 [38]	34	Tube weaning and food variety	43% of children had complete weaning from FT, and 54% were partially weaned	92% of available patients maintained their target or improved at 6-month follow-up
Sharp et al. 2020 [39]	81	Oral intake, tube weaning, weight, and caregiver satisfaction	33% of patients completely weaned from FT, and oral intake improved by 71% at discharge	72% of patients weaned from FTs in follow-up
Sharp et al. 2022 [40]	81	Time to complete tube wean and time to complete partial wean	33% of children achieved a full wean; 67% of children achieved a partial wean	72% of children achieved a full wean, and 28% of children achieved a partial wean by the last follow-up (average 12 months)

(Continues)

TABLE 2 (Continued)

First author, year	*N*	Primary study measure(s)	Short-term[a] outcomes	Long-term[b] outcomes
Silverman et al. 2013 [41]	77	AYCE, Mealtime Behavior Questionnaire, and Parenting Stress Index Short Form	18% of patients had tubes removed, 61% of patients still had FTs for supplemental calories. Average oral intake increased from 30% (±2.5%) to 82% (±3%).	51% of patients were fully weaned from tube feeding after 2 weeks. An additional 12% completed within 1 year. Patients maintained nutritional stability at the 1-year posttreatment follow-up.
Tarbell et al. 2002 [8]	83	Tolerance of different textures, amount of oral consumption, and tube weaning	Outcomes reported by subgroups. Disrupted hunger/satiety: 24% weaned from FT. Inexperience: 86% increased food consumption; Sensory: 50% increased food consumption; Cognitive: 73% increased food consumption; Psychosocial: 25% increased food consumption.	72% of children weaned from their FTs after 5–7 months post-discharge
Taylor et al. 2017 [42]	58	Maladaptive behaviors, percentage of goals met, total grams consumed, weight, and caregiver satisfaction	For both groups, behavioral treatment was similarly effective in increasing consumption and in decreasing refusals. On average, oral intake increased by over 6 ounces irrespective of diagnosis.	
Taylor et al. 2019 [43]	9	Food acceptance, weight, oral intake, tube intake, treatment satisfaction, caregiver stress, and estimated treatment cost savings	Oral intake increased from an average of 28 g (SD = 99 g) at pretreatment to 569 g (SD = 370 g) at posttreatment. Mean pretreatment FT intake was 80% (SD = 26%), whereas the mean posttreatment FT intake was 48% (SD = 32%).	Oral intake increased further to 857 g (SD = 427 g) at 12-month follow-up posttreatment. Mean FT intake dropped further to 27% (SD = 26%) during follow-up; 67% of children had stopped tube feeding, and 11% had tube feeds reduced at final assessment.
Trabi et al. 2010 [44]	221	Tube weaning	81% of patients were successfully weaned from FTs, and an additional 10% of patients were partially weaned	Partially weaned children were completely weaned in follow-up at 16 months. None of the weaned children relapsed to tube feeding.
Wilken et al. 2013 [9]	45	Tube weaning, feeding behavior, and growth outcome		90% of patients transitioned from FT to oral feeding during the follow-up period (median 2 years). In all cases where oral feeding was achieved, the feeding behavior improved after treatment.
Williams et al. 2017 [4]	45	Tube weaning, variety of foods, caloric intake, weight, and fluid volume	Children in the IFT cohort had a median reduction in FT dependence of 49% (35–59%) versus a median reduction of 0% (0–25%) for traditional therapy. Almost half of the IFT cohort no longer required FTs by the end of the program.	
Wright 2013 [45]	222	Tube weaning, cost effectiveness		38% of cohort who had been FT or oral supplement-dependent fully weaned

Abbreviations: AYCE, About Your Child's Health; BMI, body mass index; FT, feeding tube; G, gastric; IFT, intensive feeding therapy; MPT, messy play therapy; PASSFP, Pediatric Assessment Scale for Feeding Problems; SD, standard deviation.

[a]Short-term outcomes are defined as outcomes at completion of the direct feeding intervention, regardless of intervention length. Blank cells indicate short-term outcomes were not reported.

[b]Long-term outcomes are defined as outcomes during follow-up. Follow-up varied among studies from 2 weeks to 6 years. Blank cells indicate long-term outcomes were not reported.

themes that largely align with the clinical practice recommendations set by the working group of FIMATHO and GFHGNP. Mainly, both our literature findings and their recommendations highlight incorporating parents into the weaning process, performing behavioral and sensorimotor interventions to promote weaning, individualizing the approach to the child, utilizing a multidisciplinary team (ideally including a physician, dietician, nurse, speech-language pathologist, occupational therapist, and psychologist), considering outpatient clinic as first-choice setting for weaning, and considering inpatient setting as a second-line intervention. Although the time at which gastrostomy tubes were removed varied among our long-term follow-up outcomes, the working group suggests removing a gastrostomy tube after 6 months of definitive discontinuation of enteral nutrition.[11]

Overall, very few studies described a single practitioner, which demonstrates that weaning from feeding to oral feeding is a complex process that requires interdisciplinary approaches and expertise. Given the important role that parents play in feeding young children, and the primacy of feeding within family and community life, parents are critical for intervention success as well as maintenance after the intervention.

In our review of feeding interventions across settings, we noted the outpatient setting was the most common, followed closely by inpatient programs. In the outpatient setting, a slower transition to oral feeding may support the gradual acquisition of feeding skills. Outpatient clinics also have the advantage of maintaining relatively normal family routines. Either outpatient or home-based settings are less costly than inpatient settings.[26,43] Community-based interventions, both in-home, at school, and via telemedicine, were found to successfully wean children from tube feeding. The home setting is the most natural environment, and bypasses travel issues for patients who live far from medical centers or who have issues with consistent transportation, and is most appealing to many parents.[43]

Several studies described that in some cases rapid tube weaning was necessary to promote hunger and overcome oral aversion, and the hospital facilitated accurate and consistent monitoring of oral intake, weight, and vital signs. Additionally, hospitals may uniquely support more medically complex patients, patients of parents with high anxiety, and patients who cannot sustain outpatient progress.[16,33,41] However, inpatient settings are the most restrictive and disruptive to child and family life, and also run the risk of learning skills not easily transferred into the home setting.

We acknowledge important limitations of our scoping review. First, any literature will inevitably lag clinical practice because of the time required for clinical intervention, data collection, and publication. We suspect this is particularly true for telemedicine interventions. Additionally, although meta-analyses would help to synthesize trends, in this review, a meta-analysis of study outcomes was not possible due to the variability of measurement across studies.

For those children who can safely feed orally to maintain adequate nutrition and growth, weaning children from tube to oral feeding improves child and family well-being and prevents chronic tube feeding morbidity. This complex process would benefit from a strong evidence base to establish guidelines. To create standard guidelines and outcome measures for tube weaning interventions, future studies should focus on prospective designs with larger populations, standardize assessment tools for measuring success, define roles within the multidisciplinary team, determine the impact of intervention duration, and evaluate long-term effects.

5 | CONCLUSIONS

This scoping review of pediatric gastrostomy FT weaning interventions demonstrated that interventions vary widely, but most often are conducted by an interdisciplinary team using a combination of approaches. Most interventions include parent education/training, and many use hunger induction as a core strategy. The interdisciplinary nature of both treatment teams and approaches demonstrates the complexity of feeding interventions for children with tube dependency. The vast majority of interventions weaned a majority of children to oral feeding, often with additional success in follow-up, highlighting that many children with prolonged tube dependency can be weaned to an oral diet if done appropriately. Future research should work to establish standard outcome measures to enable comparisons among studies and establish best practices.

ACKNOWLEDGMENTS

The authors would like to thank Karen Dilfer, MS, OTR/L, for her review of this paper as an expert in feeding interventions. Dr. Sarah A. Sobotka is supported by the T73 Leadership Education in Neurodevelopmental and Related Disorders Training Program (LEND, T73MC11047), funded by the U.S. Department of Health and Human Services–Health Resources and Services Administration (HRSA).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

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

How to cite this article: Goldstein A, High M, Lynch E, Fawcett A, Sobotka SA. Pediatric gastrostomy feeding tube weaning strategies: a scoping review. *J Pediatr Gastroenterol Nutr*. 2025;1-17. doi:10.1002/jpn3.70078