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The purpose of this study was to improve our understanding of gagging in children with pediatric feeding disorder (PFD). This study explored prevalence and common triggers for gagging. Children with and without gagging were compared using the medical, nutrition, feeding skill, and psychosocial domains of PFD (Goday et al., 2019, Sharp et al., 2022).

One-hundred and sixteen participants met inclusion criteria through a retrospective chart review of three months of new patients seen in a hospital-based feeding clinic. The gagging group and non-gagging group were compared by demographics, frequency of domain identification, specific items within each domain, and the number of domains identified per participant between groups.

Results indicated that 60% of children in this sample had gagging as part of their PFD. Significant findings included that 70% of the gagging group was under the age of three years and was more likely to have issues in the medical domain, specifically gastrointestinal diagnoses (gastroesophageal reflux, emesis, and hypersensitivity). Additionally, the gagging group had more issues in the feeding skill domain, as well as signs of pharyngeal dysphagia, and oral motor delay as compared to the non-gagging group. The most common triggers were textured puree, mixed textures, dry solids, and non-preferred foods.

Given these findings, when working with young children who experience gagging as part of their PFD, clinicians are encouraged to carefully explore gastrointestinal issues, swallowing, and oral motor function. Additional research is needed to better understand how these factors influence gagging and to explore assessment and treatment strategies.

ASSESSING PEDIATRIC FEEDING DISORDERS

BY DOMAIN IN CHILDREN WITH

HYPERSENSITIVE GAGGING

by

Kristen Brackett

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Approved by

Dr. Kristine Lundgren
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DEDICATION

I would like to dedicate this dissertation to John, Zach, and Noah. I would also like to thank my Dad for always believing in me.

APPROVAL PAGE

This dissertation written by Kristen Brackett has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I: INTRODUCTION

Gagging is a common phenomenon reported in the pediatric population across a wide variety of literature including medical, dental, therapeutic, pharmaceutical, and psychological articles. Gagging begins as an expected infant oral reflex that continues through life, typically without interruption of feeding skills and nutritional intake. Hypersensitive or aberrant gagging is reported as a symptom of many different diagnoses and/or a response to a particular procedure (Brackett et al., 2024, under review). Hypersensitive gagging is a commonly reported clinical problem that is described in association with pediatric feeding disorders; other associations may include problems with texture progression, oral aversion, gastrointestinal issues, pharyngeal dysphagia, and oral care (Brackett et al., 2024, under review). While feeding therapists working on feeding progression often observe gagging, it is not well understood.

Abnormal gagging response may fall on a continuum from gagging to vomiting and may be associated with pharyngeal swallowing (Brackett et al., 2024, under review). Because of the wide range of symptoms, there is a lack of thorough understanding of a hyperactive gag response in a child with a pediatric feeding disorder (PFD) (Brackett et al., 2024, under review), which leads to a number of questions about the nature of the disorder. PFD is defined as impaired oral intake that is not age appropriate and associated with one or more of four domains (medical, nutritional, feeding skill, or psychosocial) (Goday et al., 2019). For example, when should we consider a gag response problematic or hyperactive? How does gagging contribute to feeding difficulties? What are the appropriate assessment tools, prevention strategies, and treatment options? These unanswered questions have contributed to inadequate intervention, prolonged feeding difficulty, poor progression of feeding skills, nutrition deficits, and family stress.

Perhaps one reason for the lack of understanding about the gagging response relates to the inconsistent terminology used to describe hypersensitive gagging. A variety of terms associated with gagging can be found in the literature. In various fields of study, terms such as abnormal gagging, retching, hypersensitivity, over-sensory response, and tactile, taste, or smell sensitivity have been used to describe the gagging behavior in children. These terms have been employed across various disciplines to better describe the phenomenon of gagging and its underlying causes. In the literature, gagging is reported in different contexts and may be used in a continuum of gagging, retching, and vomiting, as a mechanism for swallowing disorders and airway protection, as a psychological response, or as an expected infant oral reflex. Despite the frequent use of the term in the literature, it is not well-defined, described, or understood. There is a need to better understand this issue to improve outcomes for individuals with PFD.

Through a retrospective chart review, this project will examine consecutive new patients referred to a hospital based pediatric feeding team over a three-month period. The aim of the study is to determine how many of these children have gagging associated with their PFD and to further explore the clinical profile of the children who are presenting with and without gagging. Four domains (medical, nutrition, feeding, skill, and psychosocial dysfunction) of PFD as described by Goday et al., (2019) and further expanded by Sharp et al., (2022) will be used in this study. By examining the clinical profile of the participants through the framework of PFD, we can gain a better understanding of the contributing factors to hypersensitive gagging and how it affects the development of feeding skills. As a comparison, the clinical profile of children with PFD, who do not have gagging reported, will also be explored to better understand contributing factors in hypersensitive gagging.

CHAPTER II: LITERATURE REVIEW

Hypersensitive gagging is a commonly reported problem in the literature across pediatric disciplines although a clear definition, description, and/or measurement tools are inconsistent (Brackett et al., 2024, under review). Gagging responses should be viewed on a continuum from absent or dimished gagging response on one end to hypersensitive gagging on the other end. Both extremes are reported and described in a variety of contexts, for example, an indication of sedation for surgery, as part of GI disease or dysphagia, fear response in dentistry, learned response, or neurological abnormality. Gagging (both typical and hypersensitive) is often observed by caregivers and feeding therapists in children with PFD. Gagging is part of normal development when infants are mouthing items and transitioning to solid foods, however, many feeding therapists and caregivers observe gagging that interferes with feeding progression. Gagging is described in association with a wide variety of PFDs, including texture progression, oral aversion, gastrointestinal issues (GI), pharyngeal dysphagia, tube dependence, and oral care activities. While gagging is often observed by feeding therapists working on feeding skill development, it is not well understood.

Gagging in Pediatric Literature

A recent scoping review explored how gagging is reported and discussed in the pediatric literature and identified 394 articles were identified from the last 61 years from the fields of medicine, dental, therapeutic, pharmaceutical, and psychological research (Brackett et al., 2024, under review). While terminology (gagging, retching, pharyngeal reflex) was used in a variety of contexts, these terms were only defined in 25% of the articles (n=93/394). However, in the remaining 301 articles the terms were used interchangeably, inconsistently, an assumption was made that the reader understood the definition and context (Brackett et al., 2024, under review).

A preference for specific terminology related to gagging was seen across disciplines in the scoping review (Brackett et al., 2024, under review). Feeding-related literature most often used the term gagging (aberrant, hypersensitive), while nutrition research preferred the term sensory sensitivity, sensory over response, tactile, taste, or smell sensitivity. The scoping review also revealed that the term retching was used and appeared more often in medical and surgical research. For other articles, gagging was also referred to as having a psychological basis (psychogenic gagging) and triggered by fear or anxiety. Furthermore, the reviewed articles often grouped terms with other diagnoses depending on the context, for example, one article might report on gagging, retching, and vomiting together while another study might use the grouping gagging and choking or gagging as a mealtime problematic behavior. Eight percent (n=31/394) of medical and surgical articles reported on an absent or diminished gag.

Most of the 394 articles in the review were categorized as empirical research. Gagging and retching were reported as a symptom, behavior, or response of many different diagnoses or procedures; however, how to measure this was inconsistent across the literature. About 88% of articles measured gagging and/or retching in some way. More than half of the articles (68%) relied on informal measures such as observation, documentation in a medical chart, or caregiver report. A small percentage of articles reported gagging as part of a normal infant oral reflex, used scales or reported gagging triggered during oral exam. Of note, the dental literature was the only field to discuss a scale to measure gagging, Katsouda et al. (2017) discussed the Gagging Assessment Scale (GAS), which examined the prevalence of gagging and evaluated gagging and dental fear.

Neurology of the Gag Reflex

The gag reflex is thought to be an evolutionary reflex that developed as a method to prevent oral contents from entering the throat to prevent choking and swallowing of foreign objects (Sivakumar & Prabhu, 2022; Miller, 2002). The gag response has been described as a simple protective reflex. It is characterized by a lowering of the mandible with forward and downward movement as well as velar and pharyngeal constriction (Leder, 1996). Gagging can have multiple causes and can be classified into two groups: somatic, which is caused by direct physical stimulation, and psychogenic or learned, which is triggered without direct physical contact. However, distinguishing between the two groups is not always possible (Katsouda, 2021; Sivakumar & Prabhu, 2022). The gag reflex is elicited with tactile stimulation within five trigger zones: the anterior and posterior faucial pillars, base of tongue, palate, uvula, and posterior pharyngeal wall (Bassi et al., 2004). In a normal gag reflex, the afferent limb of the reflex is supplied by the glossopharyngeal nerve which inputs to the nucleus tracts solitarius (NTS) of the medulla and spinal trigeminal nucleus (Logemann, 1983; Martin, 1996, Perlman & Schulze-Delrieu, 1997). The area of the medulla oblongata that receives these afferent impulses is close to the vomiting, salivary, and cardiac centers, which may be stimulated during gagging (Bassi et al., 2004). The efferent limb of the reflex is supplied by the vagus nerve from the nucleus ambiguous (NA) of the medulla (Logemann, 1983; Martin, 1996, Perlman & Schulze-Delrieu, 1997). Embryologically, the glossopharyngeal nerve is associated with the derivatives of the third pharyngeal arch, while the vagus nerve is associated with the derivatives of the fourth and sixth pharyngeal arches (Sivakumar & Prabhu, 2022). According to Eachempati et al., (2019), neural pathways from the gagging center to the cerebral cortex allow the reflex to be modified, making it possible to initiate gagging just by imagining an experience or controlling the reflex with distraction.

The elicitation of the gag reflex varies among healthy individuals and is not directly correlated with swallowing physiology. The posterior pharyngeal muscles (controlling the gag reflex) are independent of the muscles responsible for swallowing (Ramsey et al., 2005). Miller (2002) cites several studies where the gag reflex was difficult to elicit in normal adult subjects, many of whom had intact pharyngeal sensitivity. Research has concluded that the gag reflex does not appear to be a valid reflex for assessing patients with compromised pharyngeal swallowing (Leder, 1996; Ramsey et al., 2005).

Miller also discusses the concept of severity of the gagging response. According to Miller (2002), more severe gagging (e.g., hyper-gag) involves forceful pharyngeal and velar contraction, retching, and appears to be a combination of reflex responses with both gagging and some aspect of the emetic response. In an adult dental study, 10-15% of individuals were reported to have a hypersensitive gag reflex and were described as gagging while eating thick or sticky foods (Neumann & McCarty, 2001).

Typical Development

In normally developing infants, the gag reflex may be triggered by tactile stimulation to the face, trunk, extremities, and anterior portions of the oral cavity. As the infant neurologically matures and the autonomic nervous system (i.e., the brainstem nucleus tractus solitarius establishes a more typical pattern of connectivity, the traditional gag reflex response usually develops (Scarborough & Isaacson, 2006). The elicitation of the gag reflex will move posteriorly in the oral cavity as the infant matures. The swallow reflex, stimulated during feeding, activates an inhibitory interneuron at the presynaptic region in the nucleus tractus solitarius which acts to inhibit incoming axonal projections arising from transient connections (Jean, 1984a, b; Perlman and Schulze-Delrieu, 1997; Jean, 2001).

Burns et al. (1987) studied oral responses in a group of preterm very low birth weight infants. The authors found that the most frequently positively elicited early response was the gag reflex. The gag reflex was consistently present and functionally mature by 33 weeks in 80% of the 81 infants tested.

Due to the motor response of gagging and proximity to the airway, caregivers may confuse gagging and choking (Tournier et al., 2021a; Tournier et al., 2021b). Gagging is differentiated from choking, which is defined by an airway obstruction produced by food inhalation (Bocquet et al., 2022).

An infant's initial reflexive oral experiences are related to tactile stimulation (rooting) from birth to 5-months of age (Kamen, 1990). Gagging may be reported as infants mouth their hands and toys or learn to eat complementary foods. While there is a wide range of infant responses during solid food introduction, gagging is often reported when children are transitioning from a liquid diet (breast or bottle) to solid foods (da Costa et al., 2019; Tournier et al., 2021b; Kamen, 1990). A study that assessed whether feeding 9-month-old infants complementary foods containing a higher number of larger pieces affects their chewing capability found that shivering, gagging, choking, and coughing occurred more often when children were given hand-mashed foods and pieces than when the manufactured foods with pieces were given (da Costa et al., 2017).

Gagging can occur when poorly chewed food moves to the back of the oral cavity, and the infant responds with a cough, moving the food anteriorly (Bocquet et al., 2022). The gag reflex can be triggered by any food that is too large or solid for an infant to manage. However, this often improves with time and practice. Around 6-7 months of age, as children experience more mouthing activities along with early solid foods feeding experiences, the gag reflex diminishes, allowing infants to successfully swallow more foods (Stevenson & Allaire, 1991; Bocquet et al., 2022; Kamen, 1990).

While not well studied, a sensitive period for texture introduction is thought to be around 8-10 months (Nicklaus & Schwartz, 2019). Gagging with food textures in typical development appears to improve with exposure and practice eating (Demonteil et al., 2018; Harris et al., 2017). In a French survey of texture exposure during complementary food introduction in healthy children, results suggest that mothers are influenced by a variety of factors when introducing texture: presence of teeth, ability to sit alone and ability to self-feed, with fingers or a fork (Demonteil et al., 2018). A frequent gag reflex was seen in 27.5% of children at 4-5 months and decreased with age to 14% at 30–36 months with developmental maturation (Demonteil et al., 2018). A negative effect of gagging was observed at 16–18 and 25–29 months in children who were less exposed to food textures (Demonteil et al., 2018).

Results of a study tracking gross motor, fine motor, and oral motor developmental patterns of 98 white, healthy children aged 2 to 24 months found that there was a wide age range for skill development (Carruth & Skinner, 2002). Authors describe that at 5-7 months, most children had some degree of head and trunk stability, the beginning of hand-to-mouth self-feeding, and eruption of lower and upper front teeth, which coincided with children eating finger foods without gagging. The study found that when assessing oral motor development, children could eat food with tiny lumps without gagging between 4.8–15.5 months with a mean age of 8.7 months, and when looking at fine motor development, children could eat finger foods without gagging between 6 –12 months with a mean age of 8months (Carruth & Skinner, 2002).

Researchers did not document information regarding gagging triggers or presence when first observed; information on gagging was reported only when children could eat successfully without gagging.

Cappellotto & Olsen's study (2021) showed an association between texture preference and children's sensory processing in the domain of smell/taste, visual/audio, and tactile sensitivity. The authors discuss the possibility that children who are more sensitive to sensory stimulation (touch, taste, sounds, light, and smells) may have specific preferences for softer and more uniform textures. The authors did not find a relationship between parental and children's texture preferences. This hypothesis is supported by research from Coulthard et al. (2016) looking at solid food acceptance and timing in a cohort of healthy breastfed infants. Results suggest that some children have a different physiological response to food, which affects early complementary feeding behavior. The study found that consumption of a novel vegetable (carrot) was strongly associated with tactile over response in the sample which may be characterized as gagging. Sensory information was elicited through the Infant/Toddler Sensory Profile (Dunn & Daniels, 2002) given before the infants started solid foods. Infants who had higher responsivity to tactile information by generally showing aversion to such stimulation consumed fewer carrots. Timing was also an influential factor, with infants starting solids later with higher levels of over response and consuming fewer carrots.

Baby-led weaning is an alternative approach to the introduction of complementary foods where solid foods are introduced first and purees are skipped. Information from this literature may provide important clues about the benefits of texture exposure on gagging with solid food introduction. In a survey examining the prevalence of gagging and choking among children fed traditionally with purees via spoon and eating using the baby-led weaning method, results indicated that gagging was more frequent among children fed with the baby-led weaning method (51.9%) but not choking which was comparable between both groups (Bialek-Dratwa et al., 2022). In a randomized controlled trial of 206 healthy infants, those in the Baby-Led Introduction to SolidS group gagged more frequently at 6 months but less frequently at 8 months, according to results gathered via a questionnaire assessing the frequency of choking and gagging at 6, 7, 8, 9, and 12 months of age (Fangupo et al., 2016).

Feeding Difficulty and Disorders

Feeding literature commonly reports gagging as a problematic behavior in relation to a hyper-sensory response when children with feeding disorders are learning to eat. Gagging may also be triggered with a variety of sensory stimulation, including the sight, smell, and/or feel of foods as well as new, textured, or non-preferred or unfamiliar foods. Gagging has been reported as a response occurring in children presenting with a variety of feeding difficulties and diagnoses. This is discussed in more detail later in this dissertation.

Although the underlying neurologic mechanism is not fully understood, an abnormal gag response in infants may also result from poor organization of the autonomic nervous system (Scarborough & Isaacson, 2006; Als, 1982). Across pediatric patients, gagging may be triggered inappropriately by smell, the taste or feel of food, or from touch to the body, face, or anterior oral cavity (Scarborough & Isaacson, 2006; Scarborough et al., 2006). Scarborough and Isaacson (2006) proposed an anatomical model that suggests that the aberrant gag reflex results from abnormal oral feedings during the first 3 months of life. The use of alternative tube feedings during critical stages of postnatal medullary development (Takashima & Becker, 1986; Vincent & Tell) and/or prolonged orogastric intubation may increase risk of a hyperactive gag reflex (Lifschitz, 2001).

A scoping review (Brackett et al., 2024, under review) examining gagging across pediatric literature reported that gagging and retching were used in feeding-related articles across 31 different diagnoses. The primary areas seen with the term gagging were symptoms of a feeding disorder, negative behavioral response (aversion), oral motor/sensory response (delayed food introduction, response to texture or other stimuli, smell), associated with GI symptoms, or associated with swallowing dysfunction. Eight articles discussed the typical gag reflex. Multiple articles (n = 29) used gagging to indicate problematic or negative feeding behavior, feeding aversion, oral aversion, or as an avoidance behavior, and nine articles mentioned gagging as an indication of an infant feeding disorder or symptom of a feeding problem. Fourteen articles associated gagging with a pharyngeal swallowing problem or choking. Gagging related to oral motor/sensory response occurred in 21 articles and included topics such as decreased exposure or delayed introduction to food, or response to sensory properties such as sight, taste, or smell of food. Ten articles focused on the gagging responses to texture introduction. Lastly, 20 articles discussed gagging in relation to GI symptomatology, including gastroesophageal reflux (GER), constipation, motility, tube feeding, and formula tolerance. Retching was used less frequently in this category but was associated with feeding behaviors, GI symptoms, swallowing difficulty, sensory response, and as part of the gag. Gag and retch were used together as associated with GI symptoms, feeding aversion, sensory response, and general signs of feeding disorder.

In some cases, gagging may contribute to PFD and prevent or delay a child's developmental feeding progress. A hypersensitive response to the sight, smell, taste or feel of food may cause a child to completely refuse or have difficulties consuming a specific food (Caldwell & Krause, 2021). Abnormal gagging is one of the most common negative sensory and motor responses that tend to occur in children who have experienced delayed feeding

(Scarborough & Isaacson, 2006) and may be triggered inappropriately by smell, touch, taste or feel of food (Scarborough & Isaacson, 2006; Scarborough et al., 2006; Scarborough, 2007). Overtime, this response may contribute to the development of oral aversion, refusal of food, and feeding difficulty.

According to Dunn (1999), sensory sensitivity is believed to be an inherent characteristic and represents one of the most influential factors that determine eating behaviors (Coulthard & Blisset, 2009). Within sensory sensitivity, texture has been shown to be the most common reason for rejecting (or accepting) specific foods among children (Cappellotto & Olsen, 2021). Food selectivity over time can negatively impact a child's diet and contribute to deficiencies (Bandini et al., 2010) and oral-motor-sensory deficits (Caldwell & Krause, 2021).

Several articles report that increased sensitivity to the smell, taste, and feel of foods can result in difficulty consuming foods, refusal of foods, poor variety of intake, as well as contribute to the development and diagnosis of a long-standing pediatric feeding disorder (Smith et al., 2020; Smith et al., 2005; Chistol et al., 2018, Chiatto et al., 2019). Smith et al., (2020) state that "greater sensitivity to taste/smell may explain why children with neurodevelopmental disorders are more likely to be fussy eaters" (p.1) and discuss that a reluctance to eat new foods and/or eat fruit and vegetables has been associated with higher levels of tactile and taste/smell sensitivity. In a review by Cermak et al., (2010), children with tactile defensiveness were reported to have poor appetite, hesitated to eat unfamiliar foods, and refused certain foods because of smell and temperature. Many children experiencing hypersensitive gagging with new, unfamiliar, and nonpreferred foods can eat preferred foods without difficulty (Yi et al., 2015).

In a case report, Overland (2011) suggests that children with sensory regulation problems may not feel the food in their mouths or may be overly sensitive to the feeling of the food in their mouths. The author describes a child who gags, chokes, and vomits on crackers and subsequently refuses them as her sensory system goes into a “fright, fight, and flight” mode (Overland, 2011, p. 60).

Previous research has discussed an association between sensory sensitivity, food neophobia, and the rejection of foods in young children and adult picky eaters (Cappellotto & Olsen, 2021). However, sensory processing and its role in the acceptance and consumption of foods among children remains a much-neglected area in the current literature (Coulthard & Blissett, 2009).

Associated Diagnoses with PFD

In the literature, gagging is mentioned as part of feeding difficulty related to many different feeding issues and diagnoses including; infantile feeding disorders, oral aversion, tube dependence, sensory dysfunction, dysphagia, cleft palate, trisomy 21, congenital heart defects, 22q11 deletion syndrome, chronic lung disease, failure to thrive, prematurity, GER, motility disorders, visceral hyperalgesia, genetic syndromes, autism spectrum disorder (ASD), and cerebral palsy (Cooper-Brown et al., 2008; Hill et al., 2014; Pados et al., 2017; Martin & Shaw, 1997; Mazze et al., 2019; Reynolds et al., 2015; Wilson & Hustad, 2009; Clawson et al., 2007; Yi et al., 2015; Twachtman-Reilly et al., 2008; Barnhill et al., 2016; Chistol et al., 2018; Seiverling et al., 2019; Levy, et al., 2009; Levine et al., 2011; Chiatto et al., 2019). Suggested factors that contribute to hypersensitive gagging are unpleasant early oral experiences, such as endotracheal tube insertion, prolonged nasogastric and orogastric feeding, late introduction of oral feeding, delayed texture exposure, food/formula intolerance, and GI etiology (GER, vomiting, eosinophilic esophagitis (EoE), constipation) (Martin & Shaw, 1997; Mazze et al., 2019). Gagging may be a result of negative feeding experiences (e.g., coughing, gagging, reflux, frequent emesis) or food texture hypersensitivity or temperatures (Bandstra et al., 2020; Padmanabhan & Shroff, 2018; Chiatto et al., 2019; Malhi et al., 2021). In Padmanabhan & Shroff's, (2018) study, when children have better taste and smell sensory integration, they were less likely to have mealtime behavior problems. Children with delayed feeding skills may not eat age-appropriate textures, receive supplemental nutrition via formula or tube feeding, or accept limited variety.

Multiple studies report gagging and retching as related to GI etiology (GER, vomiting, EoE, constipation) (Martin & Shaw, 1997; Mazze et al., 2019, Minor et al., 2016). Visceral hyperalgesia is defined as an altered threshold to pain in response to a stimulus in the GI tract (Delgado-Aros et al., 2005). According to Hauer (2017), pain in the GI tract is reported to have a high pain intensity, and many children with central nervous system impairment continue to have symptoms despite treatment for GER, leading to feeding intolerance. In these children, normal stimulus in the GI tract or tissue inflammation, such as from GER, may result in visceral hyperalgesia with retching and vomiting, resulting in feeding intolerance (Hauer, 2017). Interestingly, within the scoping review (Brackett et al., 2024, under review), much of the research reporting on feeding intolerance and GI issues does not specifically discuss gagging but instead report on oral aversion, intolerance, retching, and vomiting.

Several studies report oral hypersensitivity and gagging in association with ASD and feeding problems (Nadon et al., 2011; Chistol et al., 2018; Provost et al., 2010; Padmanabhan & Hemal Shroff, 2018; Twachtman-Reilly et al., 2008; Barnhill et al., 2016). When comparing mealtime behaviors of young children (3–6 years old) with ASD to children of the same age with typical development, the authors found that significantly more children with ASD were picky eaters and 25% had problems with gagging (Provost et al., 2010). Another study comparing similar groups found that children with ASD, with atypical oral sensory sensitivity, refused more foods and ate fewer vegetables than those with typical oral sensory sensitivity (Chistol et al., 2018).

Clinically, a child who experiences gagging at mealtime commonly receives a diagnosis of oral defensiveness, oral aversions, or food aversion (Chiatto et al. 2019; Smith et al., 2005; Bandstra et al., 2020; Yi et al., 2015). Furthermore, in response to avoiding gagging, children and their caregivers often begin to avoid these foods due to the negative sensory response. Studies comparing children with heightened sensory responses to typical children show a more limited variety and aversion toward textures or consistencies, smells, and temperatures of food in the sensory group (Smith et al., 2005).

Gagging may also result from immature chewing, oral motor deficits, and swallowing food whole which can lead to the refusal of solids textures (Edwards et al., 2015). Bandstra et al., (2020) identified children as orally averse based on their tolerance of a nonnutritive intra-oral task completed as part of an oral–motor assessment. If the task could not be assessed due to significant behavior and/or distress with presentation of the oral stimulus it was deemed not tolerated (Bandstra et al., 2020). Despite the serious consequences that a negative sensory response such as hypersensitive gagging may have on a child's food intake, feeding skills and psychosocial function, there is no clear understanding of how to assess and treat these responses. More importantly, currently as a profession we do not have a systematic path for prevention or treatment approaches to lessen the effects in children with higher risk of feeding delays.

Feeding tube dependence is defined as an unintended result of long-term tube feeding in infants and young children (Dunitz-Scheer et al., 2011). Children who remain tube dependent may be physically capable of managing oral feeding. Complications of tube feeding, feeding intolerance, or oral feeding introduction can include recurrent vomiting, gagging, discomfort, oversensitivity, fussiness, and oppositional and aversive behaviors (Dunitz-Scheer et al., 2011; Dunitz-Scheer et al., 2009; Gutentag & Hammer, 2000; Heikenen et al., 1999; Krom et al., 2019). Gagging may be a barrier to progress when transitioning from tube to oral feeding and may be a result of hypersensitivity due to lack of exposure to food/liquid sensations (Scarborough et al., 2006).

A study examining children who were tube fed reported gagging as a symptom of intolerance along with retching, vomiting, and other GI etiology (Minor et al., 2016). Interestingly, in this study, gagging improved in 92% of subjects with formula manipulation using a 100% whey peptide formula within 1 week after the formula change (Minor et al., 2016). Another study examining the clinical characteristics of pediatric tube feeding in the Netherlands found that 28.7% of the children had gagging as a symptom (Krom et al., 2019). The authors noted that they examined the presence of gagging, not severity. In a large cohort of 425 children, adverse effects of nasogastric and percutaneous endoscopic gastrostomy tube feeding, as reported by parents, found that 56% of all tube-fed children had regular gagging and retching episodes (terms were assessed together) (Pahsini et al., 2016).

Wilken et al. (2018) examined a large cohort of children with feeding tube dependency. The authors aimed to assess if food-avoidant behaviors were present, whether food-avoidant symptoms were related to age or method of enteral feeding, and whether the presence and severity of feeding tube dependency was negatively associated with growth and weight gain. Significant findings included daily food avoidance, vomiting, and gagging in this group of children and that daily gagging and vomiting were present across age groups and types of tube feeding (Wilken et al., 2018).

Gagging may be reported as an adverse behavior when trying to avoid oral intake (Gutentag & Hammer, 2000; Kamen, 1990). In this case report, a young child's gag reflex and GER were discussed as interfering with her acceptance of solid foods (Gutentag & Hammer, 2000). Kamen writes that any food textures may elicit a gag reflex due to oral hypersensitivity and that frequent gagging may reinforce a child's fear of oral feeding (Kamen, 1990). She further explains that gagging is an aversive behavior children may exhibit to avoid food when it does not feel right in their mouths and to stop caregivers from feeding them (Kamen, 1990).

Multiple studies have written about the benefits of using blenderized tube feeding, which refers to feeding a child blended food that is liquified or made into a thin puree to allow for tube feeding. Benefits often include improved GI tolerance and reduced or elimination of gagging (O'Connor et al., 2022; Alabbas & Durant, 2022; Pentiuk et al., 2011; Batsis et al., 2020; Johnson et al., 2013; Gallagher et al., 2018; Shrager et al., 2023; Bobo, 2016; Chandrasekar et al., 2021).

Alabbas & Durant, (2022) reported that 60% of tube dependent children in their study experienced gagging. The authors stated that retching, gagging, and emesis are most likely caused by GER and motility dysfunction. Gagging/retching improved in all patients (100%) with a blenderized tube feeding diet, allowing children to discontinue or reduce antacid administration (Alabbas & Durant, 2022). Another study included 33 children with feeding disorders after fundoplication surgery; authors observed that after 3 months on the blenderized tube feeding diet, gagging and retching improved in 76–100% of the patients. The authors surmised that the improvement in gagging and retching may be related to the increased viscosity of the blend, which may reduce gastric dumping or the rate of gastric emptying (Pentiuk et al., 2011).

In a retrospective review, Batsis et al. (2020) indicated that while on standard enteral formulas, 21 of 23 (91%) patients experienced upper GI symptoms: 9 (40%) gagging and retching, 11 (48%) emesis, and 1 (4%) persistent cough with concern for aspiration. GI symptoms improved within the first 3 months in children fed blended diets via gastrostomy tube.

O'Connor et al. (2022)'s study using the blenderized tube feeding diet also showed a reduction of GI symptoms, including gagging. They discuss possible reasons the blenderized tube feeding diet helps GI function which may be due to the "beneficial effect of fiber on the gut microbiota" and "the increased viscosity which means that digested chyme reaches the small intestine at a pace that stimulates a more regular hormonal response" (p.933). Gallagher et al. (2018) found the prevalence of gagging/retching decreased by 35% and vomiting decreased by 23%, use of acid-suppressive agents decreased 12%, and stool softener use increased from 24% to 29% with blenderized tube feedings.

Pediatric Feeding Disorder (PFD)

Due to a lack of a universally accepted terminology across disciplines, a consensus definition of PFD was developed in 2019 using the framework of the World Health Organization International Classification of Functioning, Disability, and Health (Goday et al., 2019). PFD is defined as impaired oral intake that is not age-appropriate, and is associated with medical issues, nutritional factors, feeding skill, and/or psychosocial dysfunction (Goday et al., 2019). Due to an interaction and influence between domains, authors explain that impairment in one domain can lead to dysfunction in any of the others, resulting in a PFD. According to the definition, children with developmental delays may have feeding skills appropriate for their level of development but not their age, thus meeting the diagnosis of PFD (Goday et., 2019).

Establishing a universal definition has enabled new research on PFD using the framework of the four domains. Further, this framework provides consistent terminology to facilitate interdisciplinary collaboration, education, and research (Mazze et al., 2019). In Sharp et al. (2022), a 28-member multidisciplinary panel including clinicians from medicine, nutrition, feeding skill, and psychology from seven national feeding programs developed a Case Report Form (CRF) to assess PFD. For clinicians and researchers, this tool promotes a standard list of items across the four domains to be used in the evaluation of children with PFD (Sharp et al., 2022). While the CRF has not yet undergone content validation, the information from the CRF form will serve as a guide for documenting domain information in this study.

PFDs are heterogeneous, complex, and common (Sharp et al., 2022). The prevalence of children with PFD is increasing and is reported to occur at a similar rate to ASD (Kovacic et al., 2021). It is estimated that the annual prevalence of PFD in US children is between 1 in 37 children under 5 years of age (Kovacic et al., 2020). The annual prevalence is higher in children with chronic diseases and is estimated to be between 1 in 5 in children under 5 years of age (Kovacic et al., 2021).

A retrospective study examining predictive factors found that low socio-economic status, low birth weight, preterm birth, and not being breastfed were more frequent in children with PFD (Galai et al, 2022). Simione et al. (2023) examined 50 children and found that children with PFD present with heterogeneous medical diagnoses and feeding impairments. The most common diagnoses in this study were neurologic/genetic disorders followed by no known medical diagnoses. According to this research, children with no known diagnose often have sensory processing dysfunction, limited volume, or food selectivity. The authors reported that children with feeding disorders presented with poor quality of life as compared to scores for other pediatric conditions, and their caregivers were negatively impacted by their feeding difficulties with higher amounts of stress and dysfunctional interactions with their children (Simione et al., 2023).

Hypersensitive gagging is disruptive to feeding skills and progression. While commonly reported by feeding therapists, the literature reveals a lack of consistent use and definition of the term gagging (Brackett et al., 2024, under review). For instance, gagging may be referred to in association with GI etiology (gagging, retching, vomiting), as part of pharyngeal dysphagia (gagging and choking), or as a behavioral response (negative mealtime behavior, fear of a procedure). In Goday et al. (2019), gagging is listed as an impairment in the feeding skills domain as part of oral sensory functioning and is seen with hyposensitivity (gagging due to lack of awareness of what is in the mouth), hypersensitivity (gagging with specific textures or bolus size), and oral motor functioning with gagging during bolus formation, and post swallowing residue. Therefore, hypersensitive gagging could potentially be part of the medical, feeding skill, or psychosocial domains in PFD.

Purpose of the Present Study

According to Goday et al. (2019), children are diagnosed with PFD based on a diagnosis of oral intake that is not age appropriate and identified with dysfunction in 1 or more of 4 domains (medical, nutrition, feeding skill, psychosocial). Through literature review, gagging response in the pediatric population is seen across disciplines in a variety of contexts. For children with PFD, gagging is described as a negative factor related to many facets of feeding including tube feeding, GI dysfunction, pharyngeal dysphagia, oral feeding, and texture progression, as well as oral care including tooth brushing. However, despite the common observation and report of gagging in children with PFD, a lack of a consistent definition, assessment, measurement, and intervention is noted in the literature. Therefore, the present study aims to establish gagging as a frequent problem in children with PFD and explore the most common triggers for gagging related to feeding and mealtime. The study will compare two groups of children with PFD, those with and without gagging, to describe clinical factors according to the four domains as outlined by Goday et al. (2019) and further defined by Sharp et al. (2022). By exploring the domains identified for each group of children, we may begin to understand the contributing factors for children who experience gagging as part of their PFD. The information gathered will allow for further research assessing contributing factors, sensitive time periods, and prevention for children with gagging responses related to mealtime.

This research aims to answer the following questions:

1. What proportion of children with PFD experience gagging as part of their feeding difficulty?

   H_o: Based on an informal pilot study, over 70 % of participants with PFD will experience gagging as part of their feeding difficulty.

2. What are the most common triggers observed or reported in individual children with PFD and gagging?

   H_o: Based on informal preliminary data, current literature, and clinical expertise, children with PFD will gag most commonly with textured foods, solid foods, tooth brushing, and mouth stuffing.

3. What is the comparison of domain identification between the gagging and non-gagging group?

   H_o: Based on informal preliminary data and current literature, there will be a higher frequency of the medical, nutritional, and feeding skills domains effected and a lower frequency in the psychosocial domain in the gagging group as compared to the non-gagging group.

4. What is the comparison between the number of identified domains for each participant between the gagging and non-gagging groups?

H_o: The gagging group will have a greater number of domains identified per participant than the non-gagging group.

5. What is the comparison between the gagging group and the non-gagging group of the type(s) of domains identified for each participant?

a. H_o: In the gagging and non-gag groups, there will be no participant with just one domain identified.

b. H_o: For the participants with two or more identified domains, the domains identified between the gagging and non-gagging groups will be different.

CHAPTER III: METHODS

A retrospective chart review of pediatric patients who underwent an initial evaluation in a hospital-based feeding clinic was conducted to answer five primary research questions. These questions relate to the frequency and triggers of gagging in children with PFD and illustrate the clinical profile of children with and without gagging according to the four domains of PFD (medical, nutrition, feeding skill, psychosocial).

Participants

Setting

Participants were identified through a retrospective chart review of new patients seen in the pediatric feeding clinics at the University of North Carolina (UNC) healthcare system between July 1 - September 30, 2023. The UNC feeding team is an interdisciplinary team consisting of a Pediatric GI Nurse Practitioner (GI NP), a registered dietitian (RD), and a speech-language pathologist (SLP). The UNC feeding team evaluates and treats children from birth to 18 years in two separate locations (Chapel Hill & Raleigh). Approximately 60 children per week are seen between both locations. Participants were evaluated as part of the UNC Chapel Hill and UNC Raleigh pediatric feeding clinics. Prior to data collection, an institutional review board (IRB) approval was obtained for this project from UNC-Chapel Hill and UNC-Greensboro.

The retrospective chart review was conducted by collecting information from various sections of the Epic electronic medical record (Epic). Both the Chapel Hill and Raleigh feeding clinics use Epic to collect and store information about each participant. The investigator obtained demographic information from the opening page of the participant’s chart in Epic, which included name, medical record number, birthdate, gender, race, and ethnicity. Current diagnoses were obtained from the Epic snapshot page which lists diagnoses by category with International

Classification of Diseases, Tenth Revision (ICD-10) codes. Lastly, domain information was retrieved from the GI NP, SLP, and RD assessments, found in the Epic chart review section, which houses clinical notes for patients.

Sample

The inclusion criteria used for this study included the following: between the ages of 0 to 18 years, infants and children who were diagnosed or met criteria for a PFD and were new patients or had not been seen for a minimum of 6 months in the UNC feeding clinic for evaluation by three disciplines (a pediatric GI NP nurse practitioner, an SLP, and an RD). As noted earlier, PFD is defined as impaired oral intake that is not age-appropriate and is associated with medical, nutritional, feeding skills, and/or psychosocial dysfunction (Goday et al., 2019). Criteria for PFD included either meeting the definition criteria through documentation by feeding team clinicians and/or the participant having documentation of the PFD ICD-10 diagnostic code R 63.32.

Exclusion criteria included an infant or child who did not receive a diagnosis of PFD or meet criteria for PFD, listed as a new patient but had been seen in the feeding clinic in the previous 6 months, was not evaluated by all three disciplines, had never eaten by mouth or was NPO due to severe dysphagia, or over the age of 18 years. If the feeding team had treated the child within the past 6 months, they were excluded from this study to avoid interventions that might change their clinical profile.

Measures

Data Collection Tool

A Research Electronic Data Capture (REDCap) tool is a secure web application that can be used to capture data for clinical research (Harris et al., 2009). A REDCap tool was built specifically for this study to capture information from Epic for those participants meeting inclusionary criteria (see appendix). The investigator obtained demographic information from the Epic medical chart, current diagnoses from the Epic snapshot page, and domain information specifically from the GI NP, SLP, and RD assessments in the Epic chart review page. The REDCap tool included questions designed to capture information about the participant's demographic information, gagging presence/absence and the four domains of PFD.

Demographic information collected included age, biological sex, race, ethnicity, and insurance type. Race was defined as per the standard hospital categories including American Indian/Alaska Native, Asian, Black, Native Hawaiian or Other Pacific Islander, White, other, or unknown/not specified. Ethnicity information collected included Hispanic or Latino, not Hispanic or Latino, other, unknown/not specified. Insurance information collected included public, private, a combination of public and private or none.

Questions that differentiated the four domains were based on the PFD definition (Goday et al., 2019) and the CRF as reported by Sharp et al. (2022). Oral motor function was reported by the SLP and confirmed with an oral motor/feeding skill table (Arvedson, 2006). In 2021, a gagging tracking tool was embedded into the electronic medical chart (Epic), specifically as part of the SLP assessment, to capture the presence of gagging either by observation or report and to document the gagging trigger. The SLP asked each caregiver consistent questions about their child's gagging behavior including if gagging was observed and what triggered the gagging. At the end of the initial development, the data collection tool had 71 total questions and is available for review in Appendix A.

Iterations of the REDCap Tool during Development

To determine the functionality of the initial tool, a pilot data extraction was completed for 10 participants. In this pilot extraction, the investigator reviewed the data collected from Epic and compared this data to the gagging data collection tool. The gagging data collection tool was embedded into the SLP assessment in Epic in 2021 and documents presence and triggers for gagging. Information collected was also evaluated for clarity of the 70 REDCap items. Based on this initial analysis, two revisions were made to the REDCap tool. Under gag trigger, *non-preferred* was added as a choice because this option was tracked in the Epic medical chart and had been inadvertently left off the initial REDCap data collection tool. However, the initial classification of dysphagia information was deemed unclear by the investigator during the pilot review, therefore the tool was changed to yes/no for presence or absence of dysphagia symptoms; followed by yes/no if the participant had a completed a modified barium swallow study (MBSS) prior to the feeding team evaluation, and finally, yes/no if aspiration was seen on the MBSS. The revised REDCap tool, which contained 71 items, was used for this study. The initial 10 participants were revised to capture the updated REDCap tool information and included in this study.

Procedure for Selecting Participants

Data collection consisted of a retrospective chart review from Epic beginning on July 1, 2023. This date was chosen due to an increase in detailed documentation through a checklist of the PFD psychosocial domain by the GI NP, which began on July 1, 2023.

To identify new patients seen in the feeding clinics, the investigator searched medical records through the calendar feature of the Epic, looking at the GI NP's feeding team clinic schedule in both locations. The GI NP schedule was used as a primary mode of identifying participants in

Epic. New patients were identified in Epic with the label "NEW FEEDING TEAM". All new patients seen in the UNC feeding clinic between July 2023 and September 2023 who met inclusionary criteria were included in the study.

Gagging Documentation

Gagging information was obtained from documentation from the assessments by the GI NP, RD, and the SLP. Each SLP evaluation included a specific gagging data tracking tool (embedded into Epic in 2021) that documented gagging presence (by report or observation, history of gagging, or no gagging) and all triggers for gagging. The gagging triggers could be selected from the data tracking tool (all that apply) included thin liquid, thickened liquid, smooth, puree, textured, puree, dry, solid food, mixed textured foods, large bites/mouth stuffing, end of meal, sight of food, spoon, smell of food, touch to facial region, touch to body, movement, bowel movement, cough, tooth brushing, tube feeding, non-preferred foods and other with a text box option to write in additional trigger(s). The GI NP and RD assessments also documented gagging presence in their clinical history. Gagging was reported as present if the GI NP, SLP, or RD assessments documented observed or reported gagging. The rationale for this methodology is that a caregiver may report different information to each individual team member. Although all patients were evaluated by the three team members together, this allowed for capturing of gagging behaviors in instances where one team member steps out of the room or works directly with the patient while other team members ask questions.

PFD Domain Documentation

Domain identification was based on the pediatric feeding disorder criteria established by Goday et al. (2019) and items listed in the CRF from Sharp et al. (2022). The CRF form (supplement, Sharp et al., 2022) is a list of items in each of the four domains associated with

PFD. The CRF information was used as a basis for establishing domain identification for each participant. Participant's information was examined in Epic for items in each of the four domains to determine if that participant had a diagnosis or issue in one of the four domains. Information for domain identification and number of domains involved for each participant was collected. This investigator made systematic decisions on domain identification based on established criteria as detailed below.

Medical Domain Documentation

The medical domain included documentation of diagnoses that predispose a child to having an increased risk of PFD. A participant had medical domain identified if any of the following specific medical diagnoses were reported: disorders that affect oral, nasal, or pharyngeal function, airway disorders, pulmonary disorders, GI disorders/food reactions, congenital cardiac issues, and neurological, developmental, and psychiatric disorders. The medical domain was also identified if there was a report of prematurity and pharyngeal dysphagia.

Nutritional Domain Documentation

The nutritional domain included documentation of the participant's primary source of nutrition (oral, tube feeding, need for supplementation) and proportion growth parameters (Body Mass Index [BMI] or weight/length). A participant was considered to have nutritional domain identification if there was reported malnutrition (mild, moderate, or severe) based on growth parameters as documented by the RD. In addition, if a child required formula supplementation, the nutritional intake was considered atypical. Formula supplementation was noted if a child was using a special formula defined as extensively hydrolyzed, or elemental, using higher calorie formula requiring a special recipe, or using formula over the age of 1 year. Finally, any participant requiring any type of tube feeding use/presence were automatically categorized as having nutritional domain identification. Assessing each participant's food group inventory, vitamin, and nutrient intake was beyond the scope of this project.

Feeding Skill Domain Documentation

The feeding skill domain included documentation of whether the participant was eating an age-appropriate diet or required any compensatory strategies to safely ingest food and/or liquid. According to Sharp et al. (2022), the question of whether a child is eating a typical age-appropriate diet refers to whether the child is eating any foods in a form or texture that is considered appropriate for that child's age. This information was documented by the SLP. In addition, oral motor delay or dysfunction was documented by the SLP and checked against Arvedson's (2006) oral motor/feeding scale for confirmation. Oral motor delay or discoordination, swallowing dysfunction, the need for special utensils, special nipples, positioning, feeding strategies, and current or past therapy were documented in the SLP report and captured under oral delay. For example, if an infant used a coordinated suck/swallow/breathe pattern but required side-lying positioning, pacing, and a Dr. Brown premature nipple, the participant was considered to have feeding skill domain identification.

Psychosocial Domain Documentation

The psychosocial domain included documentation of child avoidance behaviors, food refusal, and caregiver management strategies (such as reported force-feeding, special meals, and grazing). Food refusal included food, liquid and/or bottle refusal. Mealtime management encompassed special meals, feeding inappropriate textures, prolonged bottle use, caregiver feeding when it is no longer age appropriate, or feeding special meals (brand specific, texture specific foods), or participant is eating differently than their family.

Analysis

Sample Population

The study population's age, sex, race, ethnicity, and type of insurance were described using frequency distribution and percentiles.

Gagging and Non-Gagging Groups

The sample was divided into two groups; participants who have observed or reported gagging and participants who do not have observed or reported gagging or who had gagging that is reported as resolved. By establishing these two groups, the PI obtained the proportion of children in this sample with PFD who experience gagging as part of their feeding difficulty.

Clinical Profile of Gagging and Non-Gagging Group

Descriptive statistics (frequency, percentile within groups) were used to describe and compare demographic information for each group. A Fisher’s exact test was used for comparison of sex, race, ethnicity, and insurance type. The Cochran-Mantel-Haenszel test was used for comparing the trend of age group between the two groups. Descriptive statistics (frequency, percentile within groups) and a Fisher’s exact text was used was used to compare groups through specific items in each of the domains based on the CRF, and to explore the most common domains identified for participants with two and three domain identification. The Cochran-Mantel-Haenszel test was used to determine the relationship between the number of domains identified per participant between groups.

Gagging Group - Trigger for Gagging

Descriptive statistics (frequency, percentile within groups) were used to report the triggers for gagging in the gagging group sample. Gagging triggers that were reported for each participant from the embedded checklist and the “other” textbox which allowed the clinician to write in a trigger that was not on the premade checklist.

Domain Comparison

Due to the relatively small sample size in some of the domains and the categorical nature of the data, a Fisher’s exact test was used to compare the proportion of identification for each domain between the gagging and non-gagging groups. Each of the four domains (medical, nutritional, feeding skill, and psychosocial) was compared between the two groups. A Fisher’s exact test was used to compare main category items (e.g., neurological issues vs. no neurological issues) in each domain between groups.

Number of Domains Involved per Participant Comparison per Group

The Cochran-Mantel-Haenszel test was used to compare the numbers of domains identified per participant between the gagging and non-gagging groups. Participants had potential for a range of one to four identified domains. To determine the significance of domains involved for participants with two domain identification and participants with three domain identification between groups, a Fisher’s exact test was used.

Intra-rater Reliability

The principle investigator completed a randomly selected second review of 20% of the data. This second data collection used the entire revised REDCap tool to determine if the domains identified between the first and second reviews were consistent. Intra-rater reliability was determined to be 96% with 88 out of 92 domains matching between reviews. During initial review, two domains were identified for participant #5. Upon second review, a third domain was added (psychosocial) due to grazing on the bottle. During initial review, one domain was identified for participant #76. Upon second review, a second domain was added (medical) due to a diagnosis of anxiety. During initial review, three domains were identified for participant #68. Upon second review, a fourth domain (nutrition) was added due use of an extensively hydrolyzed protein formula. Lastly, during initial review, three domains were identified for participant #59. Upon second review, one domain was removed (nutrition) due to participant having one stable food in the vegetable category.

CHAPTER IV: RESULTS

Sample Description

Description of the Full Sample, Gagging Group, and Non-gagging Group

The full sample consisted of 116 participants, with 75 males (65%) and 41 females (35%). The sample was divided into two groups: participants identified with gagging and participants without gagging. Table 1 provides demographic information about each group and Figure 1 illustrates the divided sample by percentage.

Table 1. Demographic information for groups

Variable	Gagging Group	Non-Gagging Group
N	70	46
Sex female	27	14
Sex male	43	32
Age		
0-6 months	13	7
6-12 months	10	4
12-18 months	14	2
18-36 months	12	9
3-5 years	14	8
5-10 years	5	13
10-18 years	2	3
Race		
Asian	3	5
Black	18	14
White	32	15
Other	9	7
Unknown	8	6
Ethnicity		
Hispanic/Latino	8	4
Not/Hispanic/Latino	56	38

Other	0	1
Unknown	6	3
Payment Type		
Public	36	23
Private	27	20
Combo	7	2
None	0	1

Figure 1. Gagging group and non-gagging group

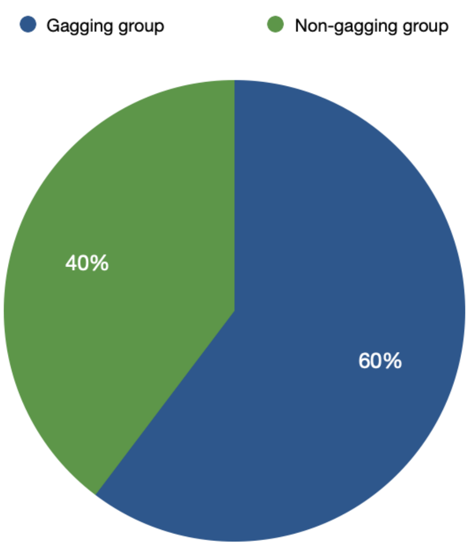


Table 2 provides details of the basic demographics, frequencies, and percentiles for the gagging and non-gagging groups and includes sex, age categories, race, ethnicity, and payment type. Some similarities between the two groups included that both had more males than females, had participants from each category of race and ethnicity and were evenly matched with 50% of participants having public insurance and 50%. The noted contrast between the two groups was that in the gagging group, most participants were under the age of three whereas in the non-gagging group, the participants were more evenly distributed across age groups.

Table 2. Demographics of gagging and non-gagging groups

Variable	Gagging Group	Non-Gagging Group
Sex, n%	70	46
Female	27 (39%)	14 (30%)
Male	43 (61%)	32 (70%)
Age, n%		
0-6 months	13 (19%)	7 (15%)
6-12 months	10 (14%)	4 (9%)
12-18 months	14 (20%)	2 (4%)
18-36 months	12 (17%)	9 (20%)
3-5 years	14 (20%)	8 (17%)
5-10 years	5 (7%)	13 (28%)
10-18 years	2 (3%)	3 (7%)
Race, n (%)		
Asian	3 (4%)	5 (11%)
Black	18 (26%)	14 (30%)
White	32 (46%)	15 (11%)
Other	9 (13%)	7 (17%)
Unknown	8 (11%)	6 (13%)
Ethnicity n (%)		
Hispanic/Latino	8 (11%)	4 (9%)
Not Hispanic/Latino	56 (94%)	38 (83%)
Other	0 (0%)	1 (2%)
Unknown	6 (9%)	3 (7%)
Payment Type, (%)		
Public	36 (51%)	23 (50%)
Private	27 (39%)	20 (43%)
Combination	7 (10%)	2 (4%)
None	0 (0%)	1 (2%)

Analysis of sample

Comparison of Population Sample Between Groups

Table 3 provides a comparison of the gagging and non-gagging group demographics. A Fisher's exact test was conducted to determine the association between the gagging group and non-gagging group for sex, race, ethnicity, or payment type. The Cochran-Mantel-Haenszel test was used for comparing the trend of age category between two groups and found a statistically significantly difference showing that age trend differed between the groups.

Table 3. Comparison of gagging and non-gagging groups

Variable n (%)	Gagging group	Non-gagging group	P-value[1]
Sex, n%	70	46	0.37
Female	27 (39%)	14 (30%)	
Male	43 (61%)	32 (70%)	
Age, n%			
0-6 months	13 (19%)	7 (15%)	**0.01**[2]
6-12 months	10 (14%)	4 (9%)	
12-18 months	14 (20%)	2 (4%)	
18-36 months	12 (17%)	9 (20%)	
3-5 years	14 (20%)	8 (17%)	
5-10 years	5 (7%)	13 (28%)	
10-18 years	2 (3%)	3 (7%)	
Race, n (%)			0.16
Non-white	38 (54%)	31 (67%)	
White	32 (46%)	15 (33%)	
Ethnicity n (%)			0.64
Not/Hispanic/Latino	62 (89%)	42 (91%)	
Hispanic/Latino	8 (11%)	4 (9%)	
Payment Type,(%)			0.42
Public	36 (51%)	23 (50%)	
Private	27 (39%)	20 (44%)	
Combination	7 (10%)	2 (4%)	

None	0 (0.0%)	1 (2%)

[1]Fisher's Exact test, [2] The Cochran-Mantel-Haenszel test.

Domains

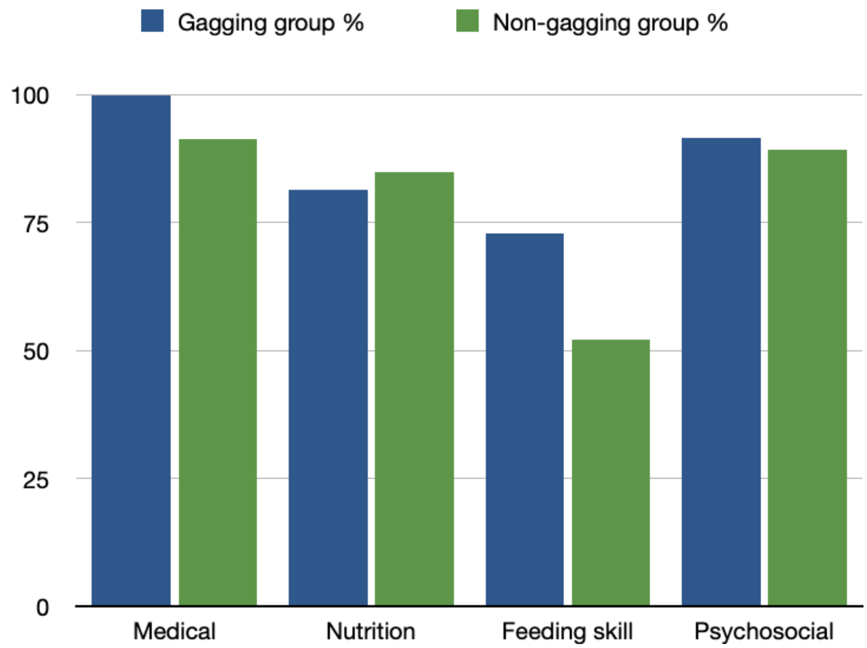
Domain Identification in the Gagging Group and the Non-gagging Group

Table 4 and Figure 2 provide details on the domain identification for each group. For both groups, the medical domain was identified with the highest frequency which included all participants in the gagging group participants. More than half of both groups demonstrated a problem in the feeding skill domain.

Table 4. Domain identification frequency for gagging group and non-gagging group

Variable	Gagging group	Non-gagging group
n	n=70	n=46
Medical Domain	70 (100%)	42 (91%)
Nutritional Domain	57 (81%)	39 (85%)
Feeding Skill Domain	51 (73%)	24 (52%)
Psychosocial Domain	64 (91%)	41 (89%)

Figure 2. Comparison of domain identification for gagging group and non-gagging group



Comparison of the Four Domains (Medical, Nutritional, Feeding Skill, Psychosocial Dysfunction) between Groups

A Fisher's exact test was used to determine if there was an association between the gagging group and the non-gagging group in each of the four domains as seen in Table 5. There was a statistically significantly association in two of the domains between groups. The gagging group was more likely to have medical domain identification and feeding skill domain identification than the non-gagging group.

Table 5. Comparison of domain identification for gagging group and non-gagging group

Variable	Gagging Group	Non-gagging Group	P-value[1]
n	n=70	n=46	
Medical domain	70 (100.0%)	42 (91.3%)	**0.02**
Nutritional domain	57 (81.4%)	39 (84.8%)	0.8
Feeding Skill domain	51 (72.9%)	24 (52.2%)	**0.03**
Psychosocial domain	64 (91.4%)	41 (89.1%)	0.75

[1]Fisher Exact p-value

Medical Domain Factors

Gastrointestinal Issues in the Gagging Group and Non-gagging Group

The frequency of GI issues for both groups is seen in Table 6. Most of the participants in the gagging group had GI issues as compared to the non-gagging group. The most prevalent GI issues in both groups were GER, constipation, and emesis with the gagging group resulting in higher percentages of each of these variables.

Table 6. GI issues in the gagging group and non-gagging group

Variable	Gagging Group	Non-gagging Group
Medical Domain n, (%)	n=70	n=46
GI issues	67 (96%)	32 (70%)
No GI issues	3 (4%)	14 (30%)
GER	38 (54%)	12 (26%)
Constipation	30 (43%)	15 (33%)
Emesis	28 (40%)	7 (15%)
Hypersensitivity	21 (30%)	1 (2%)
EoE[1]	1 (1%)	1 (2%)
Food allergy/intolerance	10 (14%)	2 (4%)
FPIES[2]	1 (1%)	0 (0%)
Other GI	9 (13%)	8 (17%)

[1]Eosinophilic esophagitis, [2]Food protein induced enterocolitis syndrome.

Neurological Issues in the Gagging Group and Non-gagging Group

Neurological issues were slightly higher in the non-gagging group as compared to the gagging group as seen in Table 7. The most reported issue was developmental delay across all groups.

Table 7. Neurological issues in the gagging group and non-gagging group

Variable	Gagging group	Non-gagging group
Medical domain n, (%)	n=70	n=46
Neurological Issues	40 (57%)	31 (67%)
No neurological issues	30 (43%)	15 (33%)
CP[1]	2 (3%)	2 (4%)
Autism	4 (6%)	10 (22%)
ADHD[2]	1 (1%)	2 (4%)
Dev Delay[3]	26 (37%)	18 (39%)
Disorder of motor control	5 (7%)	3 (7%)
Chromosome abnormal	10 (14%)	3 (7%)
Stroke brain bleed	2 (3%)	2 (4%)
Spina bifida	0 (0%)	1 (2%)
Seizures	5 (7%)	3 (7%)
Other neuro	14 (20%)	13 (28%)

[1] Cerebral Palsy, [2] Attention Deficit Hyperactivity Disorder, [3]Developmental Delay

Airway/respiratory Issues in the Gagging Group and Non-gagging Group

The percentage of airway/respiratory issues were slightly different across groups (see Table 8). More than half of all groups reported no airway or respiratory issues.

Table 8. Airway/respiratory issues in the gagging group and non-gagging group

Variable	Gagging Group	Non-Gagging Group
Medical domain n, (%)	n=70	n=46
Airway Issues	30 (43%)	14 (30%)
No Airway issues	40 (57%)	32 (70%)
Malacia[1]	4 (6%)	0 (0.0%)
Airway abnormal	2 (3%)	1 (2.2%)
Tracheostomy	0 (0%)	1 (2.2%)
RAD[2]/asthma	5 (7%)	2 (4.3%)
BPD[3]	3 (4%)	3 (6.5%)
Laryngeal cleft	2 (3%)	0 (0.0%)
Ankyloglossia	5 (7%)	3 (6.5%)
Sleep apnea	1 (1%)	1 (2.2%)
Tonsillar hyper	5 (7%)	0 (0.0%)
Other Airway	15 (21%)	6 (13.0%)

[1] Laryngomalcia, tracheomalacia, bronchomalacia, [2]Reactive Airway Disease, [3]Bronchopulmonarydysplasia

Congenital Heart Issues in the Gagging Group and Non-gagging Group

When comparing groups, the gagging group had a higher frequency of congenital heart issues as compared to the non-gagging group (see Table 9).

Table 9. Congenital heart issues in the gagging group and non-gagging group

Variable	Gagging group	Non-gagging group
Medical domain n, (%)	n=70	n=46
Cardiac issues	18 (26%)	5 (11%)
No cardiac issues	52 (74%)	41 (89%)

Gestational Age Issues in the Gagging group and Non-gagging Group

Table 10 provides the group distribution of gestational ages. Both groups reported more than 60% of participants with term birth. When comparing groups, the gagging group had a slightly higher rate of preterm births than the non-gagging group.

Table 10. Gestational age in the gagging group and non-gagging group

Variable	Gagging Group	Non- gagging Group
Medical domain n, (%)	n=70	n=46
Gestational age		
Term > 37 weeks	43 (61%)	35 (76%)
Moderate preterm < 32-37 weeks	17 (24%)	7 (15%)
Very preterm < 28-32 weeks	6 (9%)	1 (2%)
Extremely preterm < 28 weeks	4 (6%)	3 (7%)

Dysphagia in the Gagging Group and Non-gagging Group

Table 11 shows the frequency of pharyngeal dysphagia in each group. The gagging group had a higher number of participants with signs of pharyngeal dysphagia than the non-gagging group.

Table 11. Pharyngeal dysphagia in the gagging group and non-gagging group

Variable	Gagging Group	Non-gagging Group
Medical domain n, (%)	n=70	n=46
Pharyngeal dysphagia	30 (43%)	11 (24%)
No pharyngeal dysphagia	40 (57%)	35 (76%)

Nutritional Domain Factors

In the full sample, approximately half of the participants had some degree of malnourishment (n=60, 52%) (see Table 12). The gagging group had more formula supplementation orally and by tube than the non-gagging group.

Table 12. Nutrition domain issues in the gagging group and non-gagging group

Variable	Gagging Group	Non-gagging Group
Nutritional Domain n, (%)	n=70	n=46
Negative BMI[1]	12 (17%)	14 (30%)
Negative weight/length	24 (34%)	10 (22%)
Oral formula	30 (43%)	18 (39%)
Tube formula	14 (20%)	7 (15%)
No tube	43 (61%)	33 (72%)
Nasal Gastric tube	3 (4%)	1 (2%)
Gastric tube	15 (21%)	18 (17%)
Gastric Jejeunal tube	1 (1%)	0 (0%)

[1]Body Mass Index

Feeding Skill Domain Factors

Both groups showed a similar trend with more participants having at least some age typical textured food in the diet and reported oral motor delay/dysfunction (see Table 13). In the gagging group more participants had an oral motor delay/dysfunction as compared with the non-gagging group. When reporting age-typical diet for texture, participants were counted yes if there was a reported food that was typical in consistency and texture for the child’s age. Data did not capture percentage of the diet or number of foods in the diet that were age-typical for texture.

Table 13. Feeding skill domain issues in the gagging group and non-gagging group

Variable	Gagging group	Non-gagging group
Feeding Skill Domain n, (%)	n=70	n=46
Eating age typical diet (textures)	38 (54%)	33 (72%)
Not eating age typical diet (textures)	32 (46%)	13 (28%)
Oral motor delay/dysfunction	51 (73%)	25 (54%)
No oral motor delay/dysfunction	19 (27%)	21 (46%)

Psychosocial Domain Factors

Food refusal and caregivers making a special meal were common in the full sample and reported in 78% of participants (n=91) (see Table 14). The non-gagging group had higher frequencies than the gagging group in all the psychosocial items (food refusal, force feeding, grazing, special meals) and similarly for stress with meals.

Table 14. Psychosocial domain issues in the gagging group and non-gagging group

Variable	Gagging Group	Non-gagging Group
Psychosocial Domain n, (%)	n=70	n=46
Food refusal	53 (76%)	38 (83%)
Stress with meals	19 (27%)	12 (26%)
Force feeding	4 (6%)	4 (9%)
Grazing	20 (29%)	21 (46%)
Special meals/feedings	52 (74%)	39 (85%)

Between Group Comparison of Items in Each Domain

A Fisher's exact test was used to compare groups across specific items in each of the domains as seen in Table 15. In the medical domain, comparisons were made between diagnostic categories (e.g., presence of GI issues vs no GI issues) and for items in the domains. Results showed that in the gagging group, participants were more likely to have GI issues with statistical significance for GER, emesis, and hypersensitivity. The gagging group was also more likely to have pharyngeal dysphagia and oral motor delay than the non-gagging group which was a statistically significant finding.

Table 15. Between group comparison of items in each domain

Variable	Gagging Group	Non-gagging Group	P-value[1]
n	n=70	n=46	
Medical domain			
GI issues	67 (96%)	32 (70%)	**<.01**
GER	38 (54%)	12 (26%)	**<.01**
Constipation	30 (43%)	15 (33%)	0.33
Emesis	28 (40%)	7 (15%)	**.01**
Hypersensitivity	21 (30%)	1 (2%)	**<.01**
Neurological Issues	40 (57%)	31 (68%)	0.33
Autism	4 (6%)	10 (22%)	**0.02**
Airway Issues	30 (43%)	14 (30%)	0.24
Cardiac issues	18 (26%)	5 (11%)	0.06
Prematurity	27 (39%)	11 (24%)	0.11
Pharyngeal dysphagia	30 (43%)	11 (24%)	**0.05**
Nutrition domain			
Malnutrition	26 (37%)	24 (52%)	0.13
G-tube	15 (21%)	8 (17%)	0.65
Formula oral/tube	44 (63%)	25 (54%)	0.44
Feeding skill domain			
Oral motor delay	51 (73%)	25 (54%)	**0.05**
Not eating age typical diet	32 (46%)	13 (28%)	0.08
Psychosocial domain			
Food refusal	53 (76%)	38 (83%)	0.49
Grazing	20 (29%)	21 (46%)	0.08
Special meals/ feedings	52 (74%)	39 (85%)	0.25

[1]Fisher exact p-value

Common Triggers Observed or Reported in Children with PFD and Gagging.

As seen in Table 16, 24 triggers for gagging were identified. The most common triggers included dry solid foods, mixed textured foods, textured puree, and non-preferred foods (foods the child dislikes).

Table 16. Gagging triggers

Variable	Gagging Group Triggers n=70, (%)
n, (%)	70
Thin liquid	9 (13%)
Thickened liquid	1 (1%)
Smooth puree	8 (11%)
Textured puree	15 (21%)
Dry solid food	29 (41%)
Mixed Texture foods	18 (26%)
Large bites/pocketing of food[1]	8 (11%)
End of meal	3 (4%)
Sight of food	5 (7%)
Spoon	3 (4%)
Smell of food	3 (4%)
Touch to facial region[2]	12 (17%)
Touch to body	1 (1%)
Movement	2 (3%)
Bowel movement	2 (3%)
Cough	8 (11%)
Tooth brushing	5 (7%)
Tube feeding	1 (1%)
Non preferred foods	15 (21%)
Crying/upset	2 (3%)
Other[3]	4 (6%)

[1]mouth stuffing; [2]includes touch with hands, bottle, nipple, chewy tube, pacifier;
[3] includes medicine, powdered formula, vitamins, force-feeding.

The Number of Identified Domains per Participant Between Groups

The percentage of domain identification (1- 4) per participant in both groups is seen in Figure 3. Across all the groups, there were no participants with only one domain identified, and over 80% of the participants had three or four domains identified. Table 17 provides details of domain identification per participant across groups with frequency and percentiles. For participants with two domains identified in both groups, the most frequent domain combination was medical and psychosocial. For participants with three domains identified in both groups, the most frequent domain combination was medical, nutrition, and psychosocial.

Figure 3. Domain identification per participant across gagging and non-gagging groups

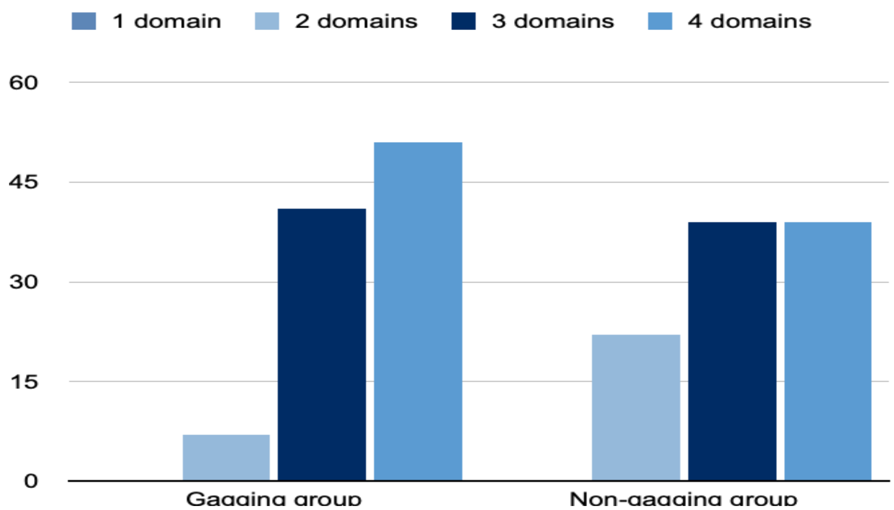


Table 17. Domain identification per participant across groups

Variable	Gag Group (n = 70)	Non-Gagging Group (n = 46)
Number of Domains		
1	0 (0.0%)	0 (0%)
2	5 (7%)	10 (22%)
3	29 (42%)	18 (40%)
4	36 (51%)	18 (40%)
Two Domain Identification		
Medical, Psychosocial	4 (6%)	5 (11%)
Medical, Feeding skill	1 (1%)	1 (2%)
Nutrition, Psychosocial	0 (0%)	3 (7%)
Medical, Nutrition	0 (0%)	1 (2%)
Three Domain Identification		
Medical, Nutrition, Psychosocial	15 (21.4%)	13 (11%)
Medical, Nutrition, Feeding Skill	6 (9%)	3 (6%)

Nutrition, Feeding Skill, Psychosocial	0 (0%)	1 (2%)
Medical, Feeding Skill, Psychosocial	8 (11%)	1 (2%)

Comparison of the Number of Involved Domains per Participant (Medical, Nutritional, Feeding Skill, Psychosocial Dysfunction) Between Groups

The Cochran-Mantel-Haenszel test was conducted to compare the number of domain identification per participant between groups. More participants in the gagging group had three and four domains as compared to the non-gagging group. While the non-gagging group had more participants with two domains. As noted above, neither group had any participant with one domain. (See Table 18).

Table 18. Comparison of number of domain identification between groups

Variable	Gag group (n = 70)	Non-gagging Group (n = 46)	P-value[1]
Domain count, n (%) (as categorical)			**0.04**
2	5 (7%)	10 (22%)	
3	29 (41%)	18 (39%)	
4	36 (51 %)	18 (39%)	

[1] The Cochran-Mantel-Haenszel test

Between Group Comparison for Domain Identification for Participants with 2 Domain Identification and 3 Domain Identification.

A Fisher's exact test was used to compare two domain identification and three domain identification for participants between groups. Participants with two and three domain identification were most likely to have identification in the medical domain with a statistically significant association between groups (see Table 19).

Table 19. Domain identification for participants with 2 domains and 3 domains in groups

Variable	Gag group (n = 34)	Non-gagging Group (n = 28)	P-value[1]
Medical domain	34 (100%)	24 (86%)	**0.04**
Nutrition domain	21 (62%)	21 (75%)	0.29
Feeding skill domain	15 (44%)	6 (21%)	0.10
Psychosocial domain	28 (82%)	23 (82%)	1.00

[1]Fisher Exact p-value

CHAPTER V: CONCLUSION

The present study aimed to improve our understanding of the nature and prevalence of gagging in children with PFD. Children with and children without gagging who were seen in a hospital-based feeding clinic were compared using the medical, nutrition, feeding skill, and psychosocial domains of PFD (Goday et al.,2019, Sharp et al., 2022). In addition, this study explored common triggers for gagging in this population. Multiple group comparisons were made. The groups were compared by frequency of domains identified and through comparison of specific items in each of the domains based on the CRF (Sharp et al., 2022). Additionally, groups were examined through the number and type of domain identification per participant.

While there are numerous studies focused on feeding disorders in children, this is the first known study to report on the prevalence of gagging in children with PFD and the first known study to describe the associated clinical factors according to the domains of PFD. In this study, 60% of the children in the sample experienced gagging. Although gagging was observed across all age groups, the analysis showed that the gagging group mainly consisted of children under 3 years of age. The non-gagging group had a more even distribution of ages ranging from birth to 18 years. In addition, 24 different triggers for gagging were reported.

There were several statistically significant findings when comparing the percentage of domains identified and specific items in each domain between the groups. The gagging group was more likely to have the medical and feeding skill domains identified than the non-gagging group. A closer examination of the medical domain showed that the gagging group was more likely to have GI issues, including a higher frequency of GER, emesis, and GI tract hypersensitivity. The gagging group was also more likely to have reported symptoms of pharyngeal dysphagia and oral motor delay. The gagging group was less likely to have a diagnosis of ASD than the non-gagging group.

This study also showed statistically significant findings when examining both the gagging and non-gagging groups by the number of domains identified per participant. Interestingly, there were no participants who presented with just one domain in either group. However, participants in the gagging group had a higher frequency of three and four domains identified as compared to the non-gagging group. This finding was not surprising given the complexity of children with feeding problems. Furthermore, statistically significant findings indicated that participants in both groups with two and three domains identified were most likely to have a factor in the medical domain.

Gagging is commonly observed in children who have experienced delayed feeding (Scarborough, 2007; Scarborough & Isaacson, 2006; Scarborough et al., 2006) and feeding disorders are becoming more common (Kovacic, 2021). Despite this fact, there is a lack of research specifically examining gagging in children with feeding problems. Furthermore, gagging is often referred to as a side effect or response in current research and is not explored as a primary issue. The current study indicated that 60% of the sample had reported/observed gagging and this may be an underestimate because collecting accurate information from caregivers on gagging or triggering behavior can be difficult. In addition, gagging may be underreported for several other reasons, including that caregivers may not fully understand the terminology (Tournier et al., 2021, Bocquet et al., 2022). Gagging triggers may be unobserved due to the caregivers or children avoiding those foods that may cause gagging. An accurate way to measure gagging has not been reported in the literature (Brackett et al., 2024, under review). In this study, gagging was measured through consistent case history questions or therapist observation and documented via a gagging tracking tool. The most common gagging triggers reported included higher-level food consistencies (solid foods, mixed textured foods, and textured purees) as well as non-preferred foods (disliked foods). Based on this information, it is recommended that therapists ask caregivers about gagging response in their child and provide clarification as to the meaning of gagging if needed. Therapists should obtain information on how the child transitioned to complementary foods as well as their current response to new foods.

The gagging group was comprised largely of children under the age of 3 years which includes the age when children naturally transition from a breast milk or formula diet to complementary foods. Solid food consistencies typically enter a child's diet around 6-8 months. These foods may elicit a protective gagging response, but by 12 months, many children are consuming a portion of their intake in a solid form without gagging (Carruth & Skinner, 2004). Gagging with food textures in typical development appears to improve with exposure and the practice of eating (Demonteil et al., 2018; Harris et al., 2017). The most common triggers reported in this study involved higher textured foods (textured puree, mixed textured foods, dry solid foods). Due to the age of the gagging group, it is possible that some of these children had gagging responses during the transition to solid foods. However, these children were not age-typical eaters due to diagnosis of PFD. Gagging can be unpleasant for children who are learning to eat, and it is possible that a child might avoid foods that trigger this reaction (Kamen, 1990). Therefore, a child not eating age-appropriate textured foods or solids should be assessed for a potential gagging hypersensitive response.

In this study, the gagging group was more likely to have an oral motor delay. Oral motor skill progression relies on the practice of eating food. It is not surprising that based on the younger age of the gagging group coupled with the trigger of gagging on solid foods, many of these children would experience oral motor deficits. When considering this phenomenon, a bidirectional relationship between gagging on solids and oral motor skill progression needs to be considered. If a child gags when trying to eat solid foods, the child may refuse/avoid the food, thus limiting critical practice with solids and contributing to oral motor delay. If a child has an oral motor delay and the caregiver offers foods that are too advanced for their oral motor function, it could result in gagging secondary to oral motor deficits, immature chewing, and swallowing food whole (Carruth & Skinner, 2004). Oral motor function, oral sensitivity, and appropriate food consistencies for the child should be thoroughly examined during a feeding evaluation.

The gagging group was more likely to have symptoms of pharyngeal dysphagia. Both gagging and swallowing are elicited in the same anatomical region with related cranial nerve involvement, but research is not clear on the relationship between gagging and swallowing. In a scoping review of gagging in pediatric literature, fourteen articles discussed gagging with a pharyngeal swallowing problem (Brackett et al., 2024, under review). In most of these studies, gagging was used as a sign of pharyngeal or esophageal dysphagia (Benfer et al., 2015, Kumbhekar et al., 2022, O'Neill et al., 2022). However, the elicitation of the gag reflex is not directly correlated with swallowing physiology (Ramsey et al., 2005). In addition, Saad et al. (2021) reported that the presence of gagging was negatively associated with the occurrence of aspiration in videofluorscopic swallowing studies (VFSS) because the gag reflex is associated with the closure of the vocal folds and might protect against aspiration.

Analysis showed statistically significant findings with the gagging group reporting a higher frequency of GI etiology, including GER, emesis, and GI tract hypersensitivity. This finding was supported by over 20 studies that report gagging as a symptom or response to GI issues. However, gagging has not been the primary focus of any of these research studies (Brackett et al., 2024, under review). Although the exact neurologic mechanism for gagging related to GI issues is not currently known, according to Scarborough (2007), the gut has direct connections with the nucleus tractus solitarius (NTS) of the medulla and vagus nerve, both of which are involved with the basic afferent/efferent loop of the gag reflex. While not well explored, visceral hyperalgesia or a heightened pain response in the GI tract (Hauer, 2017, Delgado-Aros & Camilleri, 2005) may contribute to the gagging response seen in children with PFD and GI etiology. According to Hauer (2017), normal stimulus in the GI tract or inflammation, such as from GER, can result in retching and feeding intolerance. Based on the findings of this study, children with gagging and PFD should be evaluated for GI issues and hypersensitive responses. Further research is needed to explore children with PFD, gagging, GI issues, visceral hypersensitivity, and pharyngeal dysphagia to better understand the relationship among these variables and prioritize treatment intervention for the best outcomes.

A surprising finding in this study was that the gagging group was less likely to have a diagnosis of ASD than the non-gagging group. Several studies report oral hypersensitivity and gagging in association with ASD and feeding problems (Nadon et al., 2011; Chistol et al., 2018; Provost et al., 2010; Padmanabhan & Hemal Shroff, 2018; Twachtman-Reilly et l., 2008; Barnhill et al., 2016). In some cases, feeding issues may be the first sign of a developmental problem. It is possible that because children in the gagging group were young (37% had developmental delay) a portion of these children had not yet had a full developmental evaluation. Alternatively, because the non-gagging group was older, these children may have normalized their gag from practice eating. Many children with ASD consume a limited variety of foods and may eat foods with specific sensory qualities (brand, color, temperature, texture). An additional possibility is that gagging was not identified in some of the children with ASD in the non-gagging group which showed that nearly all of them had food refusal and were receiving some type of meal accommodation (preferred foods, liquids, special meals).

Based on the results of this study, it is suggested that assessment of gagging behaviors should be a key component during all feeding evaluations. Furthermore, if gagging is reported during an evaluation, careful review of GI issues and swallowing is warranted. Gagging may contribute to reduced quality of life, and caregiver's stress, both of which, according to Simione (2023), may be experienced by children with PFD and their caregivers. Clinicians should be aware of the potential for caregiver confusion in interpreting gagging and may need to provide clear explanations of the difference between gagging and choking. Questions about the child's transition to complementary foods should be explored as well as current response to new or non-preferred foods. Children with PFD who are not consuming age-appropriate consistencies, avoid foods, or have a limited diet should be assessed for hypersensitive response. When working with young children who experience gagging as part of their PFD, clinicians are encouraged to investigate GI, swallowing, and oral sensory-motor function. Additional research is needed to better understand how these factors influence gagging and to explore assessment and treatment strategies.

Limitations

There were several limitations of this study. Children attending a hospital-based feeding clinic tend to have more complex feeding needs, which may have influenced the results. Due to retrospective nature of this study, it was not clear if clinicians provided education to caregivers on gagging behavior and response. Certain items on the CRF (Sharp et al., 2022) were difficult to interpret in a research context. CRF items that were difficult to interpret included dietary intake and intake of age-appropriate textures because the volume of these foods in a child's diet was difficult to determine from a retrospective review. Increasing research in PFDs is reporting on children through the framework of the four domains. Therefore, it is crucial that there is a clear understanding of items in each domain so that investigators can confidently interpret domain identification in a systematic and consistent way.

Future Directions

Despite gagging being a common issue in feeding disorders, there is a lack of empirical research exploring this important issue. Further research is needed to better understand the underlying pathophysiology and to provide effective assessment and intervention to children who experience gagging as part of their PFD. Goday et al. (2019) discusses sensory-motor impairment and gagging as part of the feeding skill domain in relation to hyposensitivity, hypersensitivity, and oral motor impairment. While the CRF is an excellent first attempt at creating a list of domain items from the Goday et al. (2019) definition to be used clinically, neither gagging, retching, nor hypersensitivity were included items on the CRF form. Since the results of this study note that gagging is observed in the majority of patients diagnosed with PFD, the CRF may be refined with further use and the relationship between gagging and GI etiology should be explored further. There is a need for a consistent method to measure gagging, especially with children who have food refusal or selectivity. Further research should examine gagging response and severity, sensitive time periods, and evidenced based treatment to improve the quality of life for these children and their families.

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APPENDIX A: REDCAP TOOL

1. **Medical Record Number**

2. **Age**
    - 0-6 months
    - 12-18 months
    - 18-36 months
    - 3-5 years
    - 5-10 years
    - 10-18 years

3. **Biological Sex**
    - Male
    - Female

4. **Race**
    - American Indian or Alaskan Native
    - Asian
    - Black
    - Native Hawaiian or Other Pacific Islander
    - White
    - More than one race
    - Unknown
    - Other (please describe below)

5. **Ethnicity**
    - Hispanic or Latino
    - Not Hispanic or Latino
    - Unknown
    - Other (please describe below)

6. **Insurance**
    - Public
    - Private
    - Combo- Public and Private
    - None

7. **Gag presence**
    - Observed/reported
    - Not reported/Resolved

8. **Gag Trigger**

- Thin liquid
- Thickened liquid
- Smooth puree
- Textured puree
- Dry Solid Food
- Mixed Texture foods
- Large bites
- End of Meal
- Sight of food
- Spoon
- Smell of food
- Touch to facial region
- Touch to body
- Movement
- Bowel movement
- Cough
- Tooth brushing
- Tube feeding
- Non-preferred foods
- Other

9. **PFD Domains**
Medical Domain: Diagnoses (up to 10 comorbidities)

GI

- GERD
- Constipation
- Gastroparesis
- Emesis
- Hypersensitivity
- Eosinophilic Esophagitis
- Esophageal dysmotility
- Food Allergy/Intolerance
- Lactose intolerance
- FPIES
- Other GI issue
- None reported

Neurology

- Cerebral palsy
- Autism
- ADHD
- Developmental delay
- Disorder of motor control (Hypotonia, Hypertonia)
- Muscular Dystrophies
- Chromosome abnormality
- HIE
- Stroke/brain bleed
- Seizures
- Spina Bifida
- Other Neuro issue
- None reported

Airway/Respiratory

- Airway malacia (Laryngo, Tracheo, Broncho)
- Cystic Fibrosis
- Airway abnormality
- Tracheostomy
- RAD/Asthma
- BPD
- Laryngeal Cleft
- Vocal Fold Paralysis/injury
- Ankyloglossia
- Present/ Had release
- Sleep Apnea
- Tonsillar Hypertrophy
- Adenoidal Hypertrophy
- Removal of Tonsils/Adenoids
- Other airway issue
- None reported

Dysphagia

- Yes/No
- If Yes - MBSS
    - Normal Swallow
    - Abnormal Swallow

        If abnormal swallow
        Aspiration
        No Aspiration

Gestational Age

- Extremely preterm (< 28 weeks)
- Very Preterm (28 - 32 weeks)
- Moderate Preterm (32-37 weeks)
- Term (> 37 weeks)

Congenital Heart Disease

- ASD
- VSD
- Hypoplastic Left Heart Syndrome
- Transposition of the Great Arteries
- Other cardiac issue
- None reported

Nutrition Domain

- BMI/weight/length z score _______________
- Formula Supplementation
    Oral formula
    Tube Formula
- Tube Feeding (Yes/No)
- NG
- G
- GJ
- Previous tube (NG, G)

Dietary Intake < 6 months

Fruits (Yes/No)
Vegetables (Yes/No)
Proteins (Yes/No)
Grains (Yes/No)
Dairy (Yes/No)
- uses dairy alternative

Sweet/Savory Low nutrient Foods (Yes/No)

Feeding Skill Domain

- Is the child eating an age typical diet (Yes/No)
- Oral motor delay/dysfunction (Yes/No)
- Gross motor delay (Yes/No)
- Past Feeding Intervention (Yes/No)
    Feeding therapy in community
    NICU/ in hospital therapy
    Other
    Unavailable

Psychosocial Domain

- Food refusal (Yes/No)
- Parents reports stress with meals (Yes/No)
- Mealtime management
- Force feeding (Yes/No)
- Grazing (Yes/No)
- Special Meals (Yes/No)

Number of Domains identified

1
2
3
4