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MODERN APPROACHES TO PEPTIC ULCER IN CHILDREN AND ADOLESCENTS

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Abstract

Introduction: Peptic ulcer disease (PUD), though traditionally associated with adults, is increasingly recognized as a significant clinical concern in children and adolescents. Pediatric peptic ulcers result from an imbalance between aggressive factors, such as gastric acid, pepsin, *Helicobacter pylori* infection, and nonsteroidal anti-inflammatory drug (NSAID) use, and protective mucosal mechanisms. The condition presents diagnostic challenges due to nonspecific symptoms and may lead to serious complications, including gastrointestinal bleeding, perforation, and gastric outlet obstruction. Understanding modern diagnostic and therapeutic approaches is essential for improving outcomes in pediatric populations.

Materials and Methods: This study employed a systematic literature review of peer-reviewed articles, clinical guidelines, and meta-analyses focusing on peptic ulcer disease in children and adolescents. Data were sourced from reputable medical databases, including PubMed, the Cochrane Library, and Scopus. Emphasis was placed on studies published within the last decade to ensure relevance to contemporary clinical practice. The review analyzed epidemiology, pathophysiology, risk factors, complications, and both pharmacological and non-pharmacological treatment strategies.

Results: The findings indicate that *H. pylori* infection remains a primary cause of peptic ulcers in pediatric populations, particularly in developing regions, while NSAID-induced ulcers are increasing globally. Proton pump inhibitors (PPIs) are the most effective pharmacological agents for acid suppression and ulcer healing. Combination antibiotic therapy demonstrates high eradication rates for *H. pylori*, although rising antibiotic resistance presents therapeutic challenges. Histamine-2 receptor antagonists, mucosal protective agents, and lifestyle modifications serve as adjunctive therapies. Non-pharmacological measures, including dietary management and stress reduction, contribute to symptom control and prevention. Surgical intervention is reserved for refractory or complicated cases.

Conclusion: Modern management of peptic ulcers in children and adolescents requires a comprehensive, individualized approach that integrates accurate diagnosis, effective pharmacological therapy, eradication of *H. pylori*, and preventive strategies. Although progress has been made in reducing infection-related ulcers, increasing NSAID use and emerging antibiotic resistance necessitate ongoing research and updated clinical protocols. Early recognition and evidence-based management are critical to preventing complications and improving long-term pediatric health outcomes.

Keywords: *Peptic ulcer disease; Children and adolescents;* Helicobacter pylori*; Proton pump inhibitors; NSAID-induced ulcers.*

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Introduction

Relevance of Topic

Peptic ulcers, while often linked to adults, are increasingly recognized as a significant health issue in children and adolescents. These ulcers, which are erosions in the stomach or duodenal lining, can cause serious complications such as bleeding, perforation, and obstruction if untreated. The growing prevalence of risk factors, including Helicobacter pylori (H. pylori) infection, greater use of non-steroidal anti-inflammatory drugs (NSAIDs), and lifestyle changes in pediatric populations, underscores the need for effective management. Understanding the causes, risk factors, and treatment options for peptic ulcers in this group is essential for improving outcomes and preventing long-term complications [1]. In children and adolescents, peptic ulcers are defined as open sores or erosions in the lining of the stomach, duodenum, or occasionally the esophagus, resulting from an imbalance between aggressive factors such as gastric acid and pepsin and protective mechanisms like mucus and bicarbonate secretion. The epidemiology of peptic ulcers in this population differs from that in adults.

Aim of Study

To evaluate the effectiveness of current approaches to diagnosing, managing, and preventing peptic ulcers in children and adolescents.

Objectives

1. Analyze current pharmacological and non-pharmacological interventions for managing peptic ulcers in pediatric populations.
2. Assess the role of H. pylori eradication in preventing ulcer recurrence.
3. Identify gaps in current practices and propose recommendations for future research.

Material and Methods

This study will use a systematic literature review, analyzing peer-reviewed articles, clinical guidelines, and meta-analyses on peptic ulcers in children and adolescents. Data will be sourced from reputable medical databases, including PubMed, the Cochrane Library, and Scopus. The review will focus on studies published in the last decade to ensure relevance.

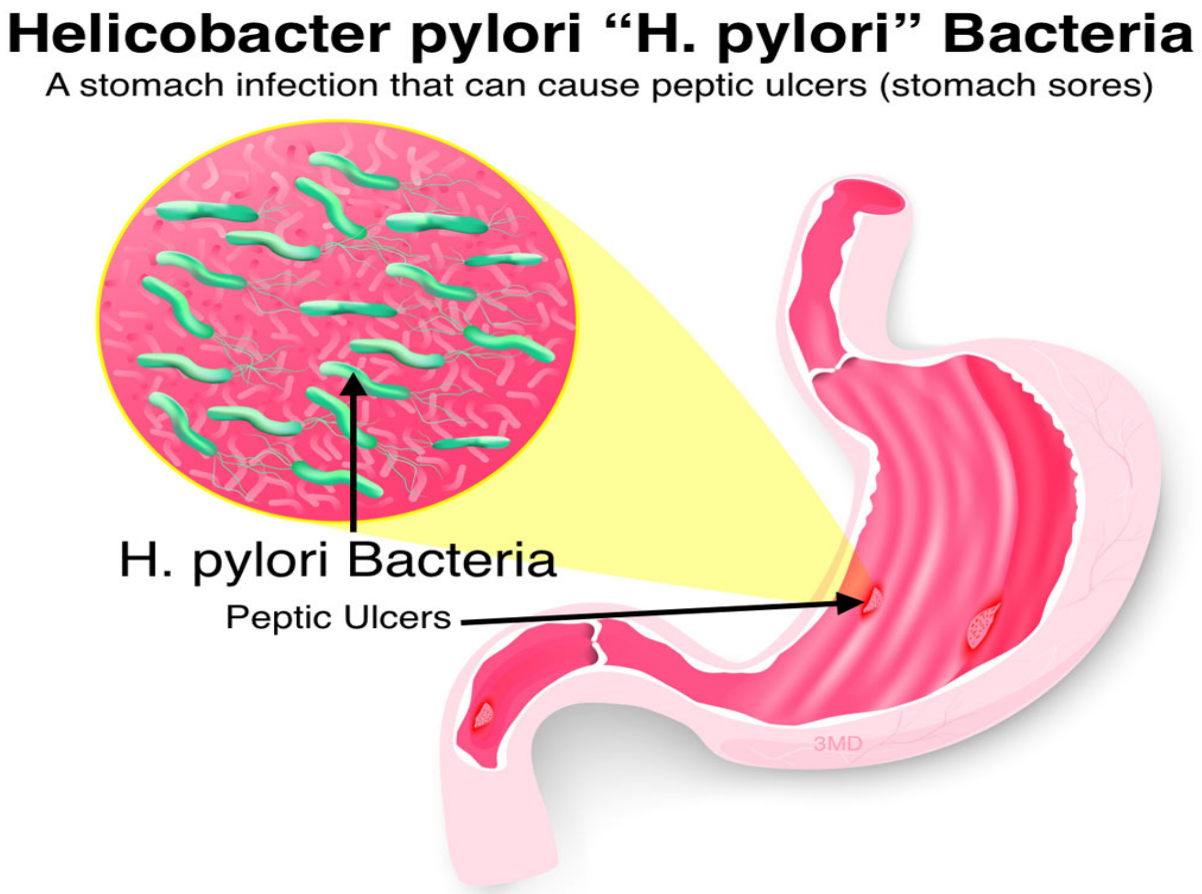
Practical Significance

This research aims to enhance clinical practice by providing healthcare professionals with updated knowledge on effective strategies for managing peptic ulcers in pediatric populations. By synthesizing current evidence-based approaches, the study seeks to improve patient outcomes and quality of care.

Chapter 1: Understanding Peptic Ulcers in Children and Adolescents

1.1 Introduction to Peptic Ulcer

Peptic ulcers are open sores that develop on the inner lining of the stomach (gastric ulcers) or the upper part of the small intestine (duodenal ulcers). In children and adolescents, the condition is often underdiagnosed due to nonspecific symptoms such as abdominal pain, nausea, and vomiting. Severe cases may present with hematemesis, melena, or signs of perforation, which require urgent medical attention [2]. In this population, primary peptic ulcers occur without an underlying cause, while secondary ulcers result from external factors such as medication use or systemic illness. Symptoms are often nonspecific, making diagnosis challenging. Epigastric pain,



nausea, vomiting, bloating, and gastrointestinal bleeding are common, but younger children may show more subtle signs, leading to misdiagnosis or delayed treatment.

1.2 Definition and Epidemiology

Definition: Peptic ulcers are defined as breaches in the mucosal lining of the stomach or duodenum, extending into the submucosa or deeper layers.

Epidemiology: The prevalence of peptic ulcers in children and adolescents varies globally, with H. pylori infection being a major causative factor in developing countries. In developed countries, the use of NSAIDs and stress-related mucosal damage are more common causes. The condition is more prevalent in adolescents than in younger children, with a slight male predominance [3].

Peptic ulcers in children and adolescents are defined as open sores or erosions that develop in the lining of the stomach, duodenum, or, occasionally, the esophagus, resulting from an imbalance between aggressive factors (such as gastric acid and pepsin) and protective mechanisms (such as mucus and bicarbonate secretion). The epidemiology of peptic ulcers in this population differs from that in adults. While historically considered rare in children, the prevalence has increased due to factors such as the rising incidence of *Helicobacter pylori* infection, which is a major

causative agent, as well as the use of nonsteroidal anti-inflammatory drugs (NSAIDs). Peptic ulcers are more common in adolescents than in younger children, and the duodenal ulcer is the most frequent type. Risk factors include *H. pylori* infection, family history, chronic illness, and stress-related mucosal damage. The condition can present with nonspecific symptoms, such as abdominal pain, nausea, or vomiting, making diagnosis challenging without proper investigation.

Definition and Epidemiology of Peptic Ulcer in Children

Definition of Peptic Ulcer in Children

A peptic ulcer is an open sore that develops in the mucosal lining of the stomach (gastric ulcer) or the first part of the small intestine, known as the duodenum (duodenal ulcer). These ulcers result from the erosive effects of stomach acid and digestive enzymes when the protective barriers of the gastrointestinal tract become compromised. Although peptic ulcer disease (PUD) is primarily observed in adults, it can also affect children, though less frequently.

Peptic ulcers in children can be categorized into two main types:

1. Primary Peptic Ulcers – These occur independently of other health conditions and are commonly linked to Helicobacter pylori (H. pylori) infection or excessive stomach acid production.
2. Secondary Peptic Ulcers – These develop as a result of underlying medical conditions, long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs), major physical stress, or severe infections.

Although peptic ulcers in children are relatively uncommon, they can lead to serious complications such as gastrointestinal bleeding, perforation, or obstruction, necessitating prompt diagnosis and management.

Epidemiology of Peptic Ulcer in Children

Peptic ulcer disease is significantly less common in children than in adults, but its occurrence varies based on factors such as infection rates, medication use, dietary habits, and socioeconomic conditions. Understanding the epidemiology of PUD in children helps in early detection and preventive strategies.

3. Prevalence and Incidence

Peptic ulcers are rare in children, accounting for less than 5% of pediatric gastrointestinal disorders.

Duodenal ulcers are more frequently diagnosed than gastric ulcers, as observed in adult cases.

Primary ulcers, particularly those caused by H. pylori, are more prevalent in low-income and developing regions, where bacterial infections are widespread due to poor sanitation.

Secondary ulcers, often linked to stress, critical illness, or NSAID use, are commonly observed in hospitalized children, especially those in intensive care units (ICUs).

4. Age and Gender Distribution

Peptic ulcers can develop at any age, but they are more commonly found in older children and teenagers compared to infants or young children.

The condition tends to affect boys more than girls, particularly in duodenal ulcers. This disparity may be due to hormonal influences, dietary habits, and genetic predispositions.

5. Geographic and Socioeconomic Factors

The prevalence of peptic ulcers and H. pylori infections is higher in developing countries, where poor hygiene promotes bacterial transmission.

Poor sanitation, overcrowding, and inadequate healthcare contribute to the spread of H. pylori, increasing the risk of primary ulcers among children.

In wealthier nations, the incidence of H. pylori-related ulcers has declined due to better hygiene, medical advancements, and antibiotic treatments. However, NSAID-induced ulcers are becoming more prevalent, reflecting increased reliance on over-the-counter pain medications.

6. Contributing Factors to Peptic Ulcers in Children

a) Helicobacter pylori Infection

H. pylori is the most common cause of primary peptic ulcers in children.

Transmission typically occurs through contaminated food, water, and close human contact, particularly within families.

Many infected children remain asymptomatic, but some develop ulcers due to persistent gastric inflammation.

b) NSAID Use

The growing use of aspirin, ibuprofen, and other NSAIDs in pediatric medicine has contributed to an increase in secondary peptic ulcers.

NSAIDs suppress the production of prostaglandins, which protect the stomach lining by maintaining mucus production and blood flow. Reduced prostaglandin levels make the stomach lining more susceptible to acid damage, leading to ulcer formation.

Long-term or excessive NSAID use is a significant risk factor for peptic ulcer development in children.

c) Stress and Critical Illness

Children experiencing severe physical trauma, major infections, or brain injuries have an increased risk of developing stress ulcers.

In critically ill children, reduced blood flow to the stomach lining impairs mucosal repair mechanisms, making them more vulnerable to ulcer formation.

Hospitalized and ICU patients frequently develop stress-induced ulcers that require medical intervention.

d) Genetic and Family History

A family history of peptic ulcers increases a child's likelihood of developing the condition, suggesting a hereditary component.

Genetic factors can influence stomach acid production, the immune response to infections, and mucosal healing.

e) Diet and Lifestyle

While food does not directly cause ulcers, spicy foods, carbonated drinks, and caffeine can worsen symptoms in children with an existing ulcer.

Skipping meals or irregular eating patterns may increase stomach acid secretion, potentially worsening mucosal damage.

f) Underlying Medical Conditions

Zollinger-Ellison syndrome (ZES) – A rare disorder where excessive gastrin production leads to overproduction of stomach acid, resulting in recurrent ulcers.

Crohn's disease – Chronic inflammation of the gastrointestinal tract can lead to ulcer formation in the stomach or duodenum.

Trends in Peptic Ulcer Disease in Children

Epidemiological trends suggest a decline in H. pylori-related ulcers while NSAID-induced ulcers are becoming more common.

1. Declining Incidence of H. pylori-Associated Ulcers

In developed nations, improved hygiene, better healthcare, and antibiotic use have significantly reduced H. pylori infection rates, leading to a decline in primary peptic ulcers.

2. Increasing Cases of NSAID-Related Ulcers

Widespread use of NSAIDs has led to a rise in secondary ulcers, especially in children who are prescribed pain relievers frequently.

Unlike H. pylori-related ulcers, which are decreasing, NSAID-induced ulcers remain a leading cause of peptic ulcers in pediatric populations.

3. Increased Recognition of Stress-Induced Ulcers

The number of stress-related ulcers has grown, particularly among hospitalized children and those in critical care settings.

Advancements in pediatric medicine have improved the early detection and management of stress ulcers.

Although peptic ulcer disease is uncommon in children, it remains a significant concern, particularly in areas with high rates of H. pylori infection or widespread NSAID use. While H. pylori-associated ulcers have decreased in developed nations due to better sanitation and medical care, NSAID-induced ulcers are rising, emphasizing the need for cautious medication use in children.

Recognizing the epidemiological patterns and risk factors of pediatric peptic ulcers is vital for effective diagnosis and prevention. Healthcare professionals should prioritize H. pylori screening, careful NSAID prescribing, and identifying high-risk children, such as those with a family history of ulcers or stress-related illnesses.

By adopting preventive strategies, including improving hygiene practices, regulating medication use, and promoting early medical evaluation, healthcare providers can minimize the impact of peptic ulcers in children. A better understanding of these factors will enhance early intervention, treatment, and overall disease management, ensuring better health outcomes for pediatric patients.

1.3 Pathophysiology of Peptic Ulcers

The development of peptic ulcers is primarily driven by an imbalance between aggressive factors (e.g., gastric acid, pepsin, H. pylori infection) and defensive factors (e.g., mucosal blood flow, bicarbonate secretion). Key mechanisms include:

H. pylori Infection- This bacterium colonizes the gastric mucosa, leading to chronic inflammation and increased acid production.

NSAID Use : NSAIDs inhibit cyclooxygenase (COX) enzymes, reducing prostaglandin synthesis and compromising mucosal defence.

Stress-Related Mucosal Damage - Critical illness or psychological stress can lead to mucosal ischemia and ulcer formation [4].

The pathophysiology of peptic ulcers in children and adolescents involves an imbalance between protective mucosal defences and damaging factors in the gastrointestinal tract. A primary contributor is *Helicobacter pylori* infection, which colonizes the gastric mucosa, causing chronic inflammation and disrupting the mucus-bicarbonate barrier, making the mucosa more vulnerable to acid and pepsin. Excessive gastric acid secretion or impaired regulation further erodes the mucosal lining, while pepsin exacerbates tissue degradation. The use of nonsteroidal anti-inflammatory drugs (NSAIDs) also plays a significant role, as they inhibit cyclooxygenase enzymes, thereby reducing prostaglandin production, which is essential for mucosal protection and repair. Additionally, physical stress from severe illness, trauma, or psychological stress can impair mucosal blood flow and defence mechanisms. Genetic predisposition and environmental factors, such as poor hygiene and socioeconomic conditions, further increase susceptibility. Together, these factors create a complex interplay that compromises mucosal integrity, leading to ulcer formation in children and adolescents.

Pathophysiology of Peptic Ulcers

Peptic ulcers are sores that develop in the lining of the stomach or duodenum due to an imbalance between harmful factors, such as stomach acid and pepsin, and protective mechanisms, such as mucus and bicarbonate secretion. Several factors contribute to ulcer formation, including Helicobacter pylori (H. pylori) infection, nonsteroidal anti-inflammatory drug (NSAID) use, excessive acid secretion, and weakened mucosal defences.

1. Impact of Gastric Acid and Pepsin

Hydrochloric acid (HCl) and pepsin, which aid digestion, can be harmful to the stomach lining if not properly regulated. Under normal conditions, a mucus-bicarbonate barrier protects the stomach and duodenum by neutralizing acid and preventing pepsin from damaging tissues. However, if this protective layer is compromised or acid production is excessive, the mucosal lining becomes vulnerable, leading to ulceration.

2. Helicobacter pylori Infection

The bacterium H. pylori plays a major role in the development of ulcers. It colonizes the stomach lining and produces urease, an enzyme that converts urea into ammonia, helping the bacterium survive in the acidic environment. However, the ammonia and bacterial toxins cause irritation and inflammation, weakening the mucosal defences. The immune response leads to chronic gastritis, making the stomach lining more prone to acid damage. Over time, this process contributes to the formation of ulcers, particularly in the stomach's antrum and the duodenum.

3. NSAID-Induced Ulcers

NSAIDs such as ibuprofen and aspirin increase the risk of ulcers by blocking cyclooxygenase (COX)-1 and COX-2 enzymes, which are essential for prostaglandin production. Prostaglandins help protect the stomach lining by promoting mucus and bicarbonate secretion, maintaining blood flow, and supporting tissue repair. When NSAID use reduces prostaglandin levels, the stomach's natural defences weaken, making it more susceptible to acid-related damage. Long-term NSAID use significantly increases the likelihood of ulcer formation, particularly in individuals with other risk factors.

4. Excessive Gastric Acid Secretion

Overproduction of stomach acid also plays a role in ulcer development. Conditions such as Zollinger-Ellison syndrome (ZES), which involves gastrin-secreting tumours (gastrinomas), result in excessive acid production, overwhelming the stomach's protective mechanisms. Other factors, including chronic stress, smoking, and high alcohol consumption, can further increase acid secretion and contribute to mucosal damage.

5. Weakening of Mucosal Defences and Reduced Blood Flow

The gastric and duodenal mucosa rely on adequate blood circulation for tissue repair and regeneration. Conditions such as chronic stress, poor circulation, and hypoxia can reduce blood supply, impairing the mucosa's ability to heal. Additionally, habits like smoking and alcohol

consumption further weaken mucosal defences by lowering prostaglandin levels and increasing oxidative stress, making the lining more vulnerable to ulceration.

Peptic ulcers develop due to an imbalance between aggressive factors, such as stomach acid, pepsin, H. pylori infection, and NSAID use, and protective mechanisms, including mucus production, bicarbonate secretion, and adequate blood circulation. When these defences are compromised, the stomach's acidic environment can erode the lining, leading to ulcers. Understanding these processes is essential for effective management, including proton pump inhibitors (PPIs), H. pylori eradication therapy, and lifestyle changes, to prevent and treat peptic ulcers effectively.

1.4 Risk Factors for Peptic Ulcers in Children and Adolescents

H. pylori Infection: The most common cause of peptic ulcers in pediatric populations, particularly in developing countries.

NSAID Use: Increasingly prevalent due to the use of over-the-counter medications for pain and fever management.

Family History: Genetic predisposition may contribute to ulcer susceptibility.

Chronic Diseases: Conditions such as Crohn's disease and cystic fibrosis are associated with an increased risk of peptic ulcers [5].

Peptic ulcers in children and adolescents are influenced by a combination of risk factors that increase susceptibility to mucosal damage in the gastrointestinal tract. The most significant risk factor is *Helicobacter pylori* infection, which is highly prevalent in areas with poor sanitation and crowded living conditions. The use of nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen or aspirin, is another major contributor, as these medications inhibit protective prostaglandins, leaving the mucosa vulnerable to acid and pepsin. Chronic illnesses, such as liver or kidney disease, and conditions that cause physical stress, such as severe burns, trauma, or surgery, can also predispose individuals to stress-related mucosal injury. Psychological stress and a family history of peptic ulcers or *H. pylori* infection further elevate the risk. Additionally, lifestyle factors, including smoking (in adolescents) and poor dietary habits, may play a role. These risk factors, either alone or in combination, disrupt the balance between

mucosal defence mechanisms and aggressive factors, increasing the likelihood of ulcer development in this population.

Risk Factors for Peptic Ulcers in Children and Adolescents

Peptic ulcers, which develop in the stomach or the upper part of the small intestine, are often associated with adults but can also affect children and teenagers. These ulcers can result from multiple factors, including bacterial infections, medication use, stress, lifestyle choices, and underlying health conditions. Understanding these risk factors is essential for prevention and early management.

1. Helicobacter pylori Infection

A leading cause of peptic ulcers in young individuals is infection with Helicobacter pylori (H. pylori). This bacterium weakens the stomach's protective lining, making it more vulnerable to acid-related damage. H. pylori is usually contracted in childhood through contaminated food, water, or close contact with infected individuals. However, not all infected children develop ulcers, as factors such as genetics, immune response, and environmental influences also play a role.

2. Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)

Frequent use of nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen and aspirin, significantly increases the risk of ulcers. These medications reduce prostaglandins, which help protect the stomach lining by regulating mucus and acid levels. Prolonged or excessive NSAID use can lead to the erosion of the stomach lining, raising the likelihood of ulcer formation. Children who take these medications regularly for pain or fever are more susceptible to this risk.

3. Emotional Stress and Psychological Factors

Although stress alone does not directly cause ulcers, it can contribute to their development and worsen existing conditions. Emotional stress from academic pressure, family conflicts, or social challenges can increase stomach acid production, heightening the risk of ulcer formation. Additionally, physical stress due to severe illnesses, surgeries, or injuries can further weaken the stomach lining, making it more prone to damage.

4. Dietary Habits and Lifestyle Choices

While diet does not directly cause peptic ulcers, certain eating habits can aggravate symptoms or make the stomach more vulnerable to acid damage. Foods that are overly spicy, acidic, or high in

caffeine, as well as carbonated beverages, can irritate the stomach lining. Skipping meals, irregular eating patterns, and excessive consumption of unhealthy foods can also negatively impact digestive health, increasing the risk of ulcers.

5. Underlying Medical Conditions

Certain medical conditions, such as Zollinger-Ellison syndrome (ZES) and Crohn's disease, can contribute to the development of peptic ulcers in children and adolescents. ZES leads to excessive stomach acid production, while Crohn's disease causes chronic inflammation in the digestive tract, both of which increase ulcer risk. Additionally, children with a family history of peptic ulcers may have a genetic predisposition to the condition.

Peptic ulcers in children and adolescents can be triggered by a combination of bacterial infections, medication use, stress, poor dietary habits, and pre-existing medical conditions. Early recognition of these risk factors is vital for prompt diagnosis and prevention. Parents and healthcare providers should monitor symptoms such as persistent stomach pain, nausea, vomiting, and appetite loss. Encouraging healthy eating habits, managing stress, and limiting NSAID use can help reduce the likelihood of peptic ulcers in young individuals.

1.5 Complications of Peptic Ulcers in Pediatric Populations

Gastrointestinal Bleeding: A common complication, often presenting as hematemesis or melena.

Perforation: A life-threatening condition requiring immediate surgical intervention.

Gastric Outlet Obstruction: Resulting from chronic inflammation and scarring.

Iron Deficiency Anemia: Due to chronic blood loss from ulcer sites [6].

Peptic ulcers in pediatric populations can lead to serious complications if left untreated. The most common complication is gastrointestinal bleeding, which may present as hematemesis (vomiting blood) or melena (black, tarry stools). Severe bleeding can result in anemia and hemodynamic instability. Perforation, though rare, is a life-threatening condition where the ulcer erodes through the stomach or duodenal wall, causing peritonitis and requiring emergency surgical intervention. Obstruction may occur due to scarring and inflammation, leading to gastric outlet obstruction and symptoms like vomiting and weight loss. Chronic ulcers can also cause persistent pain and nutritional deficiencies, impacting growth and development. Early diagnosis and treatment are crucial to prevent these complications and ensure better outcomes.

Table 1. Demographic, clinical and endoscopic findings of patients with peptic ulcer

Characteristics	H.pylori (+) (n=12)	H.pylori (-) (n=48)	P
Mean age± SD (years)	11.95±4.77	11.6±5.4	0.09
Gender (M/F)	7/5	25/23	0.37
Location n(%)			
Cardia	1 (8.3)	2 (4.2)	0.55
Fundus	0 (0)	2 (4.2)	-
Corpus	0 (0)	8 (16.6)	-
Antrum	9 (75)	29 (60.4)	0.35
Antrum and corpus	2 (16.6)	5 (10.2)	0.54
Fundus and corpus	0 (0)	1 (2.1)	-
Cardia and corpus	0 (0)	1 (2.1)	-
Presenting symptom n(%)			
Abdominal pain	9(75)	31(64.5)	0.49
Nausea/vomiting	5(41.6)	15(31.2)	0.49
Hematemesis/melena	2(16.6)	15(31.2)	0.32
Anemia n(%)	6 (50)	13(27.1)	0.12

Fig.1 - Demographic, Clinical finding of patients with peptic ulcer

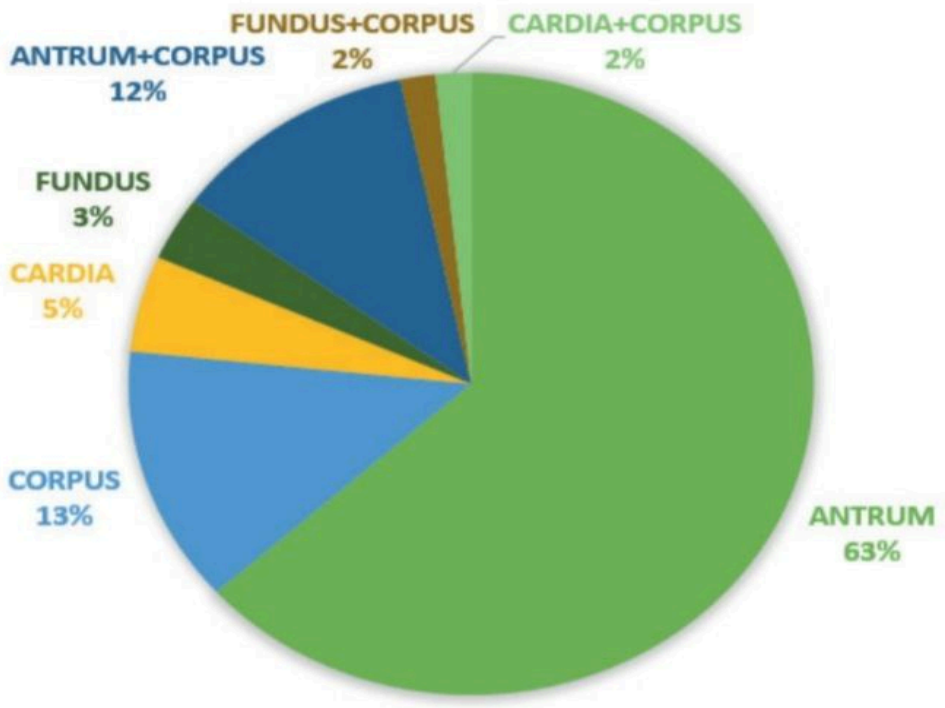


Fig. 1. The locations of peptic ulcers

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Chapter 2: Pharmacological and Non-Pharmacological Approaches to Peptic Ulcer Management

2.1 Pharmacological Treatments for Peptic Ulcers

Pharmacological management focuses on reducing gastric acid secretion, eradicating H. pylori infection, and promoting mucosal healing. Key drug classes include proton pump inhibitors (PPIs), histamine-2 receptor antagonists (H2RAs), and antibiotics for H. pylori eradication [7]. Pharmacological treatment of peptic ulcers in children and adolescents focuses on reducing gastric acid secretion, eradicating *Helicobacter pylori* infection (if present), and promoting mucosal healing. Proton pump inhibitors (PPIs), such as omeprazole or lansoprazole, are the mainstay of therapy, as they effectively suppress gastric acid production and allow ulcer healing. For *H. pylori*-associated ulcers, a combination of antibiotics (e.g., amoxicillin, clarithromycin, or metronidazole) and PPIs is used in a triple or quadruple therapy regimen, often supplemented with bismuth subsalicylate to enhance eradication rates. Histamine-2 receptor antagonists (H2RAs), such as ranitidine or famotidine, may be used as an alternative to PPIs for acid suppression, though they are less potent. Sucralfate, a mucosal protectant, is sometimes employed to coat the ulcer and promote healing, particularly in stress-related ulcers. Additionally, antacids may provide symptomatic relief by neutralizing gastric acid. Avoidance of NSAIDs and other ulcerogenic agents is recommended, and if NSAID use is necessary, co-administration of PPIs or misoprostol (a prostaglandin analog) may be considered to reduce mucosal damage. Tailored treatment based on the underlying cause and individual patient factors is essential for effective management.

2.2 Proton Pump Inhibitors (PPIs)

Mechanism of Action: PPIs inhibit the H+/K+ ATPase enzyme in gastric parietal cells, reducing acid secretion.

Efficacy: PPIs are highly effective in promoting ulcer healing and preventing recurrence.

Safety: Generally well-tolerated, but long-term use may be associated with risks such as vitamin B12 deficiency and bone fractures [8].

2.3 Histamine-2 Receptor Antagonists (H2RAs)

Mechanism of Action: H2RAs block histamine receptors on parietal cells, reducing acid secretion.

Efficacy: Less potent than PPIs but effective for mild to moderate ulcers.

Safety: Rare side effects include headaches and gastrointestinal disturbances [9].

2.4 Antibiotic therapy for Helicobacter pylori Infection

First-Line Therapy: Typically involves a combination of a PPI, clarithromycin, and amoxicillin or metronidazole for 7–14 days.

Efficacy: Successful eradication rates exceed 90% with appropriate therapy.

Challenges : Increasing antibiotic resistance necessitates alternative regimens in some cases [10].

Antibiotic therapy for *Helicobacter pylori* infection in children and adolescents is a critical component of treating *H. pylori*-associated peptic ulcers. The standard approach involves a combination of antibiotics and acid-suppressing agents to enhance eradication rates. Triple therapy, the most commonly used regimen, includes a proton pump inhibitor (PPI) such as omeprazole or lansoprazole, along with two antibiotics, typically amoxicillin and clarithromycin or metronidazole, administered for 10–14 days. In regions with high clarithromycin resistance or when triple therapy fails, quadruple therapy is recommended, which adds bismuth subsalicylate to the PPI and two antibiotics. Sequential therapy, involving a PPI and amoxicillin for the first five days, followed by a PPI, clarithromycin, and metronidazole for the next five days, is another effective option. The choice of regimen depends on local antibiotic resistance patterns, patient allergies, and tolerability. Adherence to the full course of therapy is crucial to prevent treatment failure and antibiotic resistance. Follow-up testing, such as a urea breath test or stool antigen test, is recommended to confirm eradication, particularly in cases of persistent symptoms or complications.

2.5 Mucosal Protective Agents

Sucralfate: Forms a protective barrier over ulcer sites, promoting healing.

Misoprostol: A synthetic prostaglandin analog that enhances mucosal defence.

Bismuth Subsalicylate: Used in combination with antibiotics for H. pylori eradication [11].

2.6 Non-Pharmacological Interventions

Dietary Modifications : Avoiding spicy foods, caffeine, and alcohol can reduce symptoms.

Stress Management: Psychological interventions may help with stress-related ulcers.

Lifestyle Changes : Encouraging regular meals and adequate sleep [12].

Non-pharmacological interventions for peptic ulcers in children and adolescents focus on

lifestyle modifications, dietary adjustments, and stress management to support healing and prevent recurrence. A balanced diet rich in fruits, vegetables, and whole grains, while avoiding spicy, acidic, or fatty foods, can help reduce gastric irritation. Smaller, more frequent meals are recommended to minimize excessive gastric acid secretion. Stress reduction techniques, such as mindfulness, relaxation exercises, and counselling, may be beneficial, particularly when psychological stress exacerbates symptoms. Avoiding known irritants like NSAIDs, alcohol (in adolescents), and smoking is crucial to prevent further mucosal damage. Ensuring proper hygiene and sanitation can reduce the risk of *Helicobacter pylori* infection, a major cause of peptic ulcers. In cases of stress-related ulcers, addressing the underlying condition, such as severe illness or trauma, is essential. Education for both patients and caregivers about the importance of adhering to treatment and making lifestyle changes plays a key role in long-term management and the prevention of complications.

2.7 Surgical Interventions for Refractory Cases

Indications: Reserved for complications such as perforation, obstruction, or uncontrolled bleeding.

Procedures: Include vagotomy, antrectomy, and laparoscopic ulcer repair [13].

Surgical interventions for peptic ulcers in children and adolescents are considered only in refractory cases where pharmacological and non-pharmacological treatments fail or when life-threatening complications arise. Indications for surgery include severe gastrointestinal bleeding that cannot be controlled endoscopically, perforation of the ulcer, or gastric outlet obstruction due to scarring and inflammation. The most common surgical procedure is **oversewing the ulcer** (suturing the perforation) and using a **patch graft** (omentum) to repair the defect. In cases of recurrent or intractable ulcers, a **vagotomy** (cutting the vagus nerve to reduce gastric acid secretion) may be performed, sometimes accompanied by a **pyloroplasty** (widening the pyloric valve) to improve gastric emptying. For severe or complicated cases, a **partial gastrectomy** (removal of part of the stomach) may be necessary. Surgical intervention is typically a last resort due to the risks associated with anesthesia and postoperative complications, and it requires careful consideration by a multidisciplinary team. Postoperative care focuses on pain management, nutritional support, and monitoring for complications such as infection or anastomotic leaks.

Conclusion

Peptic ulcers in children and adolescents, though less common than in adults, present significant diagnostic and therapeutic challenges. The condition is closely associated with H. pylori infection, NSAID use, and stress-related factors. Effective management requires a combination of pharmacological and non-pharmacological approaches, tailored to the individual patient's needs. Future research should focus on optimizing H. pylori eradication regimens, exploring novel therapeutic targets, and improving diagnostic tools for early detection in pediatric populations.

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