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The Current State of Paediatric Gastroenterology in Under Resourced Nations

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Abbreviations

LMICs; low- and middle-income countries; HIC; high-income countries, IBD; inflammatory bowel disease, NAFLD, non-alcoholic fatty liver disease; UC; ulcerative colitis, CD; Crohn's disease, CeD; coeliac disease, GI; gastrointestinal, GE; gastroenteritis, NSAID; non-steroidal anti-inflammatory drug, UGIB; upper gastrointestinal bleeding, HAV; hepatitis A, HBV; hepatitis B, HCV; hepatitis C, HEV; hepatitis E, SSA; Sub-Saharan Africa, WHO; World Health Organisation, WGO; World Gastroenterology Organisation

Abstract:

Background:

Paediatric gastroenterology (GI) care in low- and middle-income countries (LMICs) faces substantial challenges due to limited healthcare infrastructure, inadequate resources, and a shortage of specialized healthcare professionals. These challenges lead to delayed diagnoses and treatment, exacerbating the morbidity and mortality associated with paediatric GI diseases, which include both infectious conditions like diarrhoea and chronic conditions such as inflammatory bowel disease (IBD) and liver diseases.

Aim:

The aim of this review is to examine the current state of paediatric GI care in LMICs, identify the key challenges these regions face, and propose strategies to improve healthcare outcomes for children affected by GI disorders.

Methods:

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This review synthesizes existing literature from a range of LMICs, analyzing factors such as the economic burden of healthcare, barriers to access, the availability of diagnostic and therapeutic services, and the state of paediatric hepatology and endoscopy. Studies included in the review were sourced from countries in sub-Saharan Africa, South Asia, and other LMIC regions, focusing on paediatric GI disorders and healthcare delivery.

Results:

- Economic Burden: Families in LMICs face significant economic barriers in accessing paediatric GI care, with treatment costs often exceeding household income, especially in private healthcare settings.
- Healthcare Access: Limited access to healthcare facilities, especially in rural areas, coupled with the shortage of trained paediatric gastroenterologists and necessary medical equipment, leads to delayed diagnoses and inadequate care for conditions like Helicobacter pylori infections and chronic liver diseases.
- Sanitation and Infectious Diseases: Poor sanitation and lack of access to clean water contribute to the high prevalence of diarrhoeal diseases, which can be reduced through better hygiene practices and improved infrastructure.
- Training Gaps: The shortage of trained healthcare workers, particularly paediatric specialists, hinders effective care delivery, with healthcare workers often overburdened due to workforce migration and low salaries.
- Hepatology and Endoscopy: Paediatric hepatology, especially in the context of viral hepatitis, and the availability of paediatric GI endoscopy are severely limited in LMICs, further complicating the management of liver diseases and GI conditions in children.

Conclusion:

Improving paediatric GI care in LMICs requires addressing systemic challenges such as inadequate healthcare infrastructure, limited financial resources, and a shortage of trained professionals. Prevention strategies like vaccination, sanitation improvements, and public health education campaigns are crucial for reducing the prevalence of paediatric GI diseases. In addition, enhancing access to specialized training, healthcare services, and diagnostic tools will improve outcomes for children in resource-limited settings. Continued international collaboration and investment in local healthcare systems are essential for creating sustainable solutions and bridging the gap in paediatric GI care.

Keywords: Paediatric Gastrointestinal Diseases; Low- and Middle-Income Countries (LMICs); Inflammatory Bowel Disease (IBD); Celiac Disease (CeD); Healthcare Access

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I. Introduction

Non-infectious paediatric GI conditions include inflammatory bowel diseases such as Crohn’s disease and ulcerative colitis (UC) and other conditions including coeliac disease.

These conditions often have a strong genetic and autoimmune component. The genes commonly associated with these conditions are HLA-DQ2, HLA-DQ, IL18RAP, PTPN2, TAGAP and PUS10 [1]. The inflammation caused by these conditions can manifest as changes in stools, per rectal bleeding, ulcers in the GI tract and improper absorption of nutrients from food. Crohn's and UC are normally pharmacologically controlled and CeD is treated with a strict gluten-free diet.

Infectious paediatric GI conditions include gastritis and hepatitis caused by various pathogens including viruses e.g. norovirus, bacteria e.g. *campylobacter jejuni* and parasites e.g. *Plasmodium falciparum* [2]. These conditions are often transmitted through poor sanitation, water and food quality causing GI symptoms such as diarrhoea, which leads to dehydration and consequently, pediatric death. The treatment of these conditions is normally pharmacological such as antibiotics and fluids; preventative measures are fundamental in managing infectious conditions by reducing their spread amongst children and the wider population.

The World Bank [3] classifies countries as being high, middle or low-income and this review utilised this classification to obtain data relating to paediatric GI care in these countries.

The state of pediatric gastroenterology in low- and middle-income countries (LMICs) faces significant challenges, with pediatric GI disorders like inflammatory bowel disease (IBD), celiac disease (CeD), and chronic liver diseases posing serious health concerns. IBD, including Crohn's disease (CD) and ulcerative colitis (UC), is increasingly recognized in LMICs, though it remains less understood compared to high-income countries (HICs) [4]. CeD, an autoimmune disorder triggered by gluten, also affects children globally, but its diagnosis is often delayed in LMICs due to limited awareness and resources. Chronic liver diseases, particularly viral hepatitis and non-alcoholic fatty liver disease (NAFLD), burden healthcare systems in sub-Saharan Africa and parts of Asia, with viral hepatitis affecting

Care delivery is hindered by inadequate healthcare infrastructure, financial constraints, and a shortage of trained professionals [5]. Many hospitals in LMICs struggle with overcrowding, lack of essential equipment, and limited access to advanced therapies and provider training [6]. Cultural and social barriers, including stigma and limited health education, further complicate diagnosis and treatment. Addressing these core issues is essential for advancing pediatric gastroenterology services and outcomes in LMICs. There is a large gap in the literature about paediatric gastrointestinal diseases and disorders in developing countries as most of the data is from developed countries. Therefore, this review explores the epidemiology of key GI conditions, the challenges limiting pediatric gastroenterology's development, and strategies to enhance care and infrastructure.

2. Methodology

This narrative review systematically gathered and assessed the literature on pediatric gastroenterology in LMICs. The search covered multiple databases—PubMed, Google Scholar, Cochrane Library, EMBASE, CINAHL, SCOPUS, and Scielo—spanning studies

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from their inception to August 16, 2024. Inclusion criteria encompassed diverse study designs, including observational, case-control, cohort, and randomized controlled trials, to ensure thorough evidence coverage. The articles were quality assessed using the SANRA framework for narrative reviews. The summary tables of articles used in this paper are available at the end of this article.

LMICs were identified using World Bank classification, and search terms included “pediatric gastroenterology,” “infectious gastroenterological diseases,” “diarrhoea,” and “malnutrition,” combined with geographical identifiers for LMICs. A manual review of references from recent reviews was also conducted. Stand-alone abstracts, unpublished studies, and trial protocols were excluded to maintain study quality and relevance.

3. Current Burden and Management of Paediatric GI Disease in LMICs

a) GI Inflammatory Diseases

Inflammatory Bowel Diseases

Pediatric GI inflammatory diseases, such as IBD—including ulcerative colitis (UC) and Crohn’s disease (CD)—and celiac disease (CeD), are rising public health concerns in LMICs. Traditionally more prevalent in high-income countries (HICs), these conditions now show increasing incidence and prevalence in developing regions, posing significant physical, psychological, and financial burdens on affected children and their families. Pediatric IBD, driven by factors like urbanization and lifestyle changes, presents unique challenges in LMICs, where limited data complicates understanding of its full impact. Globally, an estimated 7 million people live with IBD, with recent studies indicating a notable rise in pediatric cases in the Asia-Pacific region and incidence rates nearing HIC levels in countries like India and China [7-10]. LMICs face severe consequences, as IBD patients have a threefold increase in mortality risk [11], but lack adequate diagnostic tools like endoscopy and access to advanced treatments such as biologics [12].

The complexity of managing IBD in LMICs is exacerbated by high medication costs, limited resources for specialized diets, and serious complications like toxic megacolon, which often necessitate surgeries that may be inaccessible due to financial and infrastructure constraints [13]. In LMICs, CD diagnosis commonly relies on endoscopy, pathology, and radiology, and when medical treatments fail, surgeries like bowel resections are often necessary. However, these procedures are challenging to provide consistently due to resource limitations, resulting in poorer outcomes for pediatric patients [14,15]. These challenges underscore an urgent need to improve healthcare infrastructure, diagnostic capacity, and access to therapies to address the rising burden of pediatric GI diseases in LMICs [16–19] (See Table 1).

Coeliac Disease

CeD is an autoimmune inflammatory condition triggered when an individual consumes gluten or molecules similar to gluten. It is strongly associated with HLA-DQ gene mutations,

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and environmental factors such as pediatric gastrointestinal infections and the early introduction of gluten into a child's diet have also been suggested as contributors. CeD leads to inflammation of the villi in the small bowel, and repeated gluten consumption can cause villous atrophy, resulting in a decreased ability to absorb essential nutrients from food, such as iron, folate, and vitamin D. CeD is increasingly being recognized in LMICs, contrary to its historical association with HICs. While the global incidence of CeD in children is estimated at 21.3 per 100,000 person-years, recent studies reveal rising rates in countries like India, Vietnam, and China, where up to 2% of children may be affected [20–22]. The true prevalence remains underrecognized due to limited awareness and diagnostic capacity, with healthcare providers in LMICs often overlooking CeD, associating it mainly with HICs [23,24]. Managing CeD is particularly difficult in resource-poor settings where gluten-free options are scarce, and gluten cross-contamination is common. Diagnostic limitations, such as restricted access to genetic testing and endoscopy, further delay treatment, leading to severe outcomes like malnutrition, growth failure, and increased mortality in untreated children [25–28]. CeD could be on the rise due to an increasing adoption of a gluten-based Western-style diet into the diets of LMIC populations especially in countries where carbohydrates like rice are traditionally more common e.g. China [29]. Additionally, CeD cases may be silent, resulting in patients who have the condition or gene being asymptomatic; these patients can live their lives without being aware of the condition hence, prevalence and the actual number of cases may actually be higher than recorded [29]. Addressing these issues will require improved diagnostic infrastructure, greater public awareness, and better strategies for managing gluten exposure in LMIC settings (See Table 2).

b) Infectious Conditions of the GI Tract

GI infections present a major health challenge in LMICs, where children face increased exposure to risk factors like inadequate sanitation, malnutrition, poor food hygiene, and limited healthcare infrastructure. Gastroenteritis (GE) is the infection of the stomach and intestines causing acute illness, inflammation and symptoms such as diarrhoea, fevers and anorexia resulting in paediatric morbidity and mortality. Diarrhea is one of the leading causes of paediatric deaths according to the Global Health Data Exchange in 2016[30]. Diarrhoea, a common symptom of GE, contributes significantly to pediatric mortality, with an estimated 443,832 [31] deaths among children under five and 50,851 deaths among those aged 5-9 globally in 2016, disproportionately impacting LMICs. WHO estimates that diarrhoea affects 1.7 billion people annually, making it the third leading cause of death in children aged 1-59 months [31]. Sub-Saharan Africa (SSA) alone reported 290,724 deaths and 371 million cases of childhood diarrhea in 2016, underscoring the urgent need for enhanced healthcare infrastructure and preventive measures in these regions [32,33].

Viruses, particularly rotavirus and norovirus, are the leading causes of GE in children, accounting for over 60% of cases worldwide. Bacterial pathogens like *Campylobacter jejuni*, *Escherichia coli*, and *Salmonella*, along with protozoa like *Cryptosporidium* and helminths,

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also contribute significantly to GE, spreading primarily through contaminated food and water, insufficient hygiene, and poor sanitation—common issues in LMICs [34,35,36].

Vaccination is essential for GE prevention, with the rotavirus vaccine widely implemented, reducing hospitalizations for diarrheal diseases among children under five. As of 2019, 100 countries have the rotavirus vaccine in their regular vaccination schedule; the vaccine has reduced the hospitalisation of children under 5 years old due to diarrhoea from 38% to 23% [37]. Hallowell et al (2020)[37], stated that data measuring the effectiveness of the vaccine in developing countries needs to be collected. However, vaccine adoption in LMICs is limited due to challenges in affordability and cold-chain storage, and while vaccines for bacterial causes like cholera and typhoid are available in HICs, they are less accessible in LMICs. Thus, vaccination must be supported by improved hygiene practices and educational efforts to more effectively combat GE in these settings [37-39].

Viral and bacterial gastroenteritis (GE) typically present with symptoms such as pyrexia, non-bloody diarrhoea, vomiting, and abdominal pain, which generally last for 1-2 weeks. If these symptoms persist, the condition can progress to chronic GE [40,41]. One of the most concerning outcomes of GE is dehydration, primarily caused by the loss of water and electrolytes through vomiting and diarrhoea, which is a leading contributor to mortality in children. Early recognition of GE and dehydration by parents or guardians, coupled with timely medical intervention, is critical for improving treatment outcomes. Public health education plays a crucial role in encouraging caregivers to seek medical attention when symptoms are still in the early stages, thus enhancing the chances of recovery. Treatment typically involves oral and intravenous rehydration fluids, nutritional support (especially for malnourished children), antibiotics for bacterial infections, antiemetic and antidiarrheal medications, as well as analgesics. In addition to dehydration, GE can result in electrolyte imbalances, metabolic acidosis, food intolerances, hemolytic uremic syndrome (HUS), and an increased susceptibility to further GE infections, which can ultimately lead to death [42]. Addressing these challenges is critical to achieving the United Nations' Sustainable Development Goal (SDG) 3.2, which aims to reduce childhood mortality. Since diarrheal illnesses remain one of the leading causes of pediatric mortality, governments in low- and middle-income countries (LMICs) must prioritize improving public health education, sanitation, food and water infrastructure, and healthcare resources to reduce mortality rates and meet the 2030 target set by the SDGs [43,44].

The economic burden of GE treatment is substantial in LMICs, where treatment costs can range from $213 to $350, often constituting a significant portion of household income, especially when care is sought in private facilities [45]. With up to 72% of child hospitalizations in certain regions attributed to GE, the economic strain on families and healthcare systems is considerable [46]. The lack of essential facilities, including pediatric endoscopy services and adequate sanitation, further impedes effective GE management. Shortages of antibiotics and clean water exacerbate the vulnerability of children, particularly those already weakened by malnutrition, to severe infections and hinder recovery [47,48]. Overburdened healthcare systems in LMICs tend to deprioritize GE care, limiting public

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health campaigns on prevention and vaccination efforts for rotavirus. This persistent gap in effective GE management results in a high and ongoing burden of disease, contributing to significant morbidity and mortality among children in LMICs [49] (See Table 3).

c) Current State of Paediatric GI Endoscopy in LMICs

The increasing burden of paediatric GI diseases in LMICs highlights the urgent need for paediatric upper GI endoscopy, a crucial diagnostic and therapeutic tool. In regions like South Asia and Africa, the incidence of GI diseases in children is growing, with significant health impacts. Conditions such as chronic NSAID-induced gastritis are common in countries like India, where over-the-counter availability of NSAIDs leads to their widespread use and subsequent complications in children [51]. Upper GI bleeding (UGIB) is another key indication for endoscopy in LMICs. Hematemesis, resulting from causes like ingested maternal blood, food impaction, or epistaxis, is frequently seen in South Asian and African contexts. A study from Thailand found that over half of the critically ill children in the ICU developed UGIB, emphasizing the vulnerability of paediatric patients to severe GI complications [50,52]. Other upper GI conditions, such as peptic ulcers and esophageal abnormalities, including those related to malignancies, are increasingly diagnosed in LMICs like Senegal. These conditions often remain undetected until they have significantly progressed, making timely endoscopic intervention crucial to avoid serious health consequences like malnutrition, delayed growth, and increased morbidity and mortality [53]. The broad range of indications for paediatric upper GI endoscopy in these settings includes recurrent abdominal pain, vomiting, dyspepsia, dysphagia, heartburn, portal hypertension, and ingestion of corrosive substances. Endoscopic findings in these cases commonly include gastritis, gastric erosions, esophageal varices, duodenitis, gastric ulcers, and gastric polyps. If untreated, these conditions can lead to severe complications, highlighting the indispensable role of endoscopy in paediatric healthcare in LMICs [12].

Despite the critical need for upper GI endoscopy, expanding its availability and accessibility in LMICs faces substantial challenges. Financial constraints are a primary obstacle, preventing the procurement of essential paediatric endoscopic equipment, such as smaller scopes and child-specific accessories, which are necessary for safe and effective procedures. In regions like Eastern Africa, where the burden of paediatric GI diseases is high, the capacity for paediatric endoscopy is severely limited. The shortage of paediatric endoscopists and appropriate equipment exacerbates the situation, leaving many children without timely diagnostic and therapeutic interventions [54]. The scarcity of trained paediatric specialists further hampers the development of paediatric endoscopy services, and many areas struggle with even basic diagnostic endoscopy. More advanced therapeutic procedures are almost non-existent in these regions, making the need for proper training and equipment even more urgent. In some cases, non-physician clinicians and specially trained nurses are tasked with performing paediatric endoscopy due to the shortage of paediatric gastroenterologists. While this approach addresses some immediate needs, it raises concerns about the quality and safety of care provided [54,55].

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The prohibitive cost of paediatric endoscopic services also limits access, with many families unable to afford necessary procedures, exacerbating health disparities and delaying diagnoses. This economic barrier contributes to poorer outcomes for children in LMICs. However, efforts to improve paediatric GI care in these regions are underway. Collaborative initiatives between HICs and LMICs have led to some progress, including training programs for local healthcare providers and the provision of essential equipment. Partnerships focused on training local specialists and renovating facilities to accommodate paediatric patients have shown promise. Despite these advancements, much work remains to bridge the gap between the availability of paediatric GI services in LMICs and HICs, highlighting the need for continued efforts to expand paediatric upper GI endoscopy services and address the systemic barriers to care [54-56] (See Table 5).

d) Paediatric Hepatology in LMICs

Hepatology, the medical field focused on liver diseases, is crucial for global health, especially in LMICs, where liver diseases like viral hepatitis, cirrhosis, and hepatocellular carcinoma are major contributors to morbidity and mortality. These regions often face significant challenges, including limited healthcare infrastructure, lack of vaccinations, and inadequate preventive measures, all of which exacerbate the burden of liver diseases. Paediatric liver diseases in LMICs are predominantly infectious, with hepatitis A (HAV), B (HBV), and E (HEV) being common.

The World Health Organization (WHO) estimates the global burden of hepatitis B and C combined to be 304 million cases. The global incidence of hepatitis B is approximately 1.23 million, with a mortality rate of 1.1 million. In comparison, hepatitis C has an incidence of 98,000 and a mortality rate of 218,000. From 1990 to 2019, the global mortality rates for hepatitis A have generally decreased, except in the Australasia region [57]. However, the incidence of hepatitis A has been rising in several low-income regions, as well as in a few high-income regions. In West Africa, a study found that Benin had the highest prevalence of pediatric hepatitis B at 10%, while Togo had the lowest at 1%. This study also highlighted the critical role of vaccination, with vaccinated children exhibiting a significantly lower prevalence (2%) compared to unvaccinated children (6%) [58].

In Pakistan, up to 75% of children have been affected by HAV, while in India, HAV and HEV are endemic, contributing to high paediatric morbidity. HBV remains a leading cause of both acute and chronic liver disease, with high prevalence rates in regions like sub-Saharan Africa, where up to 8% of children under five are affected. Transmission occurs primarily through mother-to-child and close contact, putting young children at high risk. Co-infection with HIV further complicates the burden of HBV, with 7% of HIV-positive individuals also infected with HBV, especially in regions with limited access to antiviral treatments and vaccines, such as for hepatitis C (HCV) [5,6,59,61].

In addition to viral hepatitis, other conditions like amoebic liver abscesses and hydatid cysts are prevalent in India, further burdening paediatric healthcare. However, other hepatological diseases, such as Wilson's disease and metabolic liver conditions, often go untreated due to

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the lack of specialized care, diagnostic tools, and expensive treatments like penicillamine. Although liver transplantation provides a potential cure for acute liver failure, end-stage liver disease, and certain cancers, it remains underutilized in LMICs due to financial constraints and logistical challenges. In India, while liver transplantation has advanced with survival rates above 90% in some centers, it is largely driven by the private sector, making it inaccessible for many. Living donor liver transplants are more common than deceased donation programs, which remain limited, particularly in northern India. Financial support through crowdfunding and philanthropic efforts has helped many families in LMICs afford these life-saving procedures, though significant barriers remain to wider accessibility [60,62,63].

The management of paediatric liver diseases in LMICs is further hindered by a shortage of trained paediatric hepatologists and limited resources for diagnosis and treatment. General paediatricians often manage complex liver conditions without specialized training, leading to delayed diagnoses and worse outcomes. In countries like Nigeria, the number of paediatric hepatologists is dwindling, and chronic liver diseases often go untreated until liver transplantation is necessary. However, due to the scarcity of medical resources, expensive antiviral drugs, and high costs of liver transplantation, effective treatment remains a major challenge in many LMICs. Despite these obstacles, collaborative initiatives between high-income and low-income countries, such as training programs and providing essential medical equipment, have shown promise in improving paediatric hepatology care. These efforts, combined with grassroots financial support, are beginning to make liver transplantation more attainable in these regions, offering hope for children with liver diseases in LMICs [64,65] (See Table 4).

4. Challenges in Paediatric Gastroenterology Care in Developing Countries

Paediatric gastroenterology care in developing countries faces numerous challenges, primarily due to limited healthcare infrastructure, resources, and access to specialized services as referred to in Figure 1. Many of these regions lack the necessary diagnostic tools and equipment for conditions such as Helicobacter pylori infections and chronic liver diseases. Hospitals are often overwhelmed, leading to overcrowding, long waiting times, and overworked healthcare staff, which diminishes the quality of care. Furthermore, geographical barriers, especially in rural areas, exacerbate these problems, as patients are often required to travel long distances to reach healthcare facilities that may not have the required specialists or equipment to effectively manage paediatric gastroenterological conditions, such as severe diarrhoeal diseases. This results in delayed diagnosis and treatment, increasing the risk of poor health outcomes for children [5,6].

Inadequate sanitation and lack of basic amenities like handwashing facilities in low-income areas also contribute to the high incidence of diarrhoeal diseases among children. In urban areas like New Delhi, India, poor sanitation has been linked to high rates of diarrhoeal diseases, which could be reduced by 70% through improved hygiene practices like proper handwashing. This highlights how broader infrastructure issues, such as poor sanitation, worsen conditions like cholera and persistent diarrhoea. Additionally, the shortage of

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healthcare workers, particularly paediatric gastroenterologists, remains a significant issue. Despite efforts such as the African Paediatric Fellowship Programme [66], many countries in sub-Saharan Africa (SSA) and other LMICs face critical shortages of trained specialists. For example, Ethiopia has only about two doctors per 100,000 population, compared to 230 per 100,000 in the UK. The migration of healthcare workers to wealthier countries further exacerbates these shortages, as LMICs lose skilled professionals who are in short supply at home. In countries like Malawi, where 85% of doctors work in urban areas, rural populations face limited access to healthcare, further straining the system [6,67,68].

Economic challenges in LMICs, worsened by the COVID-19 pandemic, have disrupted training programs for paediatric gastroenterology and created gaps in care delivery. Financial limitations hinder the procurement of medical supplies and equipment, while unstable economies make it difficult to retain and train healthcare workers. The lack of funding, compounded by insufficient salaries for medical professionals, prevents many countries from attracting or retaining specialists in fields like paediatric gastroenterology. This issue is particularly acute in countries like Malawi, where only 8% of paediatric gastroenterology posts are filled due to inadequate salaries. Furthermore, many clinical guidelines for managing paediatric gastroenterological conditions, established in developed countries, are not implemented in LMICs due to the high costs of investigations and a lack of insurance. Cultural barriers also play a role in delaying care, as conditions like inflammatory bowel disease (IBD) are often hidden or denied by families due to stigma, preventing timely diagnosis and treatment. Refugees, who often face language and cultural challenges, are particularly vulnerable, as they may be reluctant to seek care due to fear of discrimination or misunderstanding. These factors contribute to the overall healthcare disparity, making access to proper paediatric gastroenterology care even more difficult in LMICs [5,6,69,70].

5. Future Prospects

5.1 Prevention Measures

There are many solutions and future prospects improve paediatric GI care in LMICs (Figure 2). Public health education is crucial for raising awareness of paediatric gastrointestinal (GI) disorders, as highlighted by Besnier et al. (2021)[71]. Campaigns focused on infectious GI conditions can inform communities about the risks of contaminated food and water, while preventive strategies like boiling water can mitigate these risks. For chronic conditions such as coeliac disease (CeD) and inflammatory bowel diseases (IBD), educating people to recognize early symptoms ensures timely intervention, potentially preventing complications [5,6]. A strong paediatric vaccination program is also essential in reducing the incidence of severe GI diseases, with vaccines for rotavirus, norovirus, hepatitis A (HAV), and hepatitis B (HBV) proving particularly effective. However, challenges in vaccine storage and administration in low- and middle-income countries (LMICs) need to be addressed to improve coverage and reduce wastage [72].

Improving sanitation and access to clean water is vital for preventing paediatric GI disorders, as contaminated water and poor sanitation are major contributors to infections. Efforts should

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focus on building sanitation infrastructure, promoting hygiene, and ensuring safe drinking water. For example, handwashing stations in schools and community centres can significantly reduce disease transmission [6,74].

5.2 Policy Recommendations

To develop effective policies for managing paediatric GI disorders, conducting local assessments such as audits and quality improvement studies is essential to collect data on patient needs and assess whether current practices meet local and global healthcare standards [73]. These assessments should be collaborative, involving both government policymakers and local healthcare workers, with support from international organizations like the WHO and UNICEF, especially in resource-limited settings. Key data required for policy development includes information on the burden, incidence, and prevalence of paediatric GI diseases, the impact on children and adolescents, the complications, and the effectiveness of current treatments. Understanding the broader public health risks—physiological, social, and psychological—is also critical in creating comprehensive policies [5,73]. Additionally, stakeholder engagement is crucial in policy formulation. Involving healthcare providers, government officials, hospital administrators, public health officers, NGOs, and parents helps identify challenges, feasibility issues, and potential solutions. This ensures that policies are effective, aligned with the population's needs, and culturally appropriate [5]. Governments should prioritize funding for preventive and primary healthcare, integrating paediatric GI disorder management into national health strategies, potentially by establishing specialized units within hospitals and clinics, and ensuring that these units are well-resourced [74].

5.3 Widening Access to Healthcare and Investing in Staff Training

Expanding healthcare access in LMICs requires addressing barriers such as financial constraints, geographic distance, language differences, and limited resources for treating paediatric GI conditions. Strategies should be cost-effective, user-friendly, and tailored to local contexts, such as using battery-operated or solar-powered medical devices in areas with unreliable electricity [74]. Bringing healthcare services closer to communities through mobile units or remote visits can also increase service uptake. Additionally, reducing healthcare costs and offering government-funded health schemes can alleviate financial burdens and improve accessibility [73].

A significant challenge is the shortage of healthcare workers in LMICs, which limits care availability. Expanding education and training is critical, yet training programs are often scarce and costly. Subsidized opportunities, such as scholarships for specialized paediatric gastroenterology training, are essential for building local expertise. Programs like those from the World Gastroenterology Organisation (WGO) offer advanced training and send specialists to areas in need of expertise. Furthermore, providing first aid training in GI-

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specific emergencies to non-medical personnel, such as parents and teachers, can improve early intervention, reduce mortality rates, and enhance outcomes, particularly in areas with delayed healthcare access [5,6].

6. Limitations

A major limitation of this study is the lack of prior research on pediatric gastrointestinal (GI) conditions, particularly non-infectious ones, in low- and middle-income countries (LMICs). The majority of existing data on pediatric conditions such as inflammatory bowel diseases (IBDs) and celiac disease primarily originates from high-income countries (HICs), making it challenging to accurately assess the current state of care, incidence, and prevalence of these conditions in LMICs. Many of these countries are located in regions such as Asia, Africa, and South America. To address this gap, future studies must focus on gathering comprehensive data on the prevalence and incidence of pediatric GI conditions in LMICs, in collaboration with international bodies such as the World Health Organization (WHO).

Furthermore, due to the lack of available data from several LMICs, generalizability is a limitation of this review. The findings may not be applicable to all LMICs, as the data included in the literature may not reflect the full diversity of these regions. A potential remedy to this limitation would be to increase research efforts in LMICs and gather more localized data to improve the analysis and support more accurate conclusions.

Another limitation of this review is the aggregation of data from both low- and middle-income countries into a single group. This approach may not adequately represent the current status of pediatric GI diseases and healthcare, as middle-income countries typically have better healthcare infrastructure and lower rates of infectious GI diseases due to advancements in sanitation measures and public health education.

Finally, as this study is a narrative review, the process of selecting studies lacks the rigor of more systematic approaches. To improve upon this, future studies could employ more robust methodologies, such as conducting a systematic review and meta-analysis, utilizing the PRISMA tool for article selection and quality assessment.

7. Conclusion

Despite advancements in the diagnosis and management of paediatric gastrointestinal (GI) disorders in low- and middle-income countries (LMICs), the burden of these conditions remains substantial. Persistent challenges, such as limited access to healthcare, a shortage of trained professionals, and inadequate public health infrastructure, continue to impede progress. Poor sanitation, contaminated water, and insufficient public awareness further exacerbate the prevalence of GI diseases among children in these regions. Although targeted interventions—such as vaccination programs, mobile healthcare units, and specialised training—have made some headway, comprehensive, context-specific solutions are still urgently needed. Addressing these barriers through robust policy development, public health education, and significant investments in local healthcare capacity is critical to improving outcomes for paediatric patients.

Looking forward, prioritising preventive measures, including expanding vaccination coverage and enhancing water and sanitation infrastructure, will be vital in reducing the incidence and

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impact of paediatric GI diseases in LMICs. Strengthening healthcare training programmes and fostering collaboration between international organisations, local governments, and community stakeholders will be essential in creating sustainable and equitable healthcare systems, capable of delivering improved care for paediatric populations.

References

1. Bosca-Watts MM, Minguez M, Planelles D, Navarro S, Rodriguez A, Santiago J, Tosca J, Mora F. HLA-DQ: Celiac disease vs inflammatory bowel disease. World J Gastroenterol. 2018 Jan 7;24(1):96-103.
2. Rivera-Dominguez G, Ward R. Pediatric Gastroenteritis. [Updated 2023 Apr 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK499939/
3. World Bank. The world by income and region [Internet]. Available from: https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html
4. Dalzell AM, Muhammad Eyad Ba'Ath. Paediatric inflammatory bowel disease: review with a focus on practice in low- to middle-income countries. Paediatrics and International Child Health. 2019 Jan 2;39(1):48–58.
5. Wireko Andrew Awuah, Favour Tope Adebusoye, Ferreira T, Azeem S, Hareesha Rishab Bharadwaj, Akpan A, et al. The unmet surgical needs of global refugee populations: A perspective review. Sage Open Medicine [Internet]. 2023 Jan 1;11. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10566266/
6. Mandeville KL, Krabshuis J, Ladep NG, Mulder CJ, Quigley EM, Khan SA. Gastroenterology in developing countries: Issues and advances. World Journal of Gastroenterology [Internet]. 2009;15(23):2839. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2699001/
7. Huang JG, Wong YKY, Chew KS, Tanpowpong P, Calixto Mercado KS, Reodica A, et al. Epidemiological characteristics of Asian children with inflammatory bowel disease at diagnosis: Insights from an Asian-Pacific multi-centre registry network. World Journal of Gastroenterology. 2022 May 7;28(17):1830–44.
8. Kuenzig ME, Fung SG, Marderfeld L, Mak JWY, Kaplan GG, Ng SC, et al. Twenty-first century trends in the global epidemiology of pediatric-onset inflammatory bowel disease: systematic review. Gastroenterology [Internet]. 2022 Jan 5;162(4). Available from: https://www.sciencedirect.com/science/article/pii/S0016508522000026
9. Wang X, Zhang Y, Xu C, Jiang L, Huang Y, Du H, et al. Inflammatory Bowel Disease in Chinese Children. Inflammatory Bowel Diseases. 2013 Feb;19(2):423–8.
10. Srivastava A, Sathiyasekharan M, Jagadisan B, Bolia R, Peethambaran M, Mammayil G, et al. Paediatric inflammatory bowel disease in India: a prospective multicentre study. European Journal of Gastroenterology & Hepatology. 2020 Aug 10;32(10):1305–11.

ACCEPTED

11. Olén O, Askling J, Sachs MC, Frumento P, Neovius M, Smedby KE et al. Increased Mortality of Patients With Childhood-Onset Inflammatory Bowel Diseases, Compared With the General Population. Gastroenterology. 2019; 156: 614-622
12. OF, Odeghe E, Olatona FA, Lawal M, Onywekwelu VI, Akinbolagbe YO, et al. Inflammatory Bowel Disease in Children: Experience and Constraints in a Resource-limited Setting. Cureus. 2020 Apr 27
13. Sarbagili-Shabat C, Albenberg L, Van Limbergen J, Pressman N, Otley A, Yaakov M, et al. A novel UC Exclusion Diet and antibiotics for treatment of mild to moderate pediatric ulcerative colitis: A prospective open-label pilot study. Nutrients. 2021 Oct 23;13(11):3736. doi:10.3390/nu13113736
14. Le Berre C, Ananthakrishnan AN, Danese S, Singh S, Peyrin-Biroulet L. Ulcerative Colitis and Crohn's Disease Have the Same Burden and Goals for Treatment. Clinical Gastroenterology and Hepatology. 2019 Jul;18(1).
15. Catherine Le Berre, Sailish Honap, Laurent Peyrin-Biroulet. Ulcerative colitis. The Lancet. 2023 Aug 1;402(10401):571–84.
16. Ng SC, Shi HY, Hamidi N, Underwood FE, Tang W, Benchimol EI, et al. Worldwide incidence and prevalence of inflammatory bowel disease in the 21st century: a systematic review of population-based studies. The Lancet. 2017 Dec;390(10114):2769–78.
17. Loftus EV. Clinical epidemiology of inflammatory bowel disease: incidence, prevalence, and environmental influences. Gastroenterology. 2004 May;126(6):1504–17.
18. White JM, O'Connor S, Winter HS, Heyman MB, Kirschner BS, Ferry GD, et al. Inflammatory Bowel Disease in African American Children Compared With Other Racial/Ethnic Groups in a Multicenter Registry. Clinical Gastroenterology and Hepatology [Internet]. 2008 Dec 1 [cited 2021 Apr 19];6(12):1361–9. Available from: https://www.cghjournal.org/article/S1542-3565(08)00799-4/fulltext
19. Rajbhandari R, Blakemore S, Gupta N, Adler AJ, Noble CA, Mannan S, et al. Crohn's disease in low and lower-middle income countries: A scoping review. World Journal of Gastroenterology [Internet]. 2020 Nov 21;26(43):6891–908. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7684456/
20. Kalle Kurppa, Mulder C, Ketil Stordal, Katri Kaukinen. Celiac Disease Affects 1% of Global Population—Who Will Manage All These Patients? What Are Criteria to Prioritize Along Risk for Complications? Gastroenterology. 2024 Jan 1;
21. Mustalahti K, Catassi C, Reunanen A, Fabiani E, Heier M, McMillan S, et al. The prevalence of celiac disease in Europe: results of a centralized, international mass screening project. Annals of medicine [Internet]. 2010;42(8):587–95. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21070098
22. Yuan J, Zhou C, Gao J, Li J, Yu F, Lu J, et al. Prevalence of Celiac Disease Autoimmunity Among Adolescents and Young Adults in China. Clinical Gastroenterology and Hepatology. 2017 Oct 1;15(10):1572-1579.e1.
23. Gupta R, Reddy DN, Makharia GK, Sood A, Ramakrishna BS, Yachha SK, et al. Indian task force for celiac disease: Current status. World Journal of Gastroenterology

[Internet]. 2009 [cited 2019 Mar 29];15(48):6028. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2797658/

24. Chen CY, Li JN. Insufficient awareness of celiac disease in China. Chinese Medical Journal. 2019 Jul 5;132(13):1513–5.
25. Paul S, Stanton L, Adams H, Basude D. Coeliac disease in children: the need to improve awareness in resource-limited settings. Sudanese Journal of Paediatrics. 2019;6–13.
26. Poddighe D, Rakhimzhanova M, Marchenko Y, Catassi C. Pediatric Celiac Disease in Central and East Asia: Current Knowledge and Prevalence. Medicina. 2019 Jan 12;55(1):11.
27. Sahin Y. Celiac disease in children: A review of the literature. World Journal of Clinical Pediatrics [Internet]. 2021 Jul 9;10(4):53–71. Available from: https://www.wjgnet.com/2219-2808/full/v10/i4/53.htm
28. Al–Toma A, Goerres MS, Meijer JWR, Peña AS, Crusius JBA, Mulder CJJ. Human Leukocyte Antigen–DQ2 Homozygosity and the Development of Refractory Celiac Disease and Enteropathy-Associated T-Cell Lymphoma. Clinical Gastroenterology and Hepatology. 2006 Mar;4(3):315–9.
29. Poddighe D, Abdukhakimova D. Celiac Disease in Asia beyond the Middle East and Indian subcontinent: Epidemiological burden and diagnostic barriers. World J Gastroenterol. 2021 May 21;27(19):2251-2256.
30. Khan MS, Ahmed F, Kazi AM, et al. A systematic review of the prevalence of malaria in Pakistan. Lancet Infect Dis. 2018 Apr;18(4):374-380. doi: 10.1016/S1473-3099(18)30362-1.
31. World Health Organization. Diarrhoeal disease [Internet]. Geneva: World Health Organization; 2023 [cited 2025 Jan 29]. Available from: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease
32. Kotloff KL, Nataro JP, Blackwelder WC, Nasrin D, Farag TH, Panchalingam S, et al. Burden and aetiology of diarrhoeal disease in infants and young children in developing countries (the Global Enteric Multicenter Study, GEMS): a prospective, case-control study. The Lancet [Internet]. 2013 Jul 20;382(9888):209–22. Available from:https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)60844-2/fulltext?rss=yes
33. Operario DJ, Platts-Mills JA, Sandrama Nadan, Page N, Mapaseka Seheri, M. Jeffrey Mphahlele, et al. Etiology of Severe Acute Watery Diarrhea in Children in the Global Rotavirus Surveillance Network Using Quantitative Polymerase Chain Reaction. The Journal of Infectious Diseases. 2017 Jun 21;216(2):220–7.
34. Hartman S, Brown E, Loomis E, Russell HA. Gastroenteritis in Children. American Family Physician [Internet]. 2019 Feb 1;99(3):159–65. Available from: https://www.aafp.org/pubs/afp/issues/2019/0201/p159.html
35. Troeger C, Blacker BF, Khalil IA, Rao PC, Cao S, Zimsen SR, et al. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Infectious Diseases [Internet]. 2018 Nov;18(11):1211–28. Available from: https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(18)30362-1/fulltext

ACCEPTED

36. Elliott EJ. Acute gastroenteritis in children. BMJ [Internet]. 2007 Jan 4;334(7583):35–40. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1764079/
37. Hallowell BD, Tate J, Parashar U. An overview of rotavirus vaccination programs in developing countries. Expert Rev Vaccines. 2020 Jun;19(6):529-537. doi: 10.1080/14760584.2020.1775079. Epub 2020 Jun 16
38. Basharat N, Sadiq A, Dawood M, Ali S, Khan A, Ullah R, et al. Rotavirus gastroenteritis in Pakistan, 2018: updated disease burden. BMC Infectious Diseases. 2021 May 6;21(1).
39. Seo H, Duan Q, Zhang W. Vaccines against gastroenteritis, current progress and challenges. Gut Microbes. 2020 Jun 18;11(6):1486–517.
40. Stuempfig ND, Seroy J. Viral Gastroenteritis. [Updated 2023 Jun 12]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK518995/
41. Sattar SBA, Singh S. Bacterial Gastroenteritis. [Updated 2023 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK513295/
42. King CK, Glass R, Bresee JS, Duggan C; Centers for Disease Control and Prevention. Managing acute gastroenteritis among children. MMWR Recomm Rep 2003;52(RR16):1-16
43. United Nations. Goal 3: Good health and well-being [Internet]. New York: United Nations; 2025 [cited 2025 Jan 29]. Available from: https://sdgs.un.org/goals/goal3#targets_and_indicators
44. Acheampong M, Ejiofor C, Salinas-Miranda A. An analysis of determinants of under-5 mortality across countries: defining priorities to achieve targets in sustainable developmental goals. Matern Child Health J. 2017;21:1428–47. doi: 10.1007/s10995-017-2260-9.
45. Fu XL, Ma Y, Li Z, Qi YY, Wang SJ, Fu LJ, et al. Cost-of-illness of gastroenteritis caused by rotavirus in Chinese children less than 5 years. Human vaccines & immunotherapeutics (Print) [Internet]. 2023 Nov 27 [cited 2024 Apr 7];19(3). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10760361/
46. Chow CM. Acute gastroenteritis: from guidelines to real life. Clinical and Experimental Gastroenterology. 2010 Jul;97.
47. Holloway B, Chandrasekar H, Purohit M, Sharma A, Mathur A, Kc A, et al. Antibiotic Use before, during, and after Seeking Care for Acute Febrile Illness at a Hospital Outpatient Department: A Cross-Sectional Study from Rural India. Antibiotics [Internet]. 2022 May 1 [cited 2024 Mar 14];11(5):574. Available from: https://www.mdpi.com/2079-6382/11/5/574
48. Guarino A, Aguilar J, Berkley J, Broekaert I, Vazquez-Frias R, Holtz L, et al. Acute Gastroenteritis in Children of the World: What Needs to Be Done? Journal of Pediatric Gastroenterology and Nutrition [Internet]. 2020 May 1;70(5):694–701.
49. Bennett A, Bar-Zeev N, Cunliffe NA. Measuring indirect effects of rotavirus vaccine in low income countries. Vaccine [Internet]. 2016 Aug 17 [cited 2020 Sep

ACCEPTED

25];34(37):4351–3. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5047945/
50. Kocic M, Rasic P, Marusic V, Prokic D, Savic D, Milickovic M, et al. Age-specific causes of upper gastrointestinal bleeding in children. World Journal of Gastroenterology [Internet]. 2023 Dec 21;29(47):6095–110. Available from: https://www.wjgnet.com/1007-9327/full/v29/i47/6095.html
51. Chawla S, Seth D, Mahajan P, Kamat D. Upper Gastrointestinal Bleeding in Children. Clinical Pediatrics. 2007 Jan;46(1):16–21.
52. Deerojanawong J, Peongsujarit D, Vivatvakin B, Prapphal N. Incidence and risk factors of upper gastrointestinal bleeding in mechanically ventilated children. Pediatric Critical Care Medicine. 2009 Jan;10(1):91–5.
53. Le Moine O, Diouf M, Mbengue M, Mbaye P, Diop P, Balme F, et al. Creation of a therapeutic digestive endoscopy suite in Senegal: renovation, training and university certification. Results of a Belgian–Senegalese inter-university project. Endoscopy. 2012 Jan 23;44(02):177–85.
54. Campos ST, Barreto L, Fernandes V, Meira T, Portela F, Carreira C, et al. Starting gastrointestinal endoscopy in a lower middle-income country in Africa: Training, creating an endoscopy facility and developing telemedicine. Endoscopy International Open [Internet]. 2022 Nov 1 [cited 2023 Aug 7];10(11):E1434–41. Available from: https://pubmed.ncbi.nlm.nih.gov/36397869/
55. Wilhelm T, Mothes H, Chiwewe D, Mwatibu B, Kähler G. Gastrointestinal endoscopy in a low budget context: delegating EGD to non-physician clinicians in Malawi can be feasible and safe. Endoscopy. 2011 Nov 8;44(02):174–6.
56. Mwachiro M, Topazian HM, Kayamba V, Mulima G, Ogutu E, Erkie M, et al. Gastrointestinal endoscopy capacity in Eastern Africa. Endoscopy International Open [Internet]. 2021 Nov 1 [cited 2022 Oct 31];09(11):E1827–36. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8589549/
57. Cao G, Jing W, Liu J, Liu M. The global trends and regional differences in incidence and mortality of hepatitis A from 1990 to 2019 and implications for its prevention. Hepatol Int. 2021 Oct;15(5):1068-1082. doi: 10.1007/s12072-021-10232-4. Epub 2021 Aug 3
58. Fofana DB, Somboro AM, Maiga M, Kampo MI, Diakité B, Cissoko Y, et al. Hepatitis B Virus in West African Children: Systematic Review and Meta-Analysis of HIV and Other Factors Associated with Hepatitis B Infection. Int J Environ Res Public Health. 2023 Feb 25;20(5):4142.
59. Butt AS. Epidemiology of Viral Hepatitis and Liver Diseases in Pakistan. Euroasian Journal of Hepato-Gastroenterology [Internet]. 2015;5(1):43–8.
60. Shanmugam N, Malathy Sathyasekaran, Rela M. Pediatric Liver Disease in India. Clinical Liver Disease. 2021 Jul 5;18(3):155–7.
61. Fofana DB, Somboro AM, Maiga M, Kampo MI, Diakité B, Cissoko Y, et al. Hepatitis B Virus in West African Children: Systematic Review and Meta-Analysis of HIV and Other Factors Associated with Hepatitis B Infection. International Journal of Environmental Research and Public Health [Internet]. 2023 Jan 1;20(5):4142. Available from: https://www.mdpi.com/1660-4601/20/5/4142
ACCEPTED

62. Kumar A, Srinivasan S, Sharma A. Pyogenic liver abscess in children—South Indian experiences. Journal of Pediatric Surgery. 1998 Mar 1;33(3):417–21.
63. Malhotra S, Sibal A, Goyal N. Pediatric Liver Transplantation in India: 22 Years and Counting. Indian Pediatrics. 2020 Dec;57(12):1110–3.
64. Allen SJ, Adepojou A, Akinyinka OO. Challenges and opportunities for paediatric gastroenterology in low- and middle-income countries: high time for action. Paediatrics and International Child Health. 2019 Jan 2;39(1):4–6.
65. Khan KM, Chakraborty R, Brown S, et al. Association between Handwashing Behavior and Infectious Diseases among Low-Income Community Children in Urban New Delhi, India: A Cross-Sectional Study. Int J Environ Res Public Health. 2021;18(23):12535. Published 2021 Nov 28. doi:10.3390/ijerph182312535
66. Wilmshurst JM, Morrow B, du Preez A, Githanga D, Kennedy N, Zar HJ. The African Pediatric Fellowship Program: Training in Africa for Africans. Pediatrics. 2016 Jan 1;137(1).
67. World Health Organization. World Health Organization Statistical Information System (WHOSIS). Accessed August 4, 2008. Available from: URL: http://www.who.int/ whosis/en/
68. World Health Organization (WHO). World Health Report 2006: working together for health. Geneva: WHO, 2006. Available from: URL: http://www.who.int/whr/2006/ whr06_en.pdf
69. Niţă AF, Tsita D, Grima AM, Cameron F, Rock NM, Tapsas D. Understanding and Responding to the Impact of COVID-19 on Paediatric Gastroenterology Training & Practice of Young ESPGHAN Members. Journal of Pediatric Gastroenterology & Nutrition. 2021 Jul 24;73(5):592–8.
70. Manasfi H, Hanna-Wakim R, Akel I, Yazbeck N. Questionnaire-based survey in a developing country showing noncompliance with paediatric gastro-oesophageal reflux practice guidelines. Acta Paediatrica. 2016 Nov 23;106(2):316–21.
71. Besnier E, Thomson K, Stonkute D, Mohammad T, Akhter N, Todd A, et al. Which public health interventions are effective in reducing morbidity, mortality and health inequalities from infectious diseases amongst children in low- and middle-income countries (LMICs): An umbrella review. Salinas-Miranda A, editor. PLOS ONE. 2021 Jun 10;16(6):e0251905.
72. Feikin DR, Flannery B, Hamel MJ, Stack M, Hansen PM. Vaccines for Children in Low- and Middle-Income Countries [Internet]. Black RE, Laxminarayan R, Temmerman M, Walker N, editors. PubMed. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2016. Available from: https://www.ncbi.nlm.nih.gov/books/NBK361927/
73. Peters DH, Garg A, Bloom G, Walker DG, Brieger WR, Hafizur Rahman M. Poverty and Access to Health Care in Developing Countries. Annals of the New York Academy of Sciences [Internet]. 2008 Jul 25;1136(1):161–71.
74. Langlois EV, McKenzie A, Schneider H, Mecaskey JW. Measures to strengthen primary health-care systems in low- and middle-income countries. Bulletin of the World Health Organization. 2020 Sep 28;98(11):781–91.

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Figure 1:

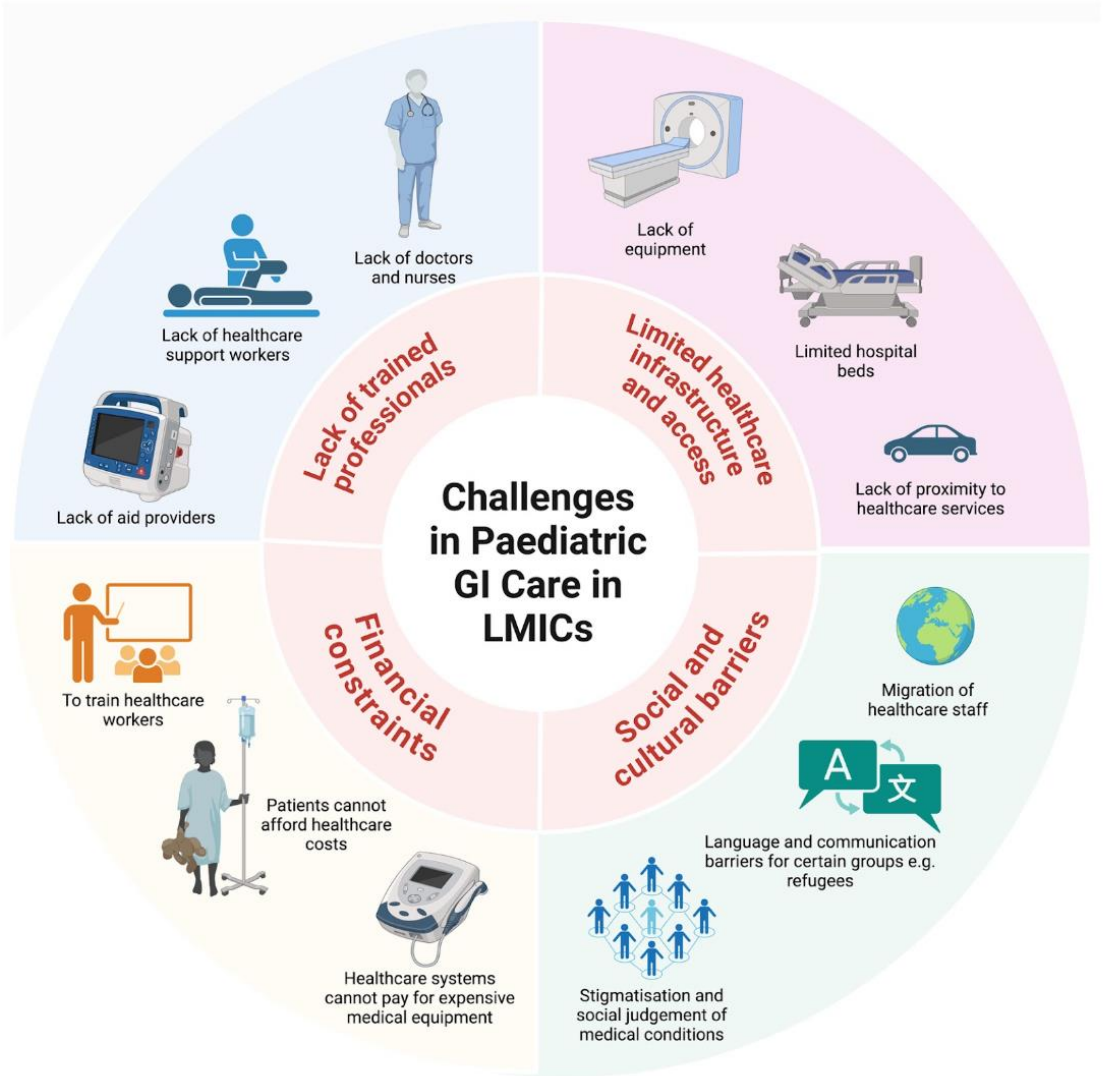

Figure 1. Challenges in Paediatric GI Care in LMICs

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Figure 2:

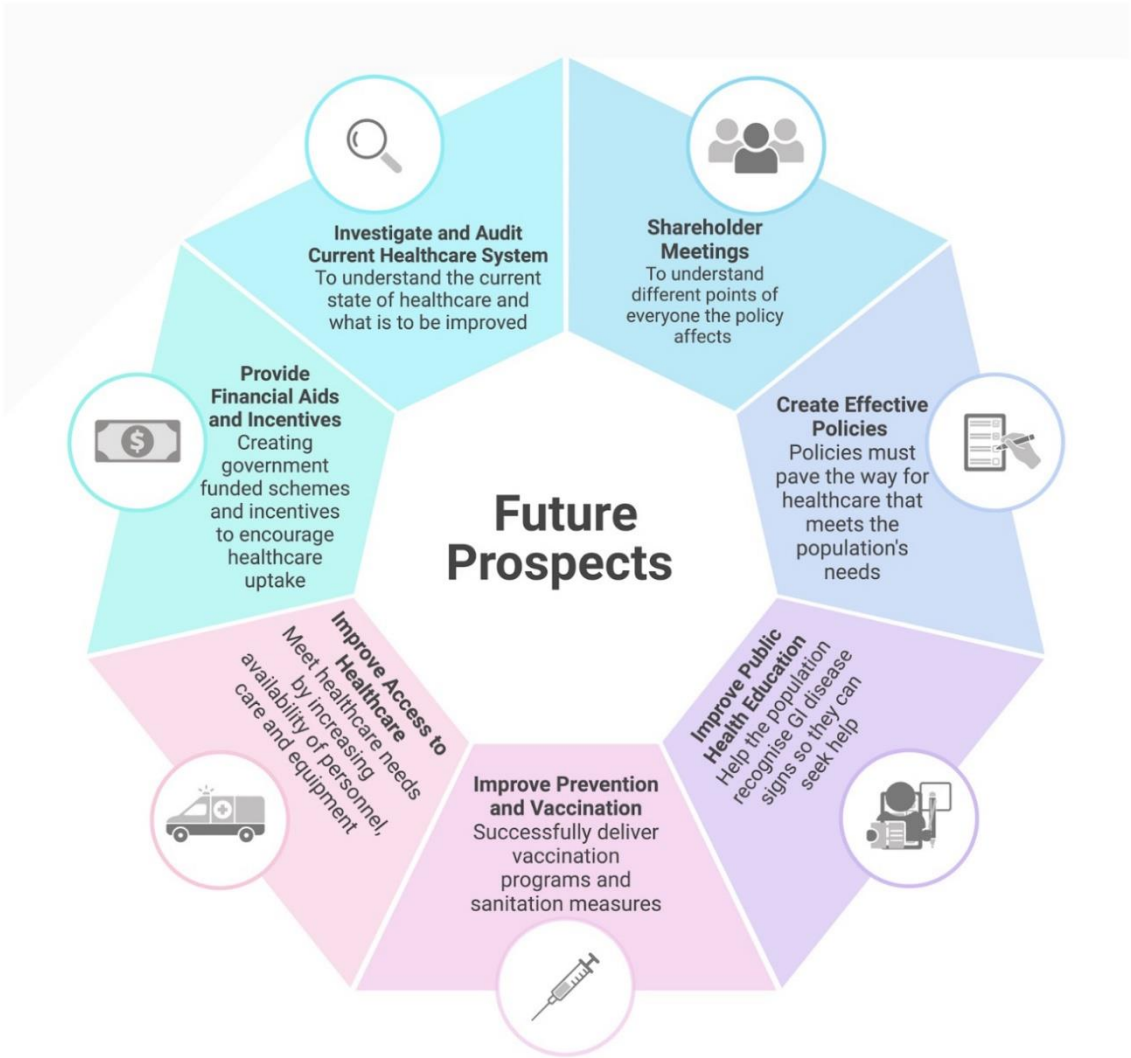

Figure 2. Future Prospects and Solutions for Paediatric GI Healthcare in LMICs

IBD

Study Author	Country	Date	Major Qualitative Findings
Huang JG et al.	Asia-Pacific	May 2022	Pediatric IBD diagnoses are more common in early adolescence, with geographical variability in incidence and symptoms such as abdominal pain, diarrhoea, and weight loss. Treatment approaches and diagnostic delays reflect disparities in resources, emphasizing the need for standardized protocols.
Kuenzig ME et al.	LMICs	Jan 2022	The highest incidence and prevalence of pediatric-onset IBD are in Northern Europe and North America. 84% of studies reported significant incidence increases over time, and all studies assessing prevalence noted significant rises. Data on very early-onset IBD (VEO-IBD) remains limited.
Srivastava A et al.	India	Aug 2020	Pediatric IBD cases are rising in India, with Crohn's disease more prevalent than ulcerative colitis. Common symptoms include abdominal pain, diarrhoea, and growth retardation. Awareness and early diagnosis are crucial to manage the increasing cases effectively.
Odeghe OF et al.	Nigeria	Apr 2020	IBD is rare in Black African children due to diagnostic challenges in resource-constrained environments. Symptoms include chronic diarrhoea, abdominal pain, and weight loss. Awareness, improved diagnostic facilities, and training are essential to better manage pediatric IBD.

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Table 1: Summary of IBD-focused studies

Celiac Disease

Study Author	Country	Date	Major Qualitative Findings
Kalle Kurppa et al.	LMICs	Jan 2024	Pediatric IBD cases are rising in India, with Crohn's disease more prevalent than ulcerative colitis. Common symptoms include abdominal pain, diarrhoea, and growth retardation. Awareness and early diagnosis are crucial to manage the increasing cases effectively.
Gupta R et al	India	2009	Limited awareness and diagnostic facilities contribute to the underdiagnosis of celiac disease in India. The Indian Task Force for Celiac Disease emphasizes the need for improved awareness and research.
Chen CY et al.	China	Jul 2019	Despite increasing prevalence, celiac disease remains under-recognized in China. Population-based screening programs and education for healthcare providers are urgently needed.
Paul S et al.	Sudan	2019	Misdiagnosis or delayed diagnosis is common in Sudan due to diverse symptoms and limited resources. Cost-effective management strategies and locally sourced gluten-free options are critical.

Table 2: Summary of CD-focused studies

Diarrhea and Gastroenteritis

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Study Author	Country	Date	Major Qualitative Findings
Kotloff KL et al.	LMICs	Jul 2013	Moderate-to-severe diarrhoea (MSD) in children under five is a leading cause of morbidity and mortality in sub-Saharan Africa and South Asia. Rotavirus, Shigella, and Cryptosporidium are key pathogens.
Operario DJ et al.	LMICs	Jun 2017	Rotavirus remains the most common cause of severe acute watery diarrhoea in children, even in vaccinated regions. Surveillance emphasizes targeting multiple pathogens, including norovirus and adenovirus.
Basharat N et al.	Pakistan	May 2021	Rotavirus is a significant cause of severe diarrhoea, leading to high morbidity and healthcare use. Improved vaccination programs and surveillance systems are needed to mitigate outbreaks.

Table 3: Summary of Diarrhea and Gatroenteritis-focused studies

Liver Diseases

Study Author	Country	Date	Major Qualitative Findings
Shanmugam N et al.	India	Jul 2021	Hepatitis B, cirrhosis, and liver failure are rising among Indian children. Vaccination programs and better healthcare access are essential, especially in rural areas.
Fofana DB et al.	West Africa	Jan 2023	HIV co-infection significantly increases hepatitis B risk in children. Factors include maternal transmission, poor vaccination,

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			and socioeconomic challenges.

Table 4: Summary of Liver Disease-focused studies

Other GI Conditions

Study Author	Country	Date	Major Qualitative Findings
Kocic M et al.	LMICs	Dec 2023	Causes of upper gastrointestinal bleeding (UGIB) vary with age: vitamin K deficiency in neonates, Mallory-Weiss tears in younger children, and erosive gastritis in older children.
Deerojanawong J et al.	Thailand	Jan 2009	UGIB is common in mechanically ventilated children. Risk factors include coagulopathy and GI diseases. Proactive monitoring and stress ulcer prophylaxis are crucial.

Table 5: Summary of Other GI Conditions-focused studies

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1. The prevalence of paediatric gastrointestinal (GI) diseases, including inflammatory bowel disease (IBD), coeliac disease (CeD), and infections like rotavirus and hepatitis, is increasing in Low- and Middle-Income Countries (LMICs) due to urbanisation and inadequate healthcare infrastructure.

2. Vaccines for GI infections, such as rotavirus, Hepatitis A Virus (HAV), and Hepatitis B Virus (HBV), are essential for reducing disease burden in LMICs but are limited by affordability and logistical challenges.

3. Limited paediatric endoscopy and hepatology services in LMICs, driven by financial constraints and a shortage of trained professionals, exacerbate the management of GI disorders.

4. Improving sanitation, hygiene education, and access to clean water are key to preventing GI infections in LMICs.

5. Strengthening healthcare systems through policy development, targeted training, and local capacity-building is crucial for addressing barriers to paediatric GI care in LMICs.

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