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# FINAL DISSERTATION

Submitted by:

**GUERMAT Yousra Sara**

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## MASTER IN BIOLOGICAL SCIENCES

**Specialty: Applied Microbiology**

THEME

# Acute Gastroenteritis (AGE) in Children Under 5 Years Old in "Hamadou Houcine Sidi Ali Hospital" Mostaganem.

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# Dedication

To the little girl who dreamt big, worked hard, and never gave up, I dedicate this work to you. I dedicate this work to my younger self.

To my parents, Words will never be enough to express how much I cherish your presence and your unwavering support throughout my journey.

To my mother—
Perhaps you didn't have the chance to pursue education yourself, but you gave life to the one who could. I carry your dreams in my success, and I dedicate this work to you—because without you, none of this would have been possible.

To my father—

Making you proud has always been my ultimate goal. Your unconditional love and countless sacrifices gave me the strength to keep going, even when things felt impossible. I owe this achievement to your unwavering belief in me. Thank you for believing in me even when I doubted myself. I dedicate this work to you with all my heart.

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To all my friends, especially Aya, If I ever had to choose between going to therapy and spending time with you, I would definitely choose you—because your presence is healing in its own special way

**List of figures :**

**List of abbreviations:**

**AGE:** Acute Gastro-Enteritis

**AIDS:** Acquired Immunodeficiency Syndrome

**DNA:** Deoxyribonucleic Acid

**EAEC:** Enteroaggregative Escherichia Coli

**EHEC:** Enterohemorrhagic Escherichia Coli

**EPEC:** Enteropathogenic Echerichia Coli

**HIV:** Human Immunodeficiency Virus

**IBD:** Inflammatory Bowel Disease

**IBS:** Irritable Bowel Syndrome

**IV:** Intravenous Fluids

**NSPs:** Non structural Proteins

**ORS:** Oral Rehydration Therapy

**PCR:** Polymerase Chain Reaction

**RNA:** Ribonucleic Acid

**UNICEF:** United Nations International Children's Emergency Fund

**WHO:** World Health Organization

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**ABSTRACT:**

Among children under five, acute gastroenteritis continues to be a major cause of hospitalization and morbidity, particularly in developing nations. Finding the primary causes, signs, and risk factors of acute gastroenteritis in children was the goal of this study. Between April and May 2025, a descriptive cross-sectional study was carried out at Sidi Ali Mostaganem Hospital. Information about sociodemographic and environmental factors was gathered from parental questionnaires. The results showed that viral gastroenteritis was the most common, with fever, vomiting, and diarrhea as dominant symptoms. Most affected children were under 2 years old, and contributing factors included lack of breastfeeding, poor hygiene, and consumption of unsafe water. To lessen the burden of this illness, the results emphasize the necessity of preventive measures like better hygiene habits, health education, and breastfeeding promotion.

**Keywords:**

Pediatric acute gastroenteritis, rehydration, bacterial pathogens, rotavirus, diarrhea

**Résumé :**

Chez les enfants de moins de cinq ans, la gastro-entérite aiguë demeure une cause majeure d'hospitalisation et de morbidité, en particulier dans les pays en développement. Cette étude avait pour objectif d'identifier les causes principales, les signes cliniques et les facteurs de risque de la gastro-entérite aiguë chez les enfants. Entre avril et mai 2025, une étude descriptive transversale a été réalisée à l'hôpital de Sidi Ali, Mostaganem. Les informations sur les facteurs sociodémographiques et environnementaux ont été recueillies à partir de questionnaires remplis par les parents. Les résultats ont montré que la gastro-entérite virale était la plus fréquente, avec comme symptômes dominants la fièvre, les vomissements et la diarrhée. La majorité des enfants touchés étaient âgés de moins de 2 ans, et les facteurs contributifs comprenaient l'absence d'allaitement, une mauvaise hygiène et la consommation d'eau non potable. Pour réduire la charge de cette maladie, les résultats soulignent la nécessité de mesures préventives telles qu'une meilleure hygiène, l'éducation sanitaire et la promotion de l'allaitement maternel.

**Mots clé :**

Gastro-entérite aiguë pédiatrique, réhydratation, pathogènes bactériens, rotavirus, diarrhée

**الملخص:**

تعدّ الالتهابات المعوية الحادة سببًا رئيسيًا لدخول الأطفال دون سن الخامسة إلى المستشفى وارتفاع معدلات المراضة، خاصةً في الدول النامية .هدفت هذه الدراسة إلى تحديد الأسباب الرئيسية، والعلامات السريرية، وعوامل الخطر المرتبطة بالتهاب المعدة والأمعاء الحاد لدى الأطفال .تم إجراء دراسة وصفية مقطعية خلال شهري أبريل وماي 2025 على مستوى مستشفى سيدي علي بولاية مستغانم .وقد جُمعت المعلومات المتعلقة بالعوامل الاجتماعية والديموغرافية والبيئية من خلال استبيانات وُزعت على أولياء الأطفال .أظهرت النتائج أن الالتهاب المعوي الفيروسي هو الأكثر شيوعًا، حيث كانت الحمى، والتقيؤ، والإسهال من بين الأعراض الأكثر ظهورًا .كما تبيّن أن معظم الأطفال المصابين كانوا دون سن العامين، ومن بين العوامل المساهمة في الإصابة: غياب الرضاعة الطبيعية، وسوء النظافة، واستهلاك المياه غير الصالحة للشرب .وتؤكد هذه النتائج على ضرورة اتخاذ تدابير وقائية مثل تحسين العادات الصحية، والتثقيف الصحي، وتعزيز الرضاعة الطبيعية لتقليل عبء هذا المرض.

**الكلمات المفتاحية**:

التهاب المعدة والأمعاء الحاد لدى الأطفال، الإماهة، مسببات الأمراض البكتيرية، فيروس الروتا ,الإسهال.

## INTRODUCTION:

Mortality and birth rates have long been used as barometers of population trends (Diallo *et al.,* 2000). The decline in mortality is concomitant with the emergence of modern states and the implementation of public health policies based on new biological and medical knowledge, as well as improvements in living conditions, particularly nutrition and housing (Michel Garenne & Enéas Gakusi, 2003).

Child mortality is defined as the number of deaths in children under five (5) years of age out of the number of live births in the same year.

In 2000 worldwide, the infant mortality rate was estimated at 57‰ of which Africa alone bore a heavy burden with 88‰. In the same year, nearly 11 million deaths of children under five were recorded; 40% of these deaths were concentrated in sub-Saharan Africa, followed by South Asia with 34%.

A newborn in West Africa is almost 20 times more likely to die in the first month of life than a baby born in northern Europe.

Infant and child mortality was dominated by malaria, prematurity, neonatal infections, acute respiratory infections, diarrheal diseases, fetal distress, meningitis, malnutrition and HIV/AIDS (Coulibaly, 2001).

Of the estimated total of 10.6 million deaths among children younger than five years of age worldwide, 42 percent occur in African region (Bryce *et al.,* 2005).

Gastroenteritis, a major health concern in Africa, particularly among children, is the second leading cause of infectious disease burden globally and is a significant contributor to mortality. While diarrhea (including viral gastroenteritis) is a major cause of death in children under 5 in sub-Saharan Africa.

Gastroenteritis involves inflammation of the gastrointestinal tract, mainly the stomach and small intestines (Al Jassas *et al.*, 2018), and can result from changes in diet, treatment with antibiotics (Pickard & Núñez, 2019), and infection involving various microbial agents, including viruses, such as rotavirus, adenovirus, and astrovirus (Makimaa *et al.*, 2020), enteric bacteria, such as *Escherichia coli*, *Campylobacter*, *Shigella*, or *Salmonella* (Janda & Abbott, 2021; Fleckenstein, Kuhlmann, & Sheikh, 2021) and parasites such as *Giardia lamblia* and *Cryptosporidium* (Garzón et *al.*, 2017)

# CHAPTER I
# LITTERATURE REVIEW

## 1. Definitions:

### 1.1 What is diarrhea in children?

According to the World Health Organization, diarrhea is at least 3 loose or liquid stools and a boost in the bowel movement in one day. (or more stools than usual for predisposed subjects).

### 1.2 What is an acute diarrhea?

It involves an alteration of stool consistency and/or elevated stool output (≥ 3/d). It lasts under a week and is usually associated with vomiting and fever.

### 1.3 What is pediatric gastroenteritis?

It is the most common gastrointestinal disease in children. A virus, bacterium, or parasite infects the stomach and intestines, leading to severe diarrhea and vomiting.

The paramount acute complication associated with gastroenteritis is dehydration, which transpires when the total fluid excretion of the child surpasses the fluid intake (Walker-Smith, 2013).

### 1.4 What is an acute gastroenteritis in children?

It is a quick-developing illness characterized by vomiting, fever or abdominal pain, greater stool volume, and an abnormal consistency.

It leads to major morbidity in children younger than five years old, accounting for 1.5 million office visits, 200,000 hospitalizations, and 300 deaths in children each year. (Hartman *et al.*, 2019)

## 2 Epidemiology :

### 2.1 Gastroenteritis in children:

Gastroenteritis predominantly occurs in low-income countries of sub-Saharan Africa (figure 2) African and Asian children are the most exposed to this disease, accounting for 80 % of annual incidence. (Simwaka *et al.*, 2018)

### 2.2 Acute gastroenteritis in children:

Worldwide, 2 million deaths from 5 billion cases happen. In developing countries, acute gastroenteritis is very common among children. According to the world health organization (WHO) and UNICEF diarrheal diseases were responsible of 10% of deaths among children under 5 years old (figure 1).

In Algeria, acute gastroenteritis is the main contributor to child mortality. The yearly morbidity rate is 2.5 episodes of diarrhea per child per year, or 10 million cases. (Lahcen, 2012)

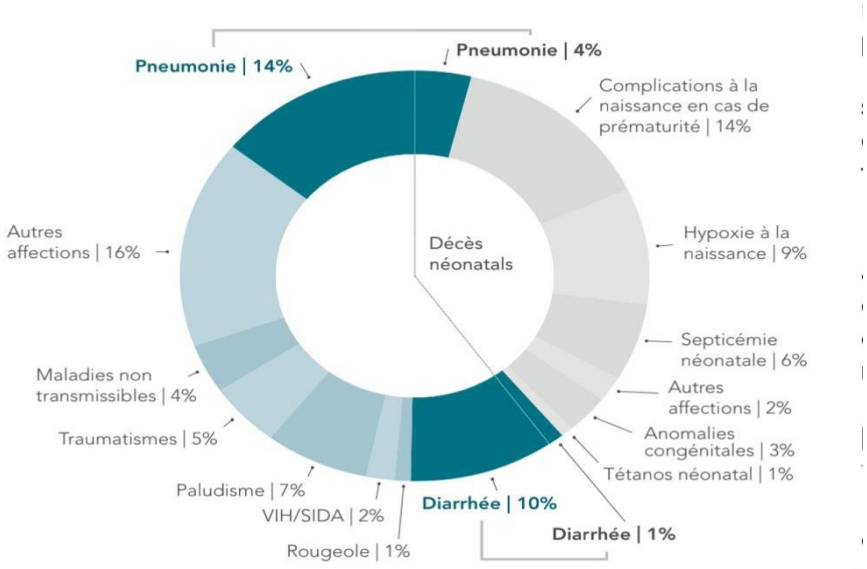


**Figure 1 : :** statistical analysis from a medical study about the major causes of infant mortality according to the WHO

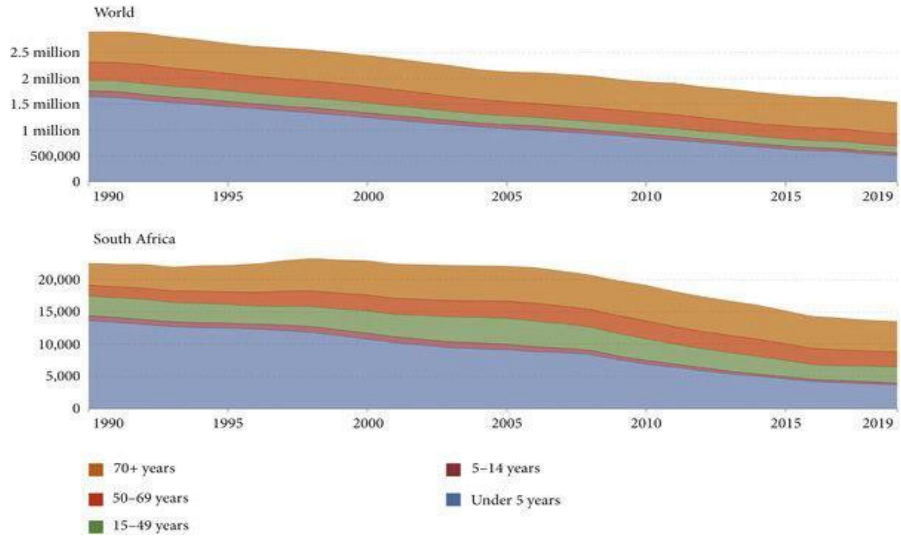


**Figure 2 :** global and south African mortality rates from diarrheal disease according to patient's age (Mafokwane *et al.*, 2023)

## 3 Ethiopathogenesis:

### 3.1 Acute gastroenteritis:

#### 3.1.1 Etiology:

Commonly caused by an infection, between 75% and 90% of cases are caused by noninflammatory agents (viral infections), and inflammatory agents (bacterial pathogens and parasites) cause another 10% to 20%. (Churgay & Aftab, 2012) Seasons and climate may affect the incidence of several pathogens. Children get infected, especially in day care centers because of the poor sanitation of the area.

#### 3.1.2 Non-inflammatory agents :

##### *3.1.2.1 Viral etiology :*

Viral gastroenteritis is an inflammation of the inside lining of the gastrointestinal tract. Many viruses can cause this disease, such as rotavirus, enteric adenovirus, calicivirus (e.g., norovirus and sapovirus), and astrovirus.

It is defined by digestive disorders such as nausea, vomiting, abdominal pain, and fluid and electrolyte diarrhea frequently accompanied by mild signs. Dehydration might be severe for infants younger than 24 months old. (Pignatelli et al., 2000 ; Rambaud & Bouhnik, 1994)

##### 3.1.2.1.1 Rotavirus:

belongs to the family Roeviridae, and it is the most common cause of acute gastroenteritis in children younger than 24 months old. About 111 million cases of gastroenteritis requiring only home care, 25 million clinic visits, 2 million hospitalizations, and 352,000–592,000 deaths (median, 440,000 deaths) in children under the age of five are caused by rotavirus each year. By the age of five, almost all children will experience a bout of rotavirus gastroenteritis, one in five will go to a clinic, one in sixty will be admitted to the hospital, and roughly one in 293 will pass away. Rotavirus kills 82% of children in the world's poorest nations. (Parashar *et al.*, 2003).

Clinical manifestations of rotavirus infection include fever, nausea, vomiting, severe watery diarrhea, and abdominal pain (Mafokwane *et al.*, 2023)

According to the World Health Organization (WHO) , rotavirus displayed a high rate during cool and dry seasons. It peaks during earlyspring time (Cho *et al.*, 2021).

**a) Morphology** :

Human rotavirus has a characteristic icosahedral structure that has a honeycomb-like appearance. The name rotavirus is derived from the Latin word rota, which means "wheel." It refers to the virion's appearance in negative-stained electron micrographs.The mature virion has a diameter of approximately 100 nm (Flewett *et al.*, 1974); it is composed of three concentric protein layers, and it is a non-enveloped virus.

**b) Structure:**

The rotavirus genome is made up of 11 double-stranded RNA segments, each gene encoding at least one protein. These viral proteins include six structural proteins VP(viral proteins), and six nonstructural proteins, NSPs (nonviral proteins) (figure 3) (Vende *et al.*, 2003).

The outer layer (the surface of the capsid) is formed of VP7 glycoprotein and spicules formed by the VP4 protein on top of each other. The viral RNA and VP2 protein bind and create the core. The VP6 produces the intermediate layer ; the VP1 and VP3 proteins are genome-associated and have enzymatic functions necessary for the infectivity of the virion.

However, non-structural proteins have an essential role in virulence and the pathogenesis of diarrhea.

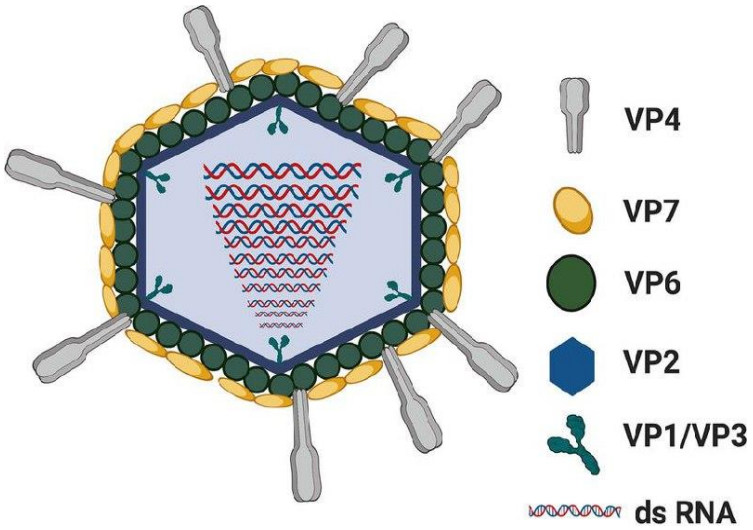


**Figure 2 :** schematic representation of rotavirus structure (Uprety *et al.*, 2021)

**c) Transmission mode:**

Rotavirus affects public health, especially children's health. The main transmission modes are human-to-human transmission, environmental transmission, and water transmission.

- Human-to-human transmission:

Rotavirus is mainly transmitted through the fecal-oral route, and it is highly contagious; it spreads quickly among children, especially in household settings (Lopman *et al.*, 2013).

- Environmental and waterborne transmission:

Rotavirus can persist in water sources, so it promotes transmission between communities (Kraay *et al.*, 2018).

**d) Serotypes :**

Rotaviruses can be categorized into Groups A-E based on the antigenic groups on VP6, the major capsid antigen. Only Group A, B, and C rotaviruses have been shown to infect humans, and Group A viruses cause the majority of human rotavirus disease. Serotypes G1-4 cause the most severe infections in young children, and G1 infections appear to have dominated the world over the last 20 years. Generally speaking, the more densely populated countries exhibit the most complex patterns of serotype occurrence (Bishop, 1996).

**e) Pathogenesis of rotavirus :**

These viruses affect the small intestine's mature enterocytes, resulting in both structural and functional harm (Jourdan *et al.*, 1998) . it reproduces in the cytosol of cells after infecting mucosal epithelial cells upon entry into the body (Amimo *et al.*, 2021). Rotaviruses cause infections in the small intestine's villi(Greenberg & Estes, 2009) Malabsorptive diarrhea is caused by a combination of factors, including virus-mediated destruction of absorptive enterocytes, virus-induced downregulation of absorptive enzyme expression, and functional alterations in tight junctions between enterocytes that result in paracellular leakage (Greenberg & Estes, 2009). Rotavirus diarrhea has a secretory component that is believed to be caused by the effects of NSP4, the first virus-encoded enterotoxin to be identified, and activation of the enteric nervous system(Greenberg & Estes, 2009). Rotavirus-induced diarrhea is partly caused by activation of cellular $Cl^-$ channels, which increases secretion of $Cl^-$ and subsequently water, according to studies of the virus and the effects of NSP4 alone in cultured cells and animal models (Greenberg & Estes, 2009).

Dehydration is a major concern in cases of rotavirus infections, and this inflammation is especially severe in infants (Omatola & Olaniran, 2022).

**f) Diagnosis :**

Although rotavirus is usually diagnosed based on symptoms and physical exams, the confirmation of the diagnosis is crucial. Several diagnostic methods are employed, which are discussed below:

- **Enzyme-Linked Immunosorbent Assay (ELISA) and Immunochromatographic Tests (ICT)**

Rotavirus antigens are frequently found in stool samples using ELISA and ICT. ELISA is an effective choice for routine diagnosis because of its high sensitivity and specificity (Habib *et al.*, 2022). Whereas, ICT is cost-effective and provides quick results, which is especially useful in environments with limited resources (Habib *et al.,* 2022).

- **Reverse Transcriptase Polymerase Chain Reaction (RT-PCR)**

Rotavirus RNA can be detected by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR), which is more sensitive and specific than ELISA (Kumar *et al.,* 2018). It offers full details about the virus strains present and is especially helpful for genotyping and recognizing mixed infections (Mousavi-Nasab *et al.,* 2020).

- **Multiplex PCR**

Multiplex-PCR allows for the detection of numerous infections and is a useful diagnostic tool for viral acute gastroenteritis (AGE). For precise therapy and future preventative measures for viral AGE, multiplex-PCR surveillance is essential. (Danino *et al.,* 2023)

- **Countercurrent Immunoelectrophoresis (CIE)**

CIE is an inexpensive and simple method that can be performed in basic laboratory settings. It provides results within a few hours and is comparable to ELISA in terms of sensitivity (Kumar *et al.,* 1984).

#### 3.1.2.1.2 Enteric adenovirus:

Adenovirus (family Adenoviridae) is the second viral agent after rotavirus that can cause viral gastroenteritis in children (Uhnoo *et al.,* 1984; Albert, 1986). It has been related to 7%–17% of cases of diarrhea in children. Clinical manifestations are watery stools, vomiting, mild fever, and rarely respiratory symptoms (Wadell et *al.,* 2007).

Human enteric adenovirus is prevalent throughout the year and shows increased incidence during the autumn and winter seasons (Bouazizi *et al.,* 2024)

**a) structure:**

All classes of vertebrates are infected by nonenveloped double-stranded DNA viruses called adenoviruses (figure 4). 240 subunits of the trimeric hexon protein form the facets of their particular icosahedral capsid architecture, while 12 copies of the penton which consists of the pentameric penton base protein and the externally projecting trimeric fiber, form the vertices. (Seiradake & Cusack, 2005)

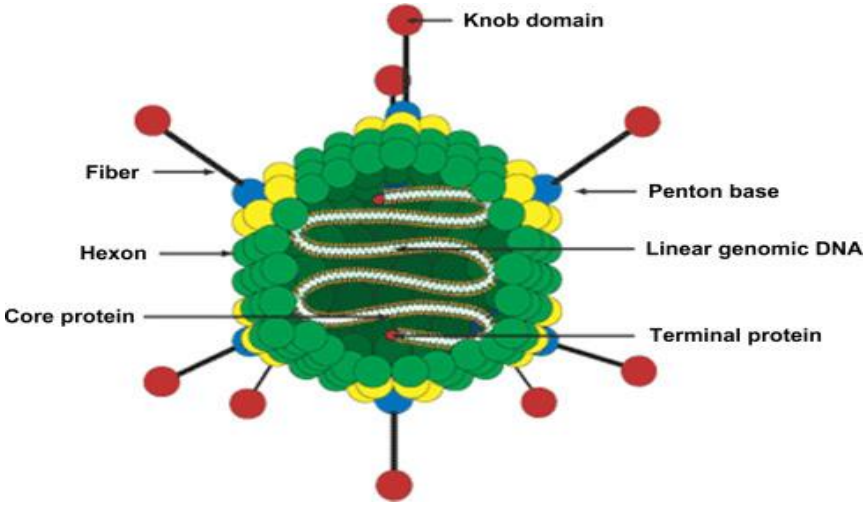


**Figure 3 :** The structure of an enteric adenovirus (Hassou *et al.*, 2020)

**b) serotype:**

There are 41 serotypes of human adenovirus classified into six subdivisions from A to F. The serotypes ad40 and ad 41 of the subgenus F are the main reason for gastroenteritis in children (Wadell *et al.*, 2007).

**c) transmission mode:**

The mode of spread of this virus is still uncertain; studies show that the transmission occurs by contact via the fecal-oral route since the virus multiplies in the gastrointestinal tract or through the respiratory route if the respiratory tract is infected (Albert, 1986).

**d) pathogenesis:**

At the acute stage of the disease, about $10^{11}$particles of the enteric adenoviruses per gram of stool are secreted. This indicates that they are proliferating in the gastrointestinal tract, expectedly in the small intestinal mucosa (Mavromichalis *et al.*, 1977).

some children with enteric adenovirus gastroenteritis manifest respiratory symptoms, indicating that the virus may also multiply in the respiratory tract organs

**e) diagnosis**:

Isolating ad40 and ad41 is hard. However, ELISA and solid-phase immune microscopy can directly identify them in addition to the identification by DNA restriction and Dot-Blot assays with enough DNA in the stool (Uhnoo *et al.*, 1990).

#### 3.1.2.1.3 Calicivirus:

Human caliciviruses (HuCV) are responsible for acute gastroenteritis; they belong to the norovirus and sapovirus genera of the Caliciviridae family. In fact, within these two genera, seven different genogroups with at least thirty-four human genotypes are currently identified. Noroviruses are now known to be major causes of both sporadic and epidemic acute gastroenteritis in all age groups, resulting in significant morbidity and costs in developed nations due to advancements in diagnostic tools (Kohli *et al.*, 2005).

The symptoms manifest in nausea, diarrhea, abdominal pain, and vomiting (Mafokwane *et al.*, 2023)

Norovirus exhibits peak activity during two distinct periods: from October to November and from February to march (Oldak *et al.*, 2012)

**a) Structure**:

Calicivirus virions measured between 35 and 40 nm in diameter. They are non-enveloped with an icosahedral symmetry. The capsid is made up of 90 dimers of the major structural protein VP1 structured on a T=3 icosahedral lattice (Prasad *et al.*, 1994). A shell (S) domain and two protruding (P) domains, which are made up of P1 and P2 subdomains, create the subunit that VP1 forms in noroviruses (Prasad *et al.*, 2016) (figure 5)

these single-stranded RNA viruses are highly variable genetically, making them difficult to detect (Kohli *et al.*, 2005).

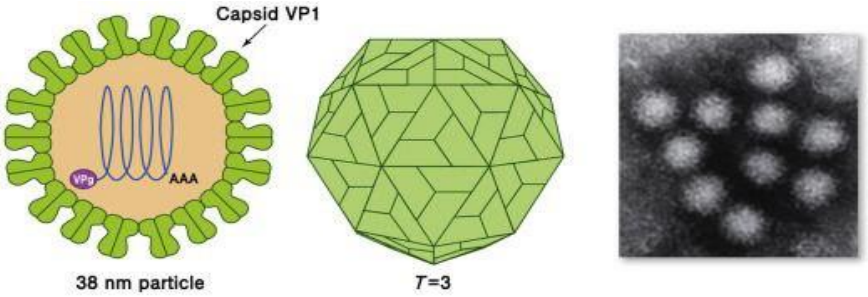


**Figure 4 :** (On the left) A cross-sectional view shows the norovirus capsid, which measures approximately 38 nm in diameter; (On the right) An electron microscope image displays the appearance of norovirus particles (Ryu, 2017)

**b) Diagnosis:**

Electron microscopy and PCR testing are the available diagnostic methods (Tarr *et al.*, 2009)

#### 3.1.2.1.4 Astrovirus:

Astroviruses are one of the agents that cause gastroenteritis in children under five years old. Watery diarrhea is one of the signs of this disease. Correspondingly, vomiting is less frequent in astrovirus illness than in rotavirus or norovirus illness. The incubation period is extended (Vu *et al.*, 2017).

Astrovirus infections peak from march to june among hospitalized young children (Dennehy *et al.*, 2001)

**a) Morphology**:

The virus is approximately 28 nm in diameter and has 5 to 6 pointed surface giving it the shape of a star (figure 6) and due to that shape it is called astrovirus (Astron, Greek for “star”) (Moser & Schultz-Cherry, 2008; Madeley & Cosgrove, 1975).

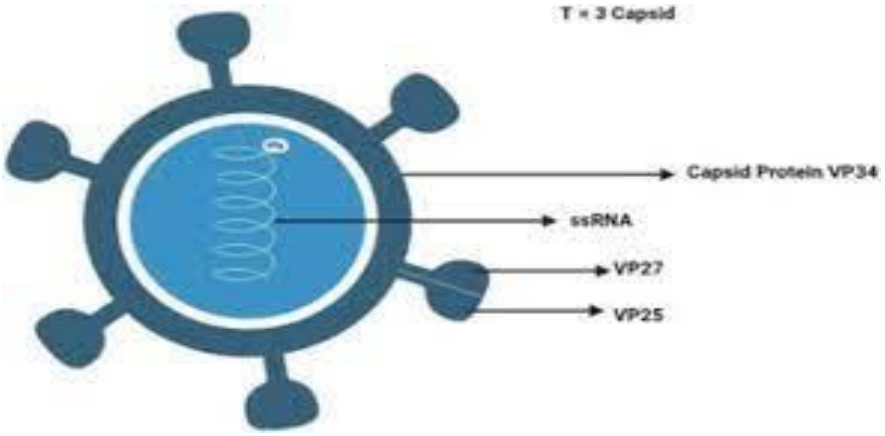


**Figure 5 :** Structure of astrovirus (Manglic *et al.*, 2024)

**b) Transmission mode:**

Human astroviruses are carried by the fecal-oral route or through marine, fresh, or sewage water. Surface and groundwater are known as drinking and bathing sources; thus, it becomes health-threatening for the public. According to the World Health Organization, children there are at risk of gastroenteritis caused by the contaminated water and the improper hygiene. (Vu *et al.,* 2017)

**c) Diagnosis:**

Astroviruses are an important cause of gastroenteritis in children; the identification of this virus in the stool is crucial for an effective diagnosis; enzyme-linked immunosorbent assay (ELISA) is one of the methods employed for this purpose (Herrmann *et al.,* 1990).

### 3.1.3 Inflammatory agents:

#### *3.1.3.1 bacterial etiology:*

- **Epidemiology:**

Worldwide, infectious diarrhea is becoming a significant public health concern (World Health Organization, 2023). Bacteria are responsible for 20%-40% of gastroenteritis in children. Every year, children under 5 years suffer from acute diarrhea; despite the high rate of mortality, it is declining in developing countries. Whereas, in developed countries, fewer episodes happen per person per year (Ranasinghe & Fhogartaigh, 2021).

##### *3.1.3.1.1 Salmonella:*

Facultative anaerobic bacteria are derived from the family of Enterobacteriaceae. It is a gram-negative bacillus responsible for many infections, such as gastroenteritis, especially in children under 3 years old.

*Salmonella* is divided into two categories: typhoidal and non-typhoidal salmonella. Typhoidal *Salmonella* serotypes are *Salmonella* typhi or *Salmonella* paratyphi, which mainly affect humans spread via contaminated water or food by feces. Non-typhoidal *Salmonella* can be transmitted directly between humans and animals (Karaaslan *et al.,* 2022).

The most common symptoms of *salmonella* gastroenteritis include diarrhea (96.5%), fever (65.7%), and abdominal pain (42.4%), with bloody diarrhea occurring in 19.2% of cases (Karaaslan *et al.,* 2022). The disease often resolves within 4–7 days.

Salmonellosis is diagnosed by the detection of *salmonella* on stool or blood cultures (Tarr *et al.,* 2009)

#### *3.1.3.1.2 Shigella:*

It is a gram negative facultatively anaerobic bacterium thatbelongs to the family Enterobacteriaceae, genetically nested within *Escherichia. S. flexneri* is the most common species isolated, followed by *S. sonnei* (Wilson *et al.*, 2006; Kara *et al.*, 2015).

There are four serogroups of *shigella* that are divided based on their serotypes: serogroup A is *Shigella* dysenteriae, serogroup B is *Shigella* flexneri, serogroup C is Shigella boydii, and serogroup D is *Shigella* sonnei (Gu, 2024).

*Shigella* dysenteriae is the one inducing acute gastroenteritis disease (Khan et al., 2013); it can develop resistance to certain antibiotics (Ranjbar & Farahani, 2019).

The gastroenteritis caused by *Shigella* is also called shigellosis; Following at least 12 hours of exposure to the bacteria, clinical manifestations include fever, stomach pains, and rectal spasms (tenesmus). Up to 50% of episodes of bloody diarrhea typically contain mucous. (Al-Dahmoshi *et al.,* 2020).

The transmission mode occurs by consuming contaminated water or food or via human to human transmission.

In order to confirm *a Shigella* infection, the pathogen must be isolated and identified by stool culture. Some patients with negative stool cultures have typical symptoms of S*higella* dysentery; in this case the stool is gathered in a sterile container and inoculated instantly on media selective for *Shigella* and *Salmonella* so we can maximize *Shigella* isolation (Tarr *et al.,* 2009).

#### *3.1.3.1.3 Campylobacter:*

*Campylobacter* is a gram negative bacterium. This bacterium is a primary cause of bacterial gastroenteritis in the developed countries.

Based on the World Health Organization(WHO), the symptoms of this infection are diarrhea (sometimes with blood), abdominal pain, fever, nausea, cephalgia, and vomiting. Symptoms usually last three to six days.

An infection transmitted from animals or their products to humans is called zoonosis, which is the case with *Campylobacter* infection. The majority of cases are caused by consuming

contaminated food, such as undercooked poultry, or beverages like unpasteurized milk. Approximately 50% - 70% of human *Campylobacter* infections are liked to contaminated water or contact with feces from infected humans or animals (Wilson & Wilson, 2021)

Fecal cultures are used for the identification of campylobacter in pediatric gastroenteritis (Bless et al., 2016)

#### *3.1.3.1.4 Escherichia coli:*

Acute gastroenteritis is an infection that may occur from consuming contaminated food or raw/undercooked meat or milk due to *Escherichia coli* O157:H7 (WHO), a gram negative bacillus and serotype of E. coli

There are different pathotypes of *Escherichia coli*:

- Enteroaggregative *E. coli* (EAEC) are linked to chronic diarrhea in children in the developing world.
- Enterohemorrhagic *E. coli* (EHEC) can cause hemorrhagic colitis and hemolytic uremic disorder.
- Enteropathogenic *E. coli* (EPEC) share a number of important virulence factors. (Kanwar *et al.,* 2023).
- enterotoxigenic *E. coli* (ETEC) it is among the main bacterial pathogens linked to human diarrheal illness (O'Ryan *et al.,* 2015).
- enteroinvasive *E. coli* (EIEC) (Lagerqvist *et al.,* 2020).

The diagnosis of gastroenteritis caused by *E. coli* relies on several methods, such as serological techniques, biochemical testing, and antibiotic sensitivity testing (Rogers & Taylor, 1961).

#### *3.1.3.1.5 Yersinia enterocolitica:*

It is a gram negative bacterium that is responsible for gastroenteritis in children.

Yersiniosis is an infection caused by *Yersinia enterocolitica* and sometimes *Y. pseudotuberculosis,* which affect children's gastrointestinal tracts (Riahi *et al.,* 2021). Symptoms manifest in diarrhea, abdominal pain, fever, and vomiting.

The infection occurs via drinking and consuming water or food that are exposed near pets or by the consumption of undercooked or raw food (Riahi *et al.,* 2021).

The identification of *Yersinia* is by the detection of this bacterium in the stool by *Yersinia* selective agar (Tarr *et al.,* 2009)

#### *3.1.3.1.6 Staphylococcus aureus:*

Staphylococcal gastroenteritis, also called staphylococcal food poisoning or food intoxication syndrome caused by *Staphylococcus aureus*. It spreads by the consumption of contaminated food by one or more enterotoxins (Jay *et al.*, 2005).

The quantity, type, and toxicity of the toxin determine the range of symptoms of staphylococcal gastroenteritis, whether it is mild, moderate, or The incubation period is about 1 to 6 hours; after that, the symptoms start to appear. It manifests in abdominal cramps, nausea, vomiting, diarrhea, fever, and dehydration, and in severe cases, it may lead to death (Bhatia & Zahoor, 2007).

Molecular techniques are used in the detection of *S.aureus* in the clinical sample.

### *3.1.3.2 parasitic etiology:*

Protozoa and helminths are the intestinal parasites for gastroenteritis in humans (Harhay *et al.*, 2010)

#### 3.1.3.2.1 protozoa:

#### *3.1.3.2.1.1 Giardia lamblia:*

Giardiasis is a form of gastroenteritis caused by *Giardia lamblia*. The parasite colonizes the duodenum and upper jejunum. In its life cycle, this flagellate shifts between trophozoite and cyst.

*Giardia lamblia* possesses two nuclei, which are structurally and functionally distinct. Observations indicate variations in nuclear pore number and distribution between the two nuclei (Benchimol, 2004).

The trophozoite has four pairs of flagella that aid in motility, with their arrangement contributing to its characteristic shape and ventral Disc allows attachment to the intestinal wall, facilitating nutrient absorption (figure 7) (Benchimol, 2005).

During encystation, the morphology changes significantly, with the formation of a protective cyst wall. This process involves the development of encystation-specific vesicles (Benchimol, 2004).

Cysts are typically oval and measure about 8-14 micrometers in length, differing from the larger trophozoite form (Al Saad & Al Emarah, 2014).

*G. lamblia* is transmitted through the ingestion of contaminated food or water, person to person or animal to person (Dumevi *et al.*, 2025)

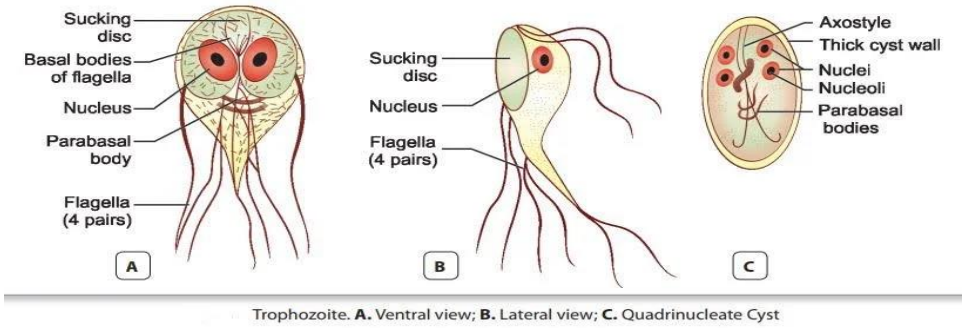


**Figure 6 :** The structure of *Giardia lamblia* (Mohammad et al., 2019)

Giardiasis varies from one to another; it might be asymptomatic which they don't develop symptoms but still can transmit the parasite by shedding cysts in the stool, or symptomatic, in which the symptoms manifest in loose and greasy diarrhea with a foul smell, bulky stool, bloating, abdominal cramps, decreased appetite, nausea, and mild fever (Adam, 1991). The incubation period is 1 to 3 weeks.

The diagnosis of giardiasis relies on the microscopic examination of the stool sample, examination of duodenal contents (duodenoscopy), or enzyme-linked immunosorbent assay ELISA (Adam, 1991).

#### *3.1.3.2.1.2 Entamoeba histolytica:*

*E.histolytica* is a major cause of gastroenteritis in children in developing countries. This protozoan parasite is responsible for causing amebiasis and amebic colitis. *E.histolytica* is more dominant in tropical areas. Humans are the main host of this parasite. Its life cycle involves trophozoite, precyst, cyst, metacyst, and metacystic trophozoite phases.

This infection might be symptomatic, manifesting in abdominal pain and an elevated rate of bowel movements. Only trophozoites are visible when amebae penetrate host tissues and the organism loses its capacity to encyst. Amebae colonize the intestinal mucosa, causing abdominal pain, diarrhea, dysentery, or weight loss (Genta, 1992). Meanwhile, this infection also can be asymptomatic depending on the host's immune system.

The most common methods for diagnosing amebiasis are microscopy observation, trichrome staining, stool culture, enzyme-linked immunosorbent assay, and MT-PCR (Tüzemen & Doğan, 2014).

#### 3.1.3.2.1.3 *Cryptosporidium spp*:

*Cryptosporidium sp.* is a protozoan parasite that is responsible for infecting the gastrointestinal epithelium, leading to cryptosporidiosis in children and immunocompromised patients (Korpe *et al.,* 2018).

fecal-oral transmission of *Cryptosporidium* is typically caused by drinking contaminated or recreational water. Transmission can also occur from fecal contamination of food and from person to person in impoverished nations with inadequate sanitation (Redlinger *et al.,* 2002).

Chlorinating water to disinfect it frequently doesn't offer enough protection. (Redlinger *et al.,* 2002)

Patients often experience severe watery diarrhea, fever, abdominal pain, and vomiting (Janssen & Snowden, 2017).

The diagnosis of *Cryptosporidium* can be made by nucleic acid/polymerase chain reaction (PCR) testing, antigen detection techniques, or by identifying the parasite in the feces using specific stains (Janssen & Snowden, 2017).

#### 3.1.3.2.2 helminths:

Helminths are multicellular worms and parasites that are common in both developing and tropical countries, affecting the gastrointestinal tract of vertebrate reservoirs. Extended infection may contribute to the development of ulcerative colitis (UC) and Crohn's disease (CD). Ulcerative colitis (UC) presents as bloody diarrhea and alters the colonic mucosa. Meanwhile, the Crohn's disease CD manifests in gastrointestinal symptoms including fever, bloody loose stool with mucus, and abdominal pain (Varyani *et al.,* 2017).

#### 3.1.3.2.2.1 *strongloides stercolaris*:

*strongloides* is an intestinal parasite responsible for strongyloidiasis. Infected, immunocompromised, or malnourished children may experience autoinfection or persistent parasite replication, which may lead to a chronic infection and death (Arifin *et al.,* 2019).

- **life cycle:**

The transmission occurs mainly through the penetration of the parasite present in the stool, water, contaminated food, or soil of the human's skin to the bloodstream. *Strongloides* migrates to the intestine and evolves into an adult female worm that lays eggs and releases them in the stool (Arifin *et al.,* 2019). The eggs that hatch in the intestine enter the parasitic life cycle and

reinvade the same host, causing autoinfection, or the larvae carry on the life cycle in the environment (figure 8) (Arifin *et al.*, 2019).

- **Diagnosis:**

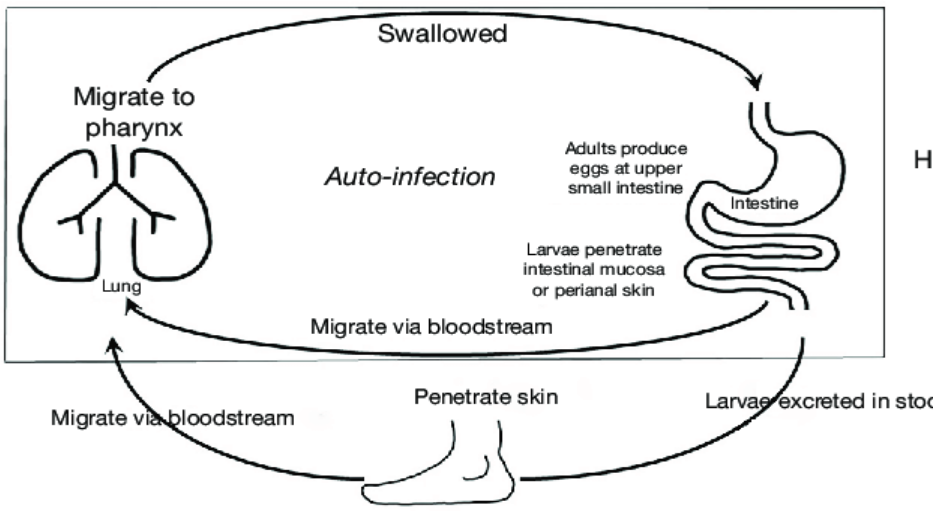


**Figure 7 :** the life cycle of *strongloides stercoralis* (Bae *et al.*, 2018)

The identification of *strongloides stercoralis* relies on the detection of the larvae in the stool, intestinal biopsy, cell free DNA detection in the urine, and Gram staining. However, serological tests are highly sensitive but less specific (Carpio & Meseeha, 2023).

#### *3.1.3.2.2.2 Ascaris lumbricoides:*

*A.Lumbricoides* is the largest nematode parasitizing humans, especially children. It is common in tropical and subtropical areas (Hagel & Guisti, 2010).

- **Life cycle:**

The parasite spreads through the ingestion of the eggs that hatch in the intestine. Before the larvae return to the small intestine lumen where adult worms live, they invade the gut mucosa and disperse through the liver and lungs (Else *et al.*, 2020).

#### *3.1.3.2.2.3 Trichuris trichiura:*

*Trichuris trichiura* is a whipworm from the helminthiasis group; this intestinal parasite spreads via soil and the consumption of contaminated food and water (Viswanath *et al.*, 2023) .it is mainly common in tropical and subtropical regions (Else *et al.*, 2020).

- **Life cycle:**

The infected host releases the eggs in the stool. The eggs have the ability to survive in the environment for a long time; they contaminate the host's hands, water, and food. The larvae

hatch in the small intestine, then they migrate to the large intestine, as a result cells are destroyed and the host's immune system is activated dragging in lymphocytes, plasma cells, and eosinophils, causing abdominal pain and rectal bleeding. The terminal ileum and cecum are typically where the parasite settles. The worm may infest the entire colon and rectum in certain patients, and without treatment the worm's lifespan could range from two to four years (Viswanath *et al.,* 2023).

- **Diagnosis:**

The identification of both *T.Trichiura* and *A.Lumbricoides* rely on the detection of the eggs or parasites DNA in the stool (Else *et al.,* 2020), microscopic observation ,colonoscopy, and PCR are also effective (Viswanath *et al.,* 2023)

### 3.2 Non-infectious gastroenteritis:

Noninfectious gastroenteritis is a gastrointestinal disorder that is not caused by infectious agents; instead, it may arise from various noninfectious agents such as

#### 3.2.1 Irritable bowel syndrome IBS:

It is a gastrointestinal disorder identified by diarrhea and/or constipation, abdominal pain, cramps, and bloating.

#### 3.2.2 Inflammatory Bowel disease IBD:

The inflammatory bowel disease IBD is expressed by Crohn's disease and ulcerative colitis.

The diagnosis of this disorder is based on the negativity of bacteriological and parasitological investigations and histological and endoscopic aspects (Lahcen, 2013).

#### 3.2.3 Medication induced diarrhea:

Usually originating from consuming certain medications, specifically antibiotics, magnesium containing antacids, laxatives, antiarrhythmic drugs, cholinergic agents, lactose- or sorbitol containing products, nonsteroidal anti-inflammatory drugs, antineoplastics, prostaglandins, and colchicine (Chassany *et al.,* 2000)

#### 3.2.4 Allergic diarrhea:

The gastrointestinal allergic disease, or allergic diarrhea often caused by food anaphylaxis and eosinophilia (Brandt *et al.,* 2003).

After minutes of the ingestion of a food allergen, diarrhea appears (Haffaf & Hmidaoui, 2013).

## 4 Factors influencing pediatric gastroenteritis:

### 4.1 Host related factors:

#### 4.1.1 Age:

Toddlers under 24 months are more exposed to severe diarrhea than the older age groups (Kim *et al.*, 2017)

#### 4.1.2 Gender:

Male children play outside more often than females, which makes them more exposed to gastroenteritis (Saeed & Ibrahim, 2023).

#### 4.1.3 Malnutrition:

Underweight children have a higher risk of severe diarrheal disorders (Saeed & Ibrahim, 2023)

### 4.2 Environmental and socioeconomic factors:

#### 4.2.1 Hygiene and sanitation:

the lack of clean water sources and lack of awareness of self-hygiene increase the risk of the infection (Saeed & Ibrahim, 2023)

#### 4.2.2 Crowded living conditions and low income:

The studies show that crowded families of more than 6 members with low income are at higher risk of being infected with gastroenteritis (Saeed & Ibrahim, 2023).

### 4.3 Feeding practices and mode of birth:

#### 4.3.1 Breast-feeding:

Based on the World Health Organization (WHO) guidelines, exclusive breastfeeding of children under 7 months helps protect them against acute gastroenteritis. On the other hand, while the child had a higher risk because of his negative phenotype, the mother's secretory positive phenotype helped protect against Norovirus AGE (Vielot *et al.*, 2022).

#### 4.3.2 Mode of birth:

Children delivered by ceasarean section and exclusively formula-fed are at higher risk of AGE. Meanwhile, children born by vaginal delivery and breast-fed are less likely to develop acute gastroenteritis due to the exposure to the vaginal bacteria (Bentley *et al.*, 2016).

### 4.4 Seasonal variations:

Norovirus is most active in winter, followed by rotavirus, which peaks in spring (Onozuka & Hashizume, 2011). While bacterial gastroenteritis peaks in summer because of the contamination of food and water (Galway *et al.*, 2014),

### 4.5 Antibiotic use and resistance:

The resistance of bacteria against antibiotics such as fluoroquinolone, ciprofloxacin, and levofloxacin has increased, which makes the infections harder to manage (Kim *et al.*, 2019). That's why the use of antibiotics is not recommended in treating acute gastroenteritis.

## 5 Diagnostic:

### 5.1 Clinical history:

Clinical history is important to differentiate acute gastroenteritis from other disorders. Clinical history should examine the following aspects:

- Food and dietary history of the child;
- Vaccination record;
- Gastrointestinal symptoms, including diarrhea, fever, constipation, vomiting, and abdominal pain;
- Past medical history;
- Medication history, including antibiotic intake;
- Quantity, consistency, frequency, character, and onset of diarrhea (King *et al.*, 2003).
- Urine and bowel movement output;
- Time frame of the disease;
- Forms of emesis: non-bilious or bilious vomiting;
- Latest consumption or exposure to untreated water (Churgay & Aftab, 2012)

### 5.2 Physical examination:

Physical examination is crucial to determine the severity of dehydration and determine the right treatment; the physician should evaluate:

- Body weight, respiratory rate, blood pressure, and heart rate;
- Absence or presence of tears and eyes appearance;
- Tongue, mouth, and lips condition;
- Skin tenting;
- Stool examination (King *et al.*, 2003).

### 5.3 Laboratory testing:

To detect the causative agents of AGE in children, some clinical examinations should be performed:

### 5.3.1 Microscopy:

It is a real time viewing of the causative agent, more likely bacteria and parasites. Gram staining, biochemical tests, and bacteriological cultures are employed (Mafekwane *et al.*, 2023).

To diagnose diarrhea and intestinal inflammation fecal leukocyte test is used (Mafekwane *et al.*, 2023).

### 5.3.2 Serology:

The fresh stool is used to detect pathogen antigen or nucleic acid. ELISA is a pathogen detector in the stool sample. It is quick but less sensitive; sometimes it may generate false positive test results.

Indirect ELISA is used to set apart between an active or previous infection by antibodies (Mafekwane *et al.*, 2023).

### 5.3.3 Molecular diagnostics:

Nucleic acid amplification test NAAT detects a single pathogen meanwhile the multiplex assay format detects multiple pathogens;

PCR identifies multi-enteric pathogens due to its sensitivity (Mafekwane *et al.*, 2023).

## 6 Differential diagnosis:

### 6.1 Diagnosis of acute vomiting:

Acute vomiting can be caused by:(Scorza *et al.*, 2007)

- Meningitis
- Intussusception
- Pylonic stenosis
- Appendicitis
- Peritonitis
- Hepatitis
- Urinary tract infection

### 6.2 Massive abdominal pain

Massive abdominal pain might be caused by (Scorza *et al.*, 2007):

- Small bowel obstruction
- Pancreatitis
- Cholecystitis

### 6.3 Persistent high fever:

Various medical conditions can cause persistent high fever, including:

- Otitis media
- Endocarditis
- Urinary tract infection

## 7 Complications:

### 7.1 Dehydration:

Dehydration is the most common complication in AGE, especially mild to moderate. Dehydration causes the loss of water and electrolytes, which leads to severe dehydration and death (Nardin Elias, 2019).

### 7.2 Disseminated intravascular coagulation DIC:

DIC is caused by hypovolemic shock brought on by severe dehydration with hyperammonemia, hyperglycemia, and hypernatremia (Sehari *et al.*, 2016).

### 7.3 Hemolytic uremic syndrome:

Escherichia coli releases Shigatoxins, causing hemolytic uremic syndrome in both children and adults. The complications of this syndrome may lead to renal failure, intussusception and seizures (Razzaq, 2006).

### 7.4 Neurological complications:

AGE may cause neurological complications, including seizures and acute encephalopathy (Karampatsas *et al.*, 2018).

### 7.5 Developing food intolerance (e.g., cow's milk protein intolerance)

## 8 Treatment:

### 8.1 Rehydration:

#### 8.1.1 For mild to moderate dehydration:

If you notice that your child is inactive, tired, and rarely urinates with much darker urine, he is likely dehydrated. ORS is the recommended treatment for this type of dehydration. Caregivers should disperse about 1 ml of ORS per kg using a syringe or a spoon every 5 minutes for 3 to 5 hours. After each episode of diarrhea or vomiting, an additional 10 ml per kg of ORS should be given (Churgay & Aftab, 2012).

### 8.1.2 For moderate to severe dehydration:

Severe dehydration is characterized by unconsciousness, shock, severe abdominal distension and ileus, vomiting, and lack of improvement despite oral rehydration (Jung, Bellache, & GFHGNP, 2024).

Oral rehydration therapy is continued alongside intravenous fluids. During the first hour, the physician administers a 20 ml per kg bolus of saline. Over the next 8 to 12 hours, appropriate intravenous fluids are added after the child has urinated or passed stool to balance the fluid deficit. During this treatment, no food is allowed. Once the child is fully hydrated (within 8 to 12 hours), intravenous fluids are discontinued and the child is allowed to drink the electrolyte solution (Issenman & Leung, 1993).

### 8.2 nutritional management:

For breastfed infants: continue breastfeeding the child alongside oral rehydration therapy (Jung *et al.*, 2024).

Formula-fed infants: In cases of mild diarrhea, continuing formula feeding is acceptable. However, if the diarrhea persists for more than 7 days, a lactose-free formula is recommended (Jung *et al.*, 2024).

If ORS is rejected, use apple juice, syrup, or sweetened water; fruits such as bananas and quince apples; dairy products; rice, pasta, carrots, potatoes, and semolina.

Your child should avoid green vegetables, burgers, fried foods, shellfish, cold meats, ready-made meals, soft drinks, and orange juice until fully recovered.

### 8.3 Probiotics:

Probiotics play a crucial role in modulating the immune response specifically against pathogen-associated antigens. They are quickly eliminated after ingestion. When used alongside ORS, probiotics decrease the duration of diarrhea by one day (Churgay & Aftab, 2012).

### 8.4 Antibiotics:

Antibiotics are used in cases of bacterial or protozoal gastroenteritis, particularly in infections such as shigellosis, salmonellosis, and giardiasis (Jung *et al.*, 2024)

### 8.5 Zinc:

In cases of acute diarrhea, ZINC is recommended for 10 to 14 days: 10 mg per day for infants under 6 months and 20 mg per day for older children (Jung *et al.*, 2024)

## 9 Prevention:

Preventive measures are a means of limiting and reducing the spread of pediatric gastroenteritis.

Reducing diarrheal disease in low-income countries requires improving water quality and sanitation (Hartman *et al.*, 2019).

Handwashing with antibacterial soap or using alcohol-based hand sanitizers is more effective against bacterial gastroenteritis (Hartman *et al.*, 2019).

An oral live, attenuated rotavirus vaccine should be administered to all children aged between 6 and 15 weeks (Hartman *et al.*, 2019).

Breastfeeding reduces the incidence of AGE due to the antibodies present in human milk (Hartman *et al.*, 2019).

# Chapter II
# Materials and Methods

**Practical part:**

## 10 objectives:

- The identification of the major risk factors of pediatric gastroenteritis, including hygiene, nutrition, water source, infant feeding, etc.
- The investigation of the impact of AGE in children and treatment guidelines

## 11 Methods:

A study was conducted on AGE in children at HAMADOU HOUCINE Hospital in Sidi Ali Mostaganem from April 20, 2025, to May 19, 2025. This study focused on 40 children aged between 0 and 5 years old. During that period the temperature of that area ranged between 21°C and 26°C, with light to moderate precipitation observed.

### 11.1 Data collection:

In this study, the main tool for gathering data was a questionnaire administered by the child's parents. The questionnaire covered multiple essential domains:

- Sociodemographic information
- Clinical symptoms
- Child's treatment status

# Chapter III
# Results and Discussion

## 12 Results:

### 12.1 Sociodemographic results:

- **Age distribution:**

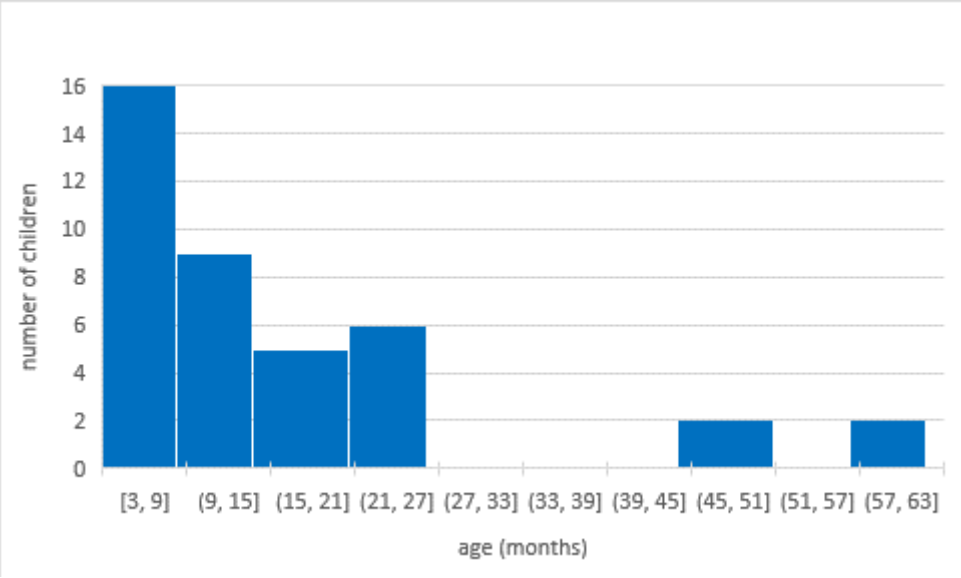


**Figure 9 :** age distribution of children with AGE

The age of the children included in the study ranges from 0 to 60 months, with an average age of 17.9 months. The class with the highest frequency is the age range (3-9].

- **Sex ratio:**

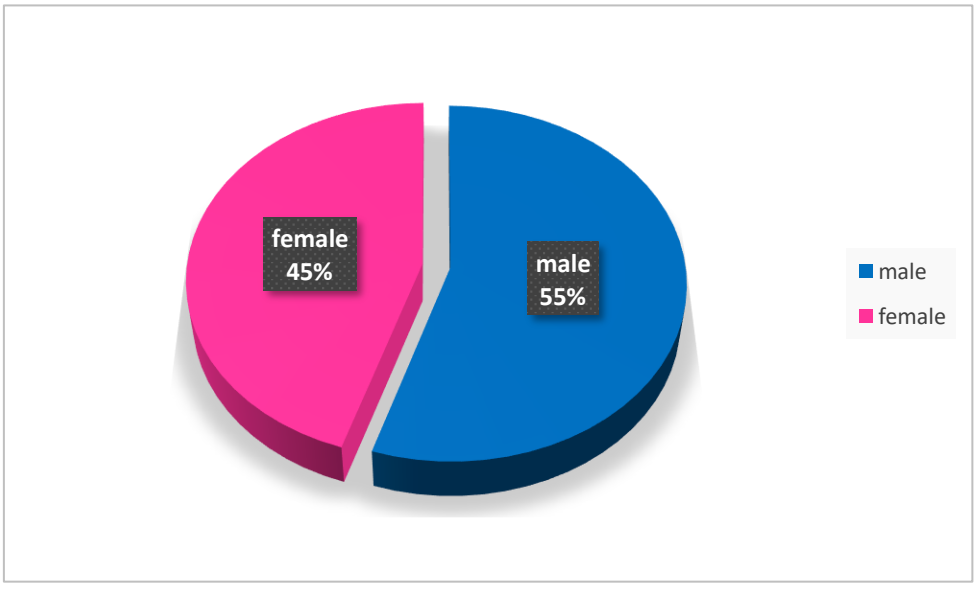


**Figure 9 :** gender distribution in recorded cases

A male predominance was observed in the study population with a sex ratio of 1.22

- **Income level:**

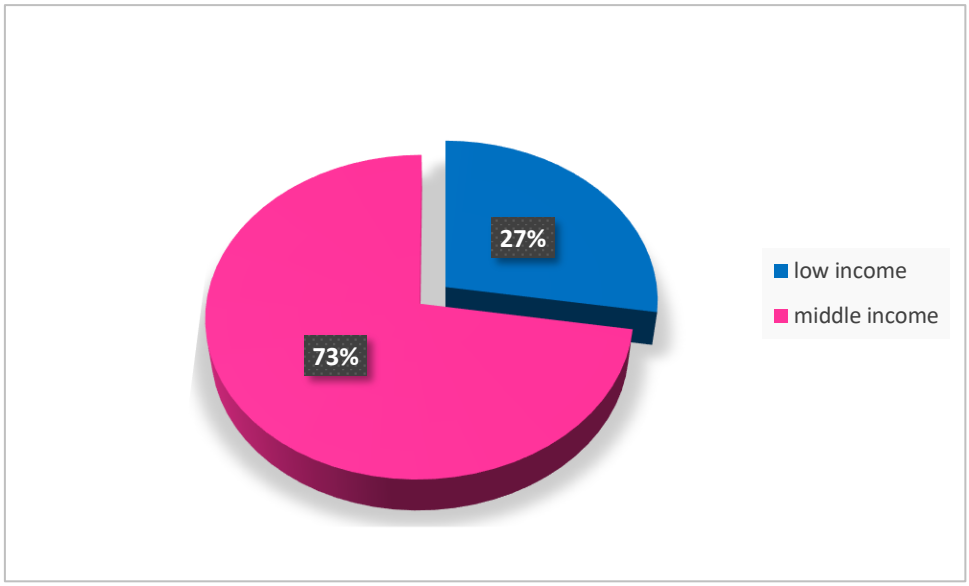


**Figure 10** : income based classification in AGE cases

Our study shows that most of the patients came from middle-income families (73%), with fewer cases from low-income families (27%).

- **water usage:**

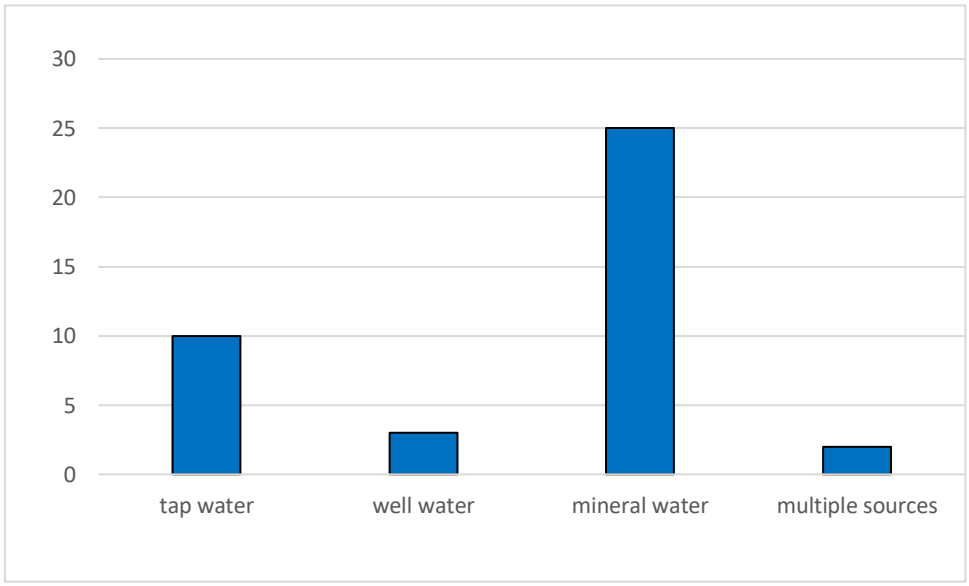


**Figure 11 :** household water sources in the study population

The most often used water source in AGE cases was the mineral water, followed by tap water meanwhile untreated sources like well water was used less frequently.

- **Infant Feeding practices:**

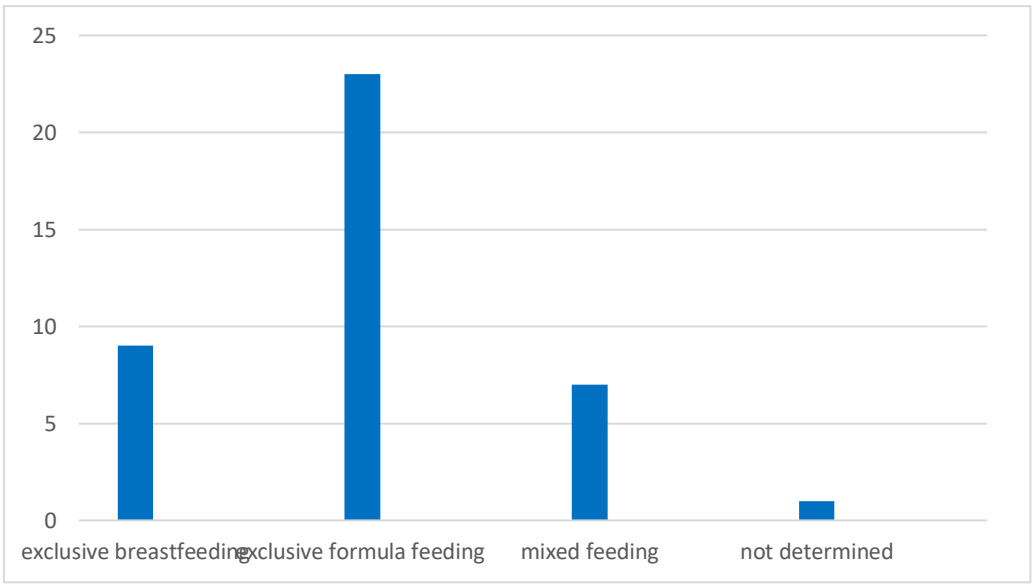


**Figure 12 :** feeding practices among children with AGE

Exclusive formula feeding is the most common practice among children with AGE, followed by exclusive breastfeeding, while few received mixed feeding.

### 12.2 Clinical features:

- **Based on the characteristics of the stools:**

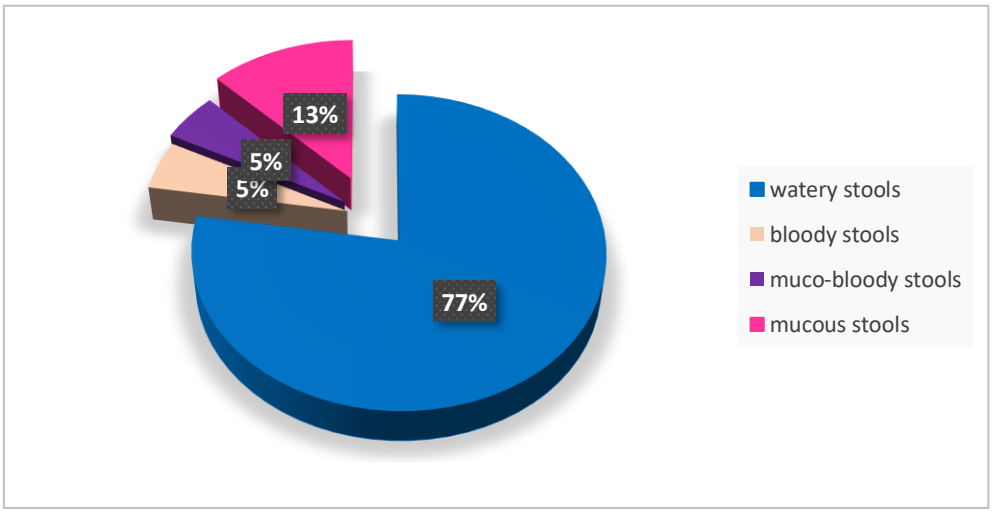


**Figure 13 :** stools characteristics among children with AGE

77% of hospitalized children have watery stools, followed by mucous stools (13%), while bloody and muco-bloody stools each accounted for 5% of cases.

- **Daily stool frequency:**

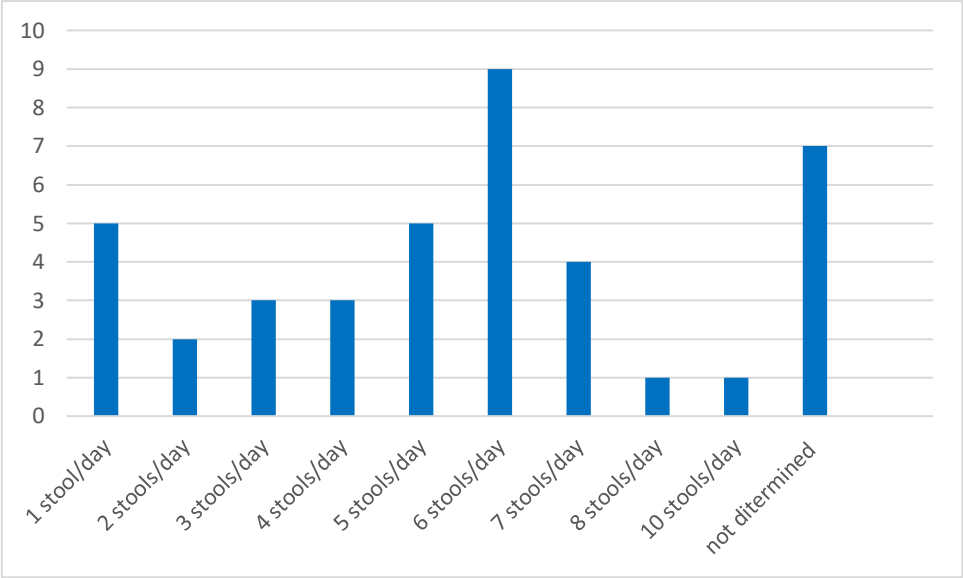


**Figure 14** : number of stools per day

The highest frequency observed was 6 stools per day.

- **Based on the presence of vomiting:**

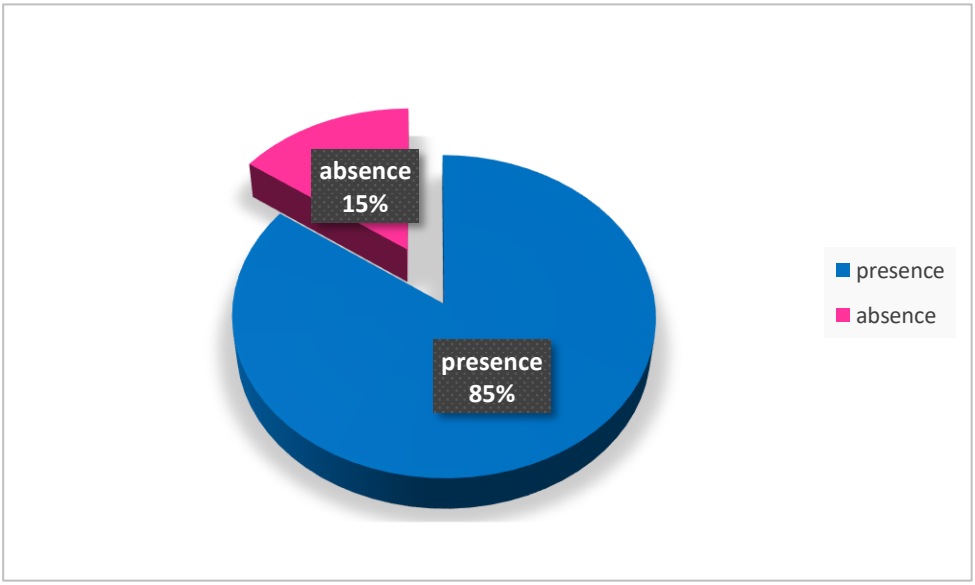


**Figure 15 :** number of vomiting cases

Vomiting was present in 85% of the cases, while a smaller percentage (15%) of the patients didn't experience vomiting.

- **Average temperature of the patients:**

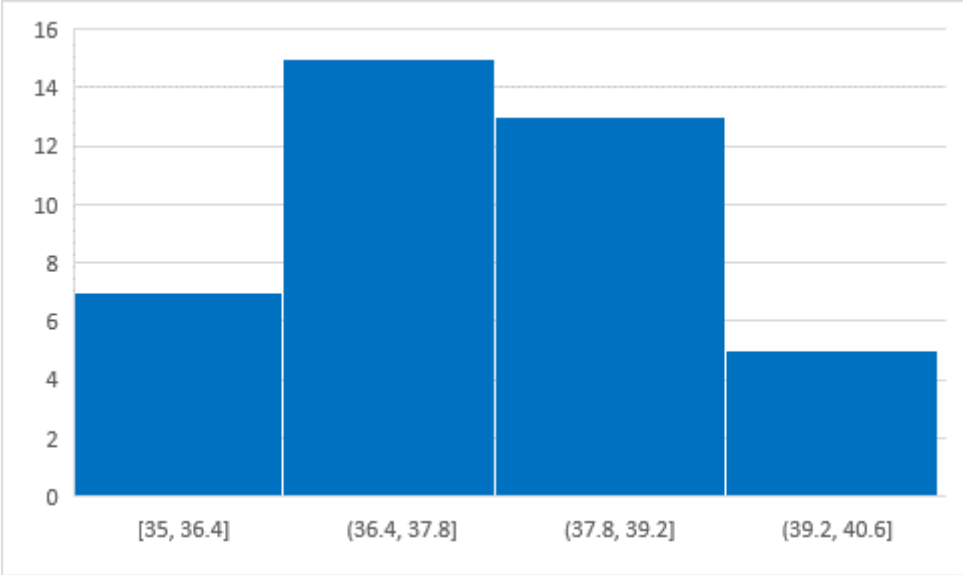


**Figure 16** : frequency of different fever temperatures

Most common range: [36.4, 37.8] (no fever)

Followed by: [37.8, 39.2] (mild to moderate fever)

The average fever temperature is approximately 38.94°C

- **Abdominal pain in patients with AGE:**

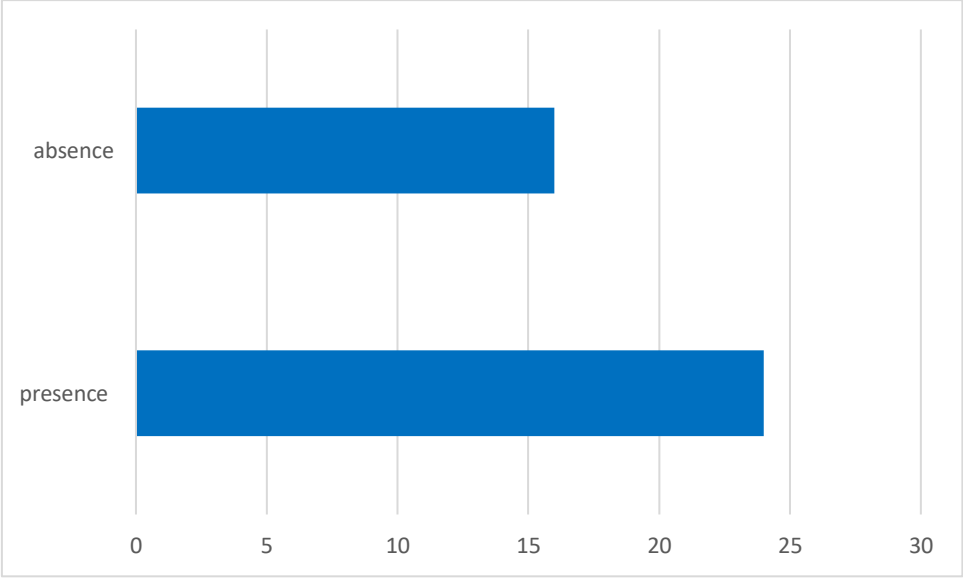


**Figure 17 :** prevalence of abdominal pain among patients

Abdominal pain was reported in 24 patients.

- **Dehydration status:**

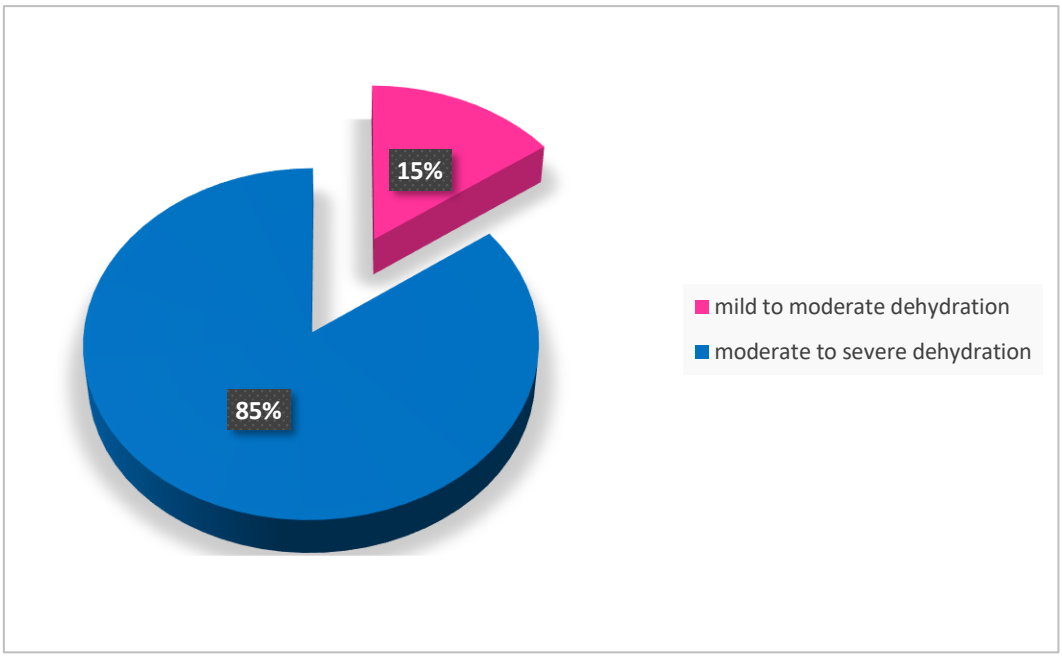


**Figure 18 :** level of dehydration in children with AGE

Hospitalized children account for 85% of moderate to severe dehydration cases.

### 12.3 Based on therapeutic approach:

- **Dehydration treatment:**

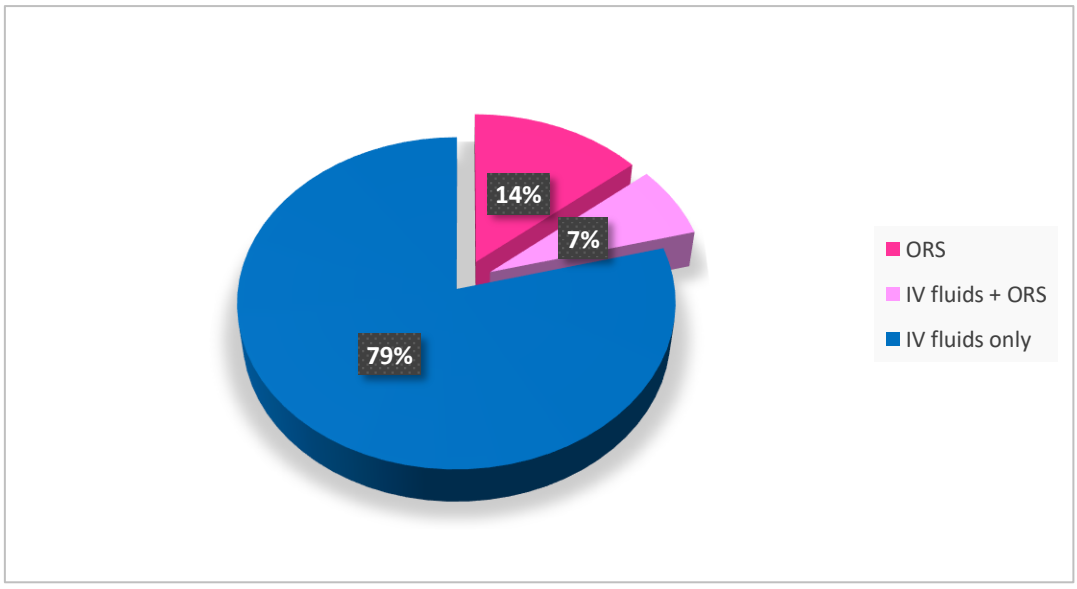


**Figure 19 :** proportion of ORS, IV, and combined rehydration treatment

IV fluids alone were used in 79% of cases, followed by oral rehydration solution in 14%, while 7% of patients received both IV and ORS therapy.

- **Pre-hospital antibiotic use:**

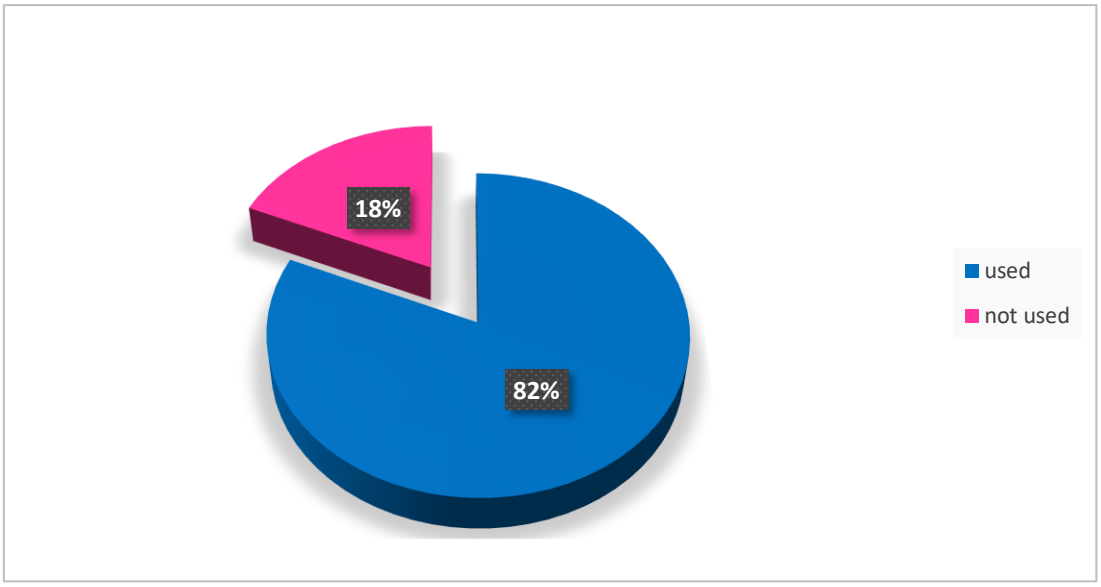


**Figure 20** : antibiotic use before hospitalization

82% of cases used antibiotics before hospitalization.

- **Previous hospitalization in the study population:**

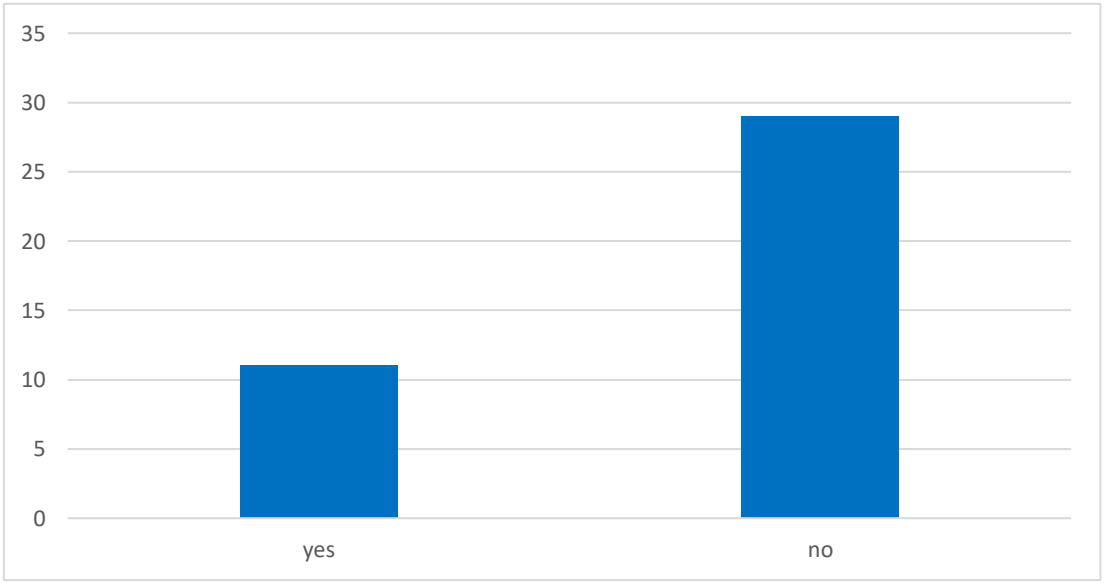


**Figure 21 :** hospitalization history in the study group

The majority of patients had no history of hospitalization.

- **Duration of hospitalization:**

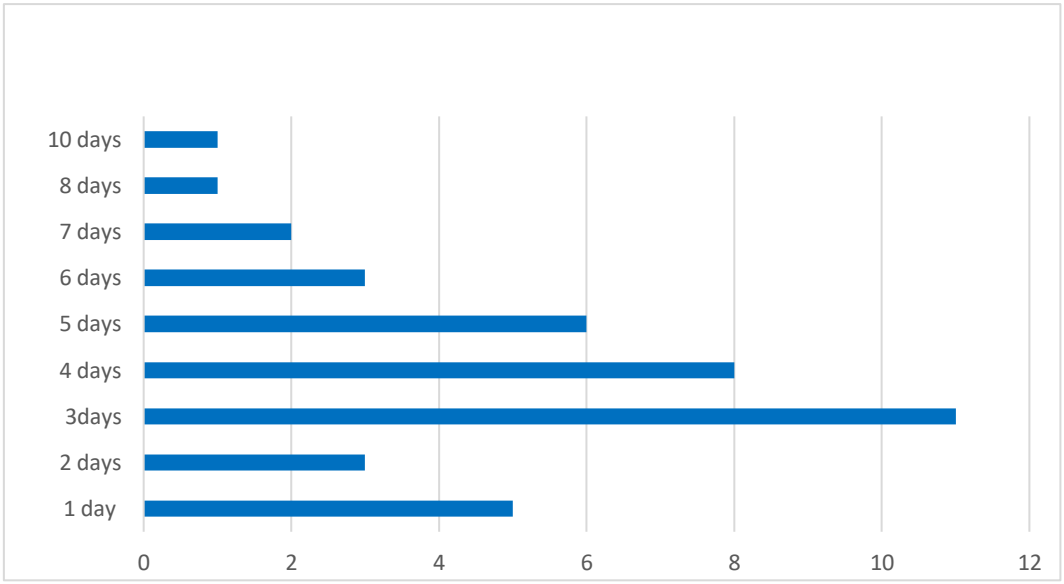


**Figure 22 :** hospital stay duration in the study population

The majority of patients had a hospital stay of 3 days.

## 13 Discussion:

Among 40 patients, AGE was more common in children aged between 3 and 9 months due to their immature immune system (Khales *et al.*, 2024).

A male predominance of 55% was observed possibly due to the fact that boys tend to play outside more frequently than girls so they are more exposed to bacterium and parasites (Saeed & Ibrahim, 2023).

The higher exposure of middle income families to AGE suggests that hygiene and living conditions are not the sole contributing factors to the disease (Simonsen *et al.,* 2008).

The consumption of mineral water is more common among reported cases compared to tap and well water; however, bottled water may become contaminated by improper storage (Raj, 2005). Although, well and tap water are used less frequently, they pose higher risk of contamination when not properly treated (Ashbolt, 2004).

Children who are exclusively formula-fed are generally more affected by AGE compared to those who are breastfed due to the lack of maternal antibodies. Breast milk contains antibodies that protect the infant's gut from several viruses and bacteria (Rogier *et al.*, 2014).

77% of the study patients experienced watery stools, most likely due to the cold weather during the winter season (October–April), which corresponds to the peak season for viral infections. These viral agents include norovirus and rotavirus (Ahmed *et al.*, 2013; Rohayem, 2009). These viruses are known to infect and damage the intestinal villi, leading to malabsorption and increased secretion of fluids and electrolytes, ultimately resulting in watery diarrhea (Lorrot & Vasseur, 2007).

A *Giardia lamblia* infection may be the cause of the greasy diarrhea, which made up 13% of the study cases and usually showed as greasy, foul smelling stools (Adam, 1991).

Invasive bacterial pathogens including *Salmonella spp*, *campylobacter*, or enterohemorrhagic *Escherichia coli* (EHEC), which are known to induce intestinal bleeding, may be responsible for 5% of cases with bloody diarrhea (Mota *et al.*, 2010).

Muco-bloody diarrhea is usually caused by *Entamoeba histolytica*. This protozoan colonizes the intestinal mucosa leading to the presence of blood and mucus in stools (Espinosa-Cantellano & Martínez-Palomo, 2000).

A stool frequency of six times per day is the most common reported among the study cases indicating the severity level seen in AGE patients (Strand *et al.,* 2012).

Vomiting cases represent 85%, which is likely due to the fact that vomiting is a prominent symptom of viral gastroenteritis (Liu *et al.,* 2005)

Bacterial infections typically present with fever (El-Radhi, 2019). However, in our case, the findings suggest that the patients were affected by viral gastroenteritis, which may explain why most of them had low grade fever or none (El-Radhi, 2019).

The high rate of abdominal pain observed is likely due to the nature of gastroenteritis, which affects the stomach and the intestines and irritates the intestinal walls, leading to abdominal pain (Stuempfig *et al.,* 2025).

Approximately 85%of hospitalized children with gastroenteritis presented with moderate to severe dehydration, primarily due to the condition's symptoms (vomiting and diarrhea) (Zodpey *et al.,* 1998) which cause significant fluid and electrolyte loss (Alharbi *et al.,* 2024).

The severity of dehydration and patient's ability to tolerate oral intake determine the appropriate rehydration method. Intravenous (IV) fluids alone where used in 79% of cases because they offer a faster and more reliable means of rehydration (Toaimah & Mohammad, 2016), especially for children who refuse or unable to drink. Oral rehydration solution (ORS) alone were used in 14% of the cases, typically in children with mild dehydration who could effectively drink (Spandorfer *et al.,* 2005). A combined approach using both IV fluids and ORS was employed in 7% of cases, usually during the transition phase when the patient's condition improved and oral intake is possible (Churgay & Aftab, 2012).

Approximately 82% of patients had used antibiotics prior to hospitalization, suggesting a lack of parental awareness regarding the consequences of improper antibiotic use. Misuse of antibiotics can disrupt the body's microbiota, potentially reducing the effectiveness of future treatments and contributing to antibiotic resistance (Ramirez *et al.,* 2020; English & Gaur, 2009).

Most of the patients (29 out of 40) had never been hospitalized before getting infected with acute gastroenteritis. This shows that the illness was probably picked up on everyday settings through contaminated food, unclean water, or poor hygiene, rather than during a hospital stay. However, 11 patients did have history of hospitalization due to the same condition. This might suggest that those individuals were repeatedly exposed to the same sources of infection.

The majority of cases had a hospital stay of 3 days, indicating that acute gastroenteritis can often be effectively managed within a short period of time if appropriately treated.

## CONCLUSION:

In conclusion, the study identifies the major factors of child morbidity due to pediatric gastroenteritis and its impact on children. The results show that acute gastroenteritis affects toddlers aged between 3 and 9 months, with a high male predominance. Moreover, Hygiene, water sources, and feeding practices are the main contributing factors of the disease. As a result, this research targets especially parents and raises awareness about the importance of sanitation, breastfeeding, and the wise use of antibiotics.

However, the study was conducted over a short period of time with limited access to samples. In addition, the lack of access to laboratory methods to investigate the specific pathogen responsible might affect the generalizability of the findings.

Viruses, bacteria and parasites are key drivers of acute gastroenteritis, causing high rate of morbidity and mortality worldwide, particularly in developing countries. Further research is crucial to develop accessible diagnostic tools that provide effective and rapid results.

Eventually, addressing this crisis requires both early detection and public sensitization to ensure effective rehabilitation.

**Recommendations**:

It is recommended to raise awareness among parents about the symptoms and the risks of this disease. Promoting early diagnosis can reduce morbidity and mortality rates of children with acute gastroenteritis.

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# ANNEXES

# Annexes:

**Annexe 1:**

**Questionnaire (English) :**

1. **Patient information**

- **Full name** : _____
- **Sex** : ☐ Male ☐ female
- **Age** : _____months

2. **Feeding history :**

- **Type of breastfeeding :**

☐ Exclusive

☐ Mixed

☐ Formula

3. **Medication and symptoms**

- **Has the child taken antibiotics recently?**

☐ Yes ☐ No

- **Is there a history of fever?**

☐Yes ☐ No

- **If yes, what was the recorded temperature?**

_____C°

- **Is there vomiting?**

☐Yes ☐ No

4. **Diarrhea information**

- **Type of diarrhea:**

☐Watery

☐Bloody

☐Mucoid

☐Mixed

- **Number of stools per day**: _____times
- **Is there abdominal pain:**

☐Yes ☐ No

**5. Dehydration and Hospitalization**

- **Dehydration status:**

☐Mild

☐Moderate

☐Severe

- **History of previous hospitalizations:**

☐Yes ☐ No

- **Rehydration methods used:**

☐Oral rehydration solution (ORS)

☐Intravenous (IV) fluids

☐Both

**6. Living conditions:**

- **Type of water consumed at home:**

☐Tap water

☐Mineral water

☐Well water

- **What is your household's monthly income?**

☐Low income

☐Middle income

☐High income

7. **Hospital stay:**

- **Date of admission: _____**
- **Date of discharge: _____**

**Questionnaire (Français) :**

1. **Informations sur l'enfant**

- **Nom complet :** _____
- **Sexe** : ☐Garçon ☐Fille
- **Age** : _____mois

2. **Antécédents d'allaitement**

- **Type d'allaitement :**

☐Exclusif

☐Mixte

☐Artificiel

3. **Médicaments et symptômes**

- **L'enfant a-t-il pris des antibiotiques récemment ?**

☐Oui ☐ Non

- **Présence de fièvre ?**

☐Oui ☐Non

- **Température mesurée** :

_____°C

- **Présence de vomissements ?**

☐Oui ☐ Non

4. **Informations sur la diarrhée**

- **Types de la diarrhée :**

☐Aqueuse

☐Sanglante

☐Mucosanglante

☐Mixte

- **Nombre de selles par jour : _____ fois**
- **Douleurs abdominales ?**

☐Oui ☐ Non

**5. Etat de déshydratation et hospitalisation**

- **Etat de déshydratation :**

☐Légère

☐Modérée

☐Sévère

- **Antécédents d'hospitalisation ?**

☐Oui ☐ Non

- **Méthode de réhydratation utilisées :**

☐Solution de réhydratation orale (SRO)

☐Perfusion (IV)

☐Les deux

**6. Conditions de vie**

- **Type d'eau consommée à la maison :**

☐Eau de robinet

☐Eau minérale

☐Eau de puits

- **Niveau de revenu de ménages :**

☐Faible

☐Moyen

☐Élevé

7. **Séjour à l'hôpital**

- **Date d'admission : _____**
- **Date de sortie : _____**

**Annexe 2 :**

**Sammary table (English) :**

| patient | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| age | | | | | |
| sex | | | | | |
| Type of breastfeeding | | | | | |
| Antobiotics intake | | | | | |
| fever | | | | | |
| vomiting | | | | | |
| Type of diarrhea | | | | | |
| Number of stools per day | | | | | |
| Abdominal pain | | | | | |
| Dehydration status | | | | | |
| History of hospitalization | | | | | |
| Rehydration methods | | | | | |
| Type of water consumed at home | | | | | |
| Income level | | | | | |
| Admission date | | | | | |
| Discharge date | | | | | |

**Tableau récapitulatif (français) :**

| patient | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| age | | | | | |
| sexe | | | | | |
| Type d'allaitements | | | | | |
| La prise d'antibiotique | | | | | |
| Fièvre | | | | | |
| vomissement | | | | | |
| Type de la diarrhée | | | | | |
| Nombre de selles par jour | | | | | |
| Douleurs abdominaux | | | | | |
| État de deshydratation | | | | | |
| Antécédent d'hospitalisation | | | | | |
| Méthode de Rehydration | | | | | |
| Type d'eau consommée à la maison | | | | | |
| Niveau de revenu de ménages | | | | | |
| Date d'admission | | | | | |
| Date de sortie | | | | | |

الجمهورية الجزائرية الديموقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة عبد الحميد بن باديس-مستغانم-

كلية علوم الطبيعة والحياة

# تصريح شرفي خاص بالالتزام بقواعد النزاهة العلمية لإنجاز البحث

أنا الممضي أدناه،

الطالب(ة): شرماط سيري حمزة ..... رقم التسجيل الجامعي: 31.34.223

الحامل لبطاقة التعريف الوطنية رقم: 40.44.24.38 ... والصادرة بتاريخ: 2023/01/24

عن بلدية سيدي علي مستغانم .

المسجل ب كلية علوم الطبيعة والحياة/ قسم البيولوجيا .....

شعبة العلوم البيولوجية / التخصص ميكروبيولوجيا تطبيقية

والمكلف بإنجاز مذكرة ماستر بعنوان:

Acute Gastroenteritis (AGE) in children under 5 years old in "Hamadou Houcine SidiAli Hospital" Mostgane

أصرح بشرفي أني ألتزم بمراعاة المعايير العلمية والمنهجية ومعايير الأخلاقيات العلمية والنزاهة الأكاديمية المطلوبة في إنجاز البحث ، وأتحمل المسؤولية الشخصية عن كل المحتوى المتضمن في البحث المذكور أعلاه .

التاريخ: 2025.06.29

إمضاء المعني

* ملحق القرار الوزاري رقم 933 المؤرخ في 28 جويلية 2016 الذي يحدد القواعد المتعلقة بالوقاية من السرقة العلمية ومكافحتها.