CEP Clin Exp Pediatr Vol. 68, No. 5, 379–387, 2025
https://doi.org/10.3345/cep.2024.01333

Original article

Enteric pathogens implicated in acute infectious diarrhea among young children in resource-limited region with rapidly growing population: a hospital-based cross-sectional study

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Background: Acute infectious diarrhea is among the leading causes of morbidity and mortality worldwide, particularly in developing countries and among children younger than 5 years of age.

Purpose: To determine the causative microorganisms in diarrhea and elucidate their epidemiological trajectory among children younger than 5 years of age to establish successful preventive measures.

Methods: This cross-sectional study was conducted in Al-Musayyib District, Babil Governorate, Iraq, using data from January 2023 to January 2024 provided by the information system of Ibn Saif Children's Hospital and Al-Musayyib General Hospital. Data from 300 children under 5 years of age with infectious diarrhea were collected to determine the causative pathogens. Patient data including sex, age, treatment, and posttreatment clinical condition, were collected from the hospital archive and analyzed.

Results: Overall, 56% of males and 44% of females had diarrhea. The 1–2-year age group was the most susceptible to diarrhea (33.3%). This rate gradually decreased with age, reaching 9.9% in the 4–5-year age group. Furthermore, bacteria were the causative organisms in 43% of cases, followed by viruses, parasites, and fungi at 24.7%, 12%, and 7.7%, respectively. Mixed infections were detected in 12.6%. Posttreatment, 89.7% of patients completely recovered, 8% experienced physiological disorders, and 2.3% died.

Conclusion: Bacteria were the most common causative organisms of infectious diarrhea among children younger than 5 years of age. Children in the 1–2-year age group were the most commonly affected. This study highlights that diarrhea continues to threaten the lives and well-being of children.

Key words: Acute infectious diarrhea, Enteric pathogens, Young children, Antibiotics, World Health Organization

Key message

Question: What are the most common enteric pathogens in acute diarrhea among children younger than 5 years of age, and which age group is most susceptible?

Finding: Bacteria were the most common causative microorganisms of diarrhea, followed by viruses, parasites, and fungi. The 1–2-year age group was the most commonly affected.

Meaning: There is a need to formulate preventive strategies targeting children exposed to enteric pathogens to limit diarrhea.

Introduction

Gastrointestinal infections, predominantly food- and water-borne, remain a major burden on global public health due to high morbidity and mortality rates, especially among children under 5 years of age.[1] Diarrhea is a common symptom associated with gastrointestinal infections. It is characterized by frequent and watery feces with a loose or liquid consistency, occurring 3 or more times daily or beyond the individual's typical baseline frequency. Diarrhea results as a direct consequence of excessive intestinal secretions or impaired absorption of fluids and electrolytes, including sodium, chloride, potassium, and bicarbonate, across the intestinal epithelium.[2,3]

Globally, diarrhea is recognized as the second most prevalent cause of death among children after pneumonia. Every year, about 1.7 billion children develop diarrhea, and at least 525,000 of them are at risk of death.[2] According to the United Nations International Children's Fund, 88% of the total deaths resulting from diarrhea in 2015 were concentrated in South Asia and sub-Saharan Africa.

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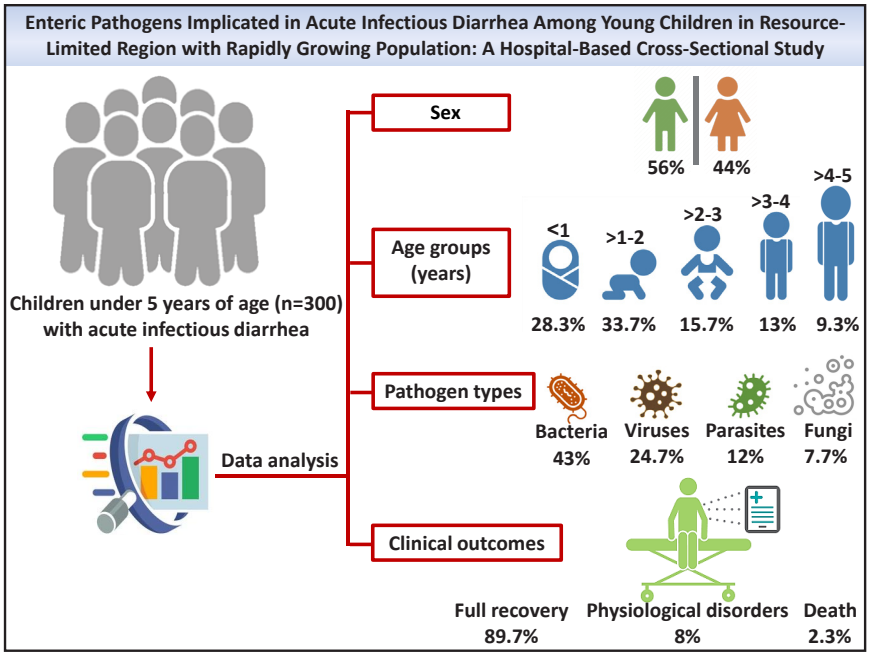
Received: 4 September 2024, Revised: 20 November 2024, Accepted: 21 November 2024



Graphical abstract

Children under 5 years of age in these areas suffer from high rates of diarrhea with at least 3 episodes annually.[4] During episodes of diarrhea, the affected child can suffer from dehydration when decompensated, leading to a series of physiological disorders.[5] This in turn may result in malnutrition, stunting, and a compromised immune system, making the affected child more vulnerable to recurring episodes of diarrhea and other diseases in the future like delayed brain development.[3]

Diarrhea is categorized based on symptoms and their duration into 2 primary clinical types and they are acute and chronic. Acute diarrhea is a condition in which diarrhea lasts for 3 or more consecutive days, not exceeding 14 days.[6] Acute diarrhea is not only the most prevalent, but also poses a significant risk factor for nutritional depletion, severe dehydration, and mortality, particularly, among children. While chronic diarrhea is long-term diarrhea that usually lasts more than 4 weeks and is not necessarily preceded by an initial severe episode of diarrhea. Chronic diarrhea can lead to digestive disorders that may harm the child's developmental trajectory.[7,8] Medical practitioners often employ the frequency of defecation and stool consistency and volume as fundamental diagnostic criteria to differentiate between acute and chronic diarrhea. This diagnostic approach allows for a more accurate assessment of the patient's condition and guides subsequent therapeutic interventions aimed at alleviating symptoms and restoring gastrointestinal homeostasis.[9]

Gastrointestinal infections that result in diarrhea are often caused by pathogenic bacteria (such as *Escherichia coli* and *Salmonella* spp.), viruses (such as *rotavirus* and *norovirus*), parasites (such as *Entamoeba histolytica* and *Giardia lamblia*), and fungi (such as *Candida* spp.).[10] The most common routes of infection transmission are either direct transmission from an infected person to a healthy person via fecal-oral transmission, or indirect transmission via food or water contaminated with pathogens.[9]

After invading a host, the incubation period usually depends on the type of pathogen. In this context, it has been observed that the incubation period for bacterial infection ranges from 1 hour to 14 days depending on the type of invading bacteria.[11] For instance, the incubation period for Staphylococcus aureus is 1 hour, while it is up to 7 days for *Shigella* spp.[12] Regarding virus-associated diarrhea, the incubation period for *rotavirus* can be up to 48 hours.[13] In contrast, the incubation period for parasites that cause diarrhea may reach several weeks or months. Watery diarrhea is usually caused by toxins produced by pathogenic microorganisms.[9,10] The toxins produced in turn stimulate the release of pro-inflammatory cytokines and necrosis of the intestinal epithelium, causing disruption of the intestinal epithelium and decreased absorption of water and digestible disaccharides.[10]

To know measures to prevent diarrhea caused by microbial infections and limit its prevalence, conducting field studies is paramount. Given the scarcity of research assessing the prevalence of infectious diarrheal disease among children in Al-Musayyab District, Babil Governorate, Iraq, this study was performed to identify enteric pathogens implicated in diarrheal occurrences in children younger than 5 years of age to formulate an effective policy to control it.

Methodology

1. Area and community of study

This study was carried out in Al-Musayyib, which is a district in Babil Governorate in the middle Euphrates region, Iraq. Al-Musayyib District is situated 65 km to the south of Baghdad's Capital. According to the current geospatial survey, the area of Musayyib District is approximately 928 km^2, and its population is about 436,108 individuals, as recorded in the latest census data from the year 2022. In general, the demographic landscape of the community in Musayyib District exhibits a predominantly urban-rural profile[14] (Supplementary Table 1).

2. Study design

A cross-sectional study was conducted to identify enteric pathogens implicated in diarrhea among children in Al-Musayyib District. The databases derived from Ibn Saif Children's Hospital and Al-Musayyab General Hospital were used, which covered the period from the 1st of January, 2023 to the 1st of January, 2024. In this research endeavor, the data of 300 children under 5 years of age with diarrhea associated with microbial infection were randomly recruited. These children had presented with acute infectious diarrhea, necessitating their admission to the pediatric ward of Al-Musayyib General Hospital and the internal medicine ward of Ibn Saif Children's Hospital. This study documented statistical information about diarrheal children, including type of pathogen, sex, age, treatments, and clinical condition posttreatment.

3. Hospital protocol for identifying pathogens of diarrhea

After obtaining the patient's personal information, including sex, age, symptoms, and duration of diarrhea, a comprehensive clinical examination was performed under the supervision of a physician specialist. In most instances, the attending physician recommends a stool sample analysis to elucidate the etiology of the diarrheal episode. A meticulously collected stool sample was subjected to rigorous microscopic examination for general diagnostic purposes. Afterward, the sample was subjected to culture and bacteriological tests for the purpose of differential diagnosis and identification of the pathogen type.

To identify bacteria implicated in diarrhea, the sample was exposed to direct plating on enrichment media such as blood agar and selective media such as MacConkey agar and inoculated into peptone and tetrathionate broth as a selective enrichment medium. The plates were then incubated at 37°C for 18–24 hours. Biochemical tests were conducted to identify bacterial isolates using the analytical profile index (Api20E) system and specific agglutinating antisera. At the same time, immunochromatographic assay and enzyme-linked immunosorbent assay were applied to detect viruses implicated in diarrhea among children. Also, the presence of parasites in stool samples was determined using the stool wet mount and stained smears. The slides were then undergone microscopic examination for the parasites and/or their ova or cysts. To identify fungi, the stool sample was placed on a culture medium that enhances the fungal growth such as Sabouraud's dextrose agar and CHROMagar Candida. The plates were incubated at 30°C–35°C for 24–48 hours. After incubation, fungal counts were detected by a colony-forming unit (CFU). The fungal counts of $>10^4$ CFU/mL were considered overgrowth and therefore significant for diarrheal infection. Fungal species were identified based on the color and morphology of colonies. The isolates were then subjected to microscopic examination for further identification.

Finally, the clinical findings were meticulously recorded and preserved within the hospital's extensive archival system for future reference and scholarly perusal, as these records constituted the research basis for the current study.

4. Exclusion criteria

During the investigative examination, special emphasis was placed on data related to diarrhea in children under 5 years of age, that were of microbial etiology. To maintain the utmost clarity and precision in our analysis, any cases of diarrhea attributed to causes other than microbial infections such as metabolic disease, children with hospital-acquired diarrhea, and those with a history of gastrointestinal surgery were excluded.

5. Data processing and analysis

Statistical analysis was carried out using the Graph Pad Prism 8 program. The chi-square test was used to determine the relationship between variables. A P value <0.05 was considered to be statistically significant.

6. Ethical consideration

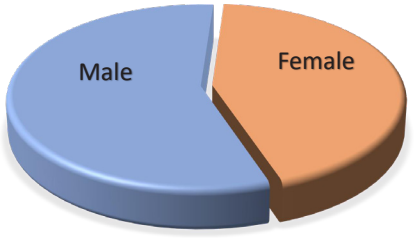
This study was conducted in accordance with the ethical principles established by the Declaration of Helsinki and the Code of Ethics in Research 2018 (The Ethical Guide for Implementing Health Research at Institutions of the Ministry of Health, Iraq). This study did not entail field-based methods and relied on data available in the hospital archive. Written approval was obtained from the institution that owns this archive.

Results

The current study included cases of acute infectious diarrhea as defined by the World Health Organization (WHO), which is characterized by the persistence of loose, watery stools for more than 72 hours, without exceeding the time threshold of 14 days.[2] Among the total patients, data related to the patient's profile, such as sex, age, and the types of pathogens along with treatments were recorded. Clinical outcomes and the extent of patients' response to treatment were ultimately determined.

As shown in Fig. 1, the acute infectious diarrhea rate in males was 56%, while in females, it was 44%. This result indicates that diarrhea can affect males and females, with no statistically significant differences in the prevalence of diarrhea between them, $P>0.05$.

The prevalence of acute infectious diarrhea among age groups was also determined. As illustrated in Fig. 2, the results showed that the diarrhea rate in the age group (0–1 year) was 28.3%. It was also clearly observed that the diarrhea rate increased in the age group (>1–2 years) to 33.7%. The diarrhea rate gradually decreased with aging, as follows: 15.7% of those aged >2–3 years, 13% of those aged >3–4 years, and 9.3% of those aged >4–5 years, with a statistically significant difference, $P<0.05$.



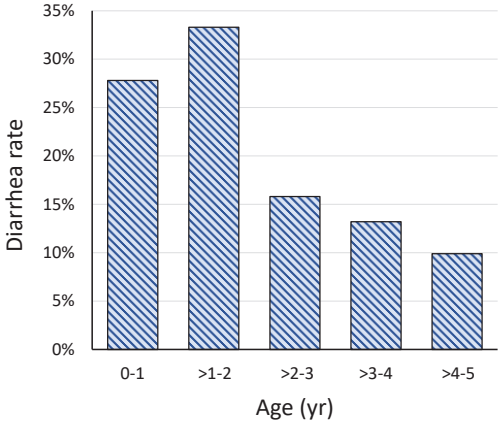
Sex	Frequency (%)	*P* value
Male	168 (56)	>0.05
Female	132 (44)	

Fig. 1. Proportions of acute infectious diarrhea cases by sex.

The present study also investigated the types of enteric microorganisms that caused cases of diarrhea in children under 5 years of age. The results demonstrated that bacteria recorded the highest prevalence among total diarrhea cases, reaching 43%, distributed as follows: *E. coli* (44.2%), *Enterobacter* spp. (27.9%), *Salmonella* spp. (14%), *Pseudomonas aeruginosa* (7.7%), *Shegilla* spp. (6.2%). The results also showed that viruses were the second most common microorganism isolated among children with diarrhea, with a rate of 24.7%. The *rotavirus* was observed to be the sole cause of all cases of viral diarrhea, at a rate of 100%. While the percentage of diarrhea cases caused by parasites reached 12%, including *E. histolytica* at 75% and G. lamblia at 25%. Moreover, the results displayed that the prevalence of fungal infection was the lowest among total cases, reaching 7.7%, and involved *Candida albicans* and *Candida krusei* by 73.9% and 26.1% respectively. In addition, the data obtained revealed that the polymicrobial (mixed) infections implicated in diarrhea cases in children younger than 5 years of age were 12.6% of total cases, as

Table 1. Enteric pathogens causing diarrhea among children younger than 5 years of age

Pathogen isolated	No. (%)
Bacteria	129 (43)
Escherichia coli	57 (44.2)
Enterobacter spp.	36 (27.9)
Salmonella spp.	18 (14)
Pseudomonas aeruginosa	10 (7.7)
Shigella spp.	8 (6.2)
Viruses	74 (24.7)
Rotavirus	74 (100)
Parasites	36 (12)
Entamoeba histolytica	27 (75)
Giardia lamblia	9 (25)
Fungi	23 (7.7)
Candida albicans	17 (73.9)
Candida krusei	6 (26.1)
Mixed infection	38 (12.6)



Age	Frequency (%)	*P*-value
0-1	85 (28.3)	<0.05
>1-2	101 (33.7)	
>2-3	47 (15.7)	
>3-4	39 (13)	
>4-5	28 (9.3)	

Fig. 2. Proportions of acute infectious diarrhea cases by age group.

described in Table 1.

Regarding cases of diarrhea caused by mixed infections, it was noted that the most common correlation was between bacteria and bacteria (31.6%), followed by bacteria and viruses (23.7%). In mixed bacterial infections, the predominant constellation was between *E. coli* and *P. aeruginosa* at 50%, followed by *E. coli* and *Enterobacter* spp. at 25%. Concerning the rate of mixed cases between bacteria and viruses, *E. coli* and *rotavirus* were found to be 55.6%, followed by *Shigella* spp. and *rotavirus* at 22.2%, as represented in Table 2.

In addition, the database reflected that the oral rehydration solution (ORS) was used as the key treatment for dehydration and electrolyte loss caused by diarrheal episodes. However, antibiotics were judiciously prescribed to children who had acute infectious diarrhea with severe clinical symptoms. The type and dosage of prescribed antibiotics were administered according to the type of pathogen identified and the age/weight of the hospitalized children (Supplementary Table 2). It was observed that antibiotics (such as azithromycin, cefixime, ceftriaxone, gentamicin, and trimethoprim/sulfamethoxazole) were applied along with ORS in cases of diarrheal episodes resulting from bacteria. In the same context, metronidazole was used against parasitic infections, and Voriconazole for fungal infections. While diarrheal episodes caused by viruses were not treated with antibiotics, and an ORS was administered to prevent dehydration.

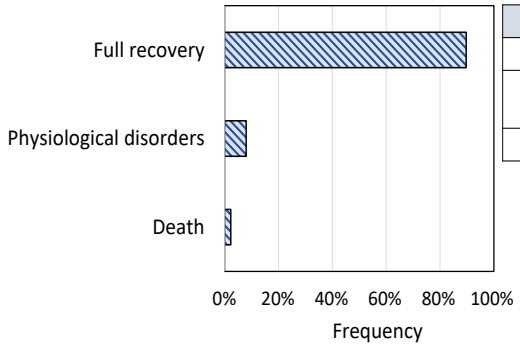
Table 2. Frequency of mixed infections causing diarrhea among children younger than 5 years of age

Mixed infection	No. (%)
Bacteria + bacteria	12 (31.6)
Escherichia coli + *Pseudomonas aeruginosa*	6 (50)
Escherichia coli + *Enterobacter* spp.	3 (25)
Salmonella spp. + *Shigella* spp.	2 (16.7)
Enterobacter spp. + *Pseudomonas aeruginosa* + *Shigella* spp.	1 (8.3)
Bacteria + viruses	9 (23.7)
Escherichia coli + *Rotavirus*	5 (55.6)
Shigella spp. + *Rotavirus*	2 (22.2)
Pseudomonas aeruginosa + *Rotavirus*	2 (22.2)
Bacteria + fungi	5 (13.1)
Escherichia coli + *Candida albicans*	3 (60)
Salmonella spp. + *Candida albicans*	1 (20)
Escherichia coli + *Pseudomonas aeruginosa* + *Candida albicans*	1 (20)
Fungi + fungi	4 (10.5)
Candida albicans + *Candida krusei*	4 (100)
Viruses + fungi	3 (7.9)
Rotavirus + *Candida albicans*	3 (100)
Bacteria + parasites	2 (5.3)
Enterobacter spp. + *Giardia lamblia*	2 (100)
Parasites + fungi	2 (5.3)
Entamoeba histolytica + *Candida albicans*	2 (100)
Bacteria + viruses +fungi	1 (2.6)
Shigella spp. + *Rotavirus* + *Candida albicans*	1 (100)

According to the patient data documented in the hospital's archives, a comprehensive analysis of the patient's response to treatment after diarrheal episodes was performed. The data showed that 89.7% of patients were fully recovered. While, 8% of patients did not fully recover and suffered from recurrent diarrhea, resulting in malnutrition. This in turn caused physiological disorders of their immune system and respiratory infections. Regrettably, the data also disclosed that 2.3% of patients died, most of whom were under 2 years of age. It was also demonstrated that *E. coli* and *rotavirus* were the most implicated as a single or mixed infection in causing acute infectious diarrhea and serious complications that resulted in death (Fig. 3).

Discussion

A hospital-based cross-sectional study was conducted to investigate the types of microorganisms implicated in diarrhea among children younger than 5 years of age. This study targeted Babil Governorate, Iraq, specifically in the Al-Musayyib District, which has a demographically diverse community between urban and rural. The District of Al-Musayyib is witnessing increasing population growth, as its population reached approximately 241,004 people in 1997, reaching 436,108 in 2022.[14] In this regard,



Cases	Frequency (%)	*P* value
Full recovery	269 (89.7)	<0.05
Physiological disorders	24 (8)	
Death	7 (2.3)	

Fig. 3. Posttreatment outcomes of children with diarrhea.

several studies have suggested that areas with a high population can be accompanied by a high number of children.[5,8] High population growth combined with poor social and economic conditions such as lack of health awareness and increasing financial challenges plays a role in the prevalence of diseases among children, including diarrhea. In the same context, Al-Musayyib District suffers from fluctuation in the efficiency level of health services, between positive-effective and negative-low. The large population growth accompanied by fluctuations in health indicators may be a major reason for increasing the chance of developing acute infectious diarrhea. Consequently, the current study in the Al-Musayyib District can reflect a similar image to many cities in Iraq and the world that have the same indicators.

The current study showed that there was no significant difference in the rate of acute infectious diarrhea between males and females. This suggests that sex was not a marked risk factor for infectious diarrhea. This outcome was consistent with several studies conducted in northeastern Ethiopia,[15] Kenya,[16] and Uganda.[17] However, the slight difference in incidence between males and females could be attributed to age, environmental, and sociodemographic agents.[18] For instance, the reason behind the slightly elevated incidence of diarrhea in males may be due to the increased propensity for them to engage in activities that involve interaction with the external environment such as playing outside the domestic abode and ingesting food tainted by pathogenic agents.[5]

It was also revealed that the age group of children between 1–2 years are more susceptible to diarrhea cases than their counterparts from other age groups. This epidemiological pattern was compatible with previous research conducted in Bangladesh,[19] Uganda,[20] and Ghana.[8] The increase in diarrheal episodes during the developmental stage is most likely attributed to the heightened exposure to enteric pathogens. This is due to the onset of the weaning process and the subsequent introduction of solid foods into the infant's diet, which inadvertently exposes the immature digestive system to a more diverse and potentially pathogen-rich environment.[10,21] In contrast, the decrease in the rate of diarrhea cases among children at the later stages of their development can be explained by the immune development due to the recurrence of diarrheal episodes. Further, the increase in the child's perceptual awareness of age progress can contribute to reducing the incidence of foreign and contaminated bodies being introduced into their oral cavities.[21]

The outcomes also recorded that bacteria were the most prevalent among cases of total diarrhea by 43%. This outcome corresponded to similar studies carried out in Iraq in Baghdad,[22] Dohuk,[23] and Kirkuk,[24] where these studies reported that bacteria occupied the highest percentage of microbial causes of diarrhea in children, reaching 58.33%, 81.61%, and 89% respectively. On the contrary, Erbil, an Iraqi Governorate in the Kurdistan region, recorded a low prevalence of bacterial infection by 34.5% among cases of diarrhea in infants and children.[25]

In the same context, viruses were the second most implicated in diarrhea among children, with a rate of 24.7%, followed by parasites at 12%. Similar results of a study conducted in Dohuk Governorate, Iraq reported that the prevalence of viral infections among children with diarrhea reached 13.21%, followed by parasitic infections at a rate of 4.02%.[23] These results were also consistent with other studies performed in Iraqi provinces such as Dhi Qar[26] and Babil,[27] and other studies in neighboring countries like Saudi Arabia.[28] On the other hand, the results were contrary to the findings of a study carried out in Iran, which showed that parasitic infection was the highest microbial cause of diarrhea in children, with a rate of 78.6%.[29]

Moreover, the results showed that fungal infection was the lowest among total cases by 7.7%. This finding was in agreement with studies conducted in Dohuk Governorate and Zakho City, Iraqi Kurdistan, as the prevalence of fungal infection in children with diarrhea was 0.95% and 1.16% respectively.[23,30] In contrast, some studies performed in different regions of Iraq recorded higher rates of diarrhea caused by fungal infections in children reaching 29.15% in Baghdad Governorate,[31] 25% in Kirkuk Governorate,[24] and 2.5% in Tikrit City.[21]

Additionally, the outcomes indicated that the rate of diarrhea cases caused by mixed infections was 12.6%, which refers to the concurrent presence and pathogenic activity of 2 or more microorganisms within the host's gastrointestinal tract. In this context, several studies reported that diarrhea among children can result from mixed infections.[5,30] Further, the findings showed that the most common correlation in the cases of mixed infections was between bacteria and bacteria, followed by bacteria and viruses.

Although the aforementioned data were consistent with a multitude of preceding investigations, they simultaneously revealed a divergent epidemiological trajectory in other scholarly studies. This discrepancy may be attributable to many interrelated determinants such as demographic diversity, economic situation, level of healthcare services, public health consciousness, and climatic conditions.[6,21]

Many studies have reported that there is a relationship between cases of diarrhea in children and malnutrition, which can eventually lead to death. Diarrhea leads to the loss of water and electrolytes through watery stools,

causing dehydration and malnutrition when they are not replaced. In the same context, malnutrition resulting from diarrheal episodes weakens the mucous barrier in the digestive system and leads to disruption of the immune system. Thereby, malnourished children have a greater susceptibility to diarrhea, creating a vicious cycle.[2,6] On the other hand, malnutrition is associated with a deficiency of micronutrients such as zinc, vitamin A, and iron, which contributes to delaying the recovery of digestive system tissues damaged by diarrhea. This in turn causes prolonged diarrhea and high mortality rates among children.[32] Additionally, children with acute diarrhea may be exposed to pneumonia, especially those who suffer from malnutrition. This can be attributed to a weak immune system and low levels of Alpha-1 antitrypsin, which is an enzyme that supports protecting the lungs.[6]

In the present study, several antibiotics were used to treat children with acute infectious diarrhea. Although antibiotics have effectiveness against most bacteria, parasites, and fungi and may reduce the duration and severity of symptoms,[10] they were used here for severe, prolonged, or complicated cases. The indiscriminate administration of antibiotics can disrupt the intestinal microbial environment. This occurs by killing beneficial bacteria that are sensitive to antibiotics and allowing multidrug-resistant bacteria to multiply, thus leading to a potentially detrimental shift in the microbial composition. Concurrently, a decrease in beneficial bacteria in the intestine leads to a reduction in the amount of short-chain fatty acids, especially butyric acid, which is a by-product of carbohydrate metabolism and is an essential source of energy for the intestinal mucous layer. Thereby, osmotic diarrhea occurs due to the high amount of carbohydrates in the intestine along with the weakening of the mucosa layer.[33] Furthermore, the administration of antibiotics at an early age can affect the immune system by disrupting the balance between T-helper 1 and T-helper 2.[34] In such cases, it is necessary to conduct comprehensive tests and use appropriate antibiotics with an integrated nutritional system.[6]

To prevent acute infectious diarrhea in children, the WHO recommended taking preventive measures. These measures include providing safe drinking water, paying attention to sanitation facilities, educating people through awareness programs on paying attention to children's hygiene and infection prevalence, and using appropriate vaccines and antibiotics after consulting a specialized physician. The WHO also induced using ORSs such as water and ORS, which mainly consists of water and salts (such as sodium chloride, potassium chloride, and trisodium citrate) and sugars (like glucose). Moreover, the WHO has endorsed the integration of a supplementary therapeutic regimen involving zinc supplementation. A course of complementary treatment for 10–14 days with zinc tablets (20 mg) dispersible in water contributes to reducing the duration of diarrhea and improving outcomes.[35]

In conclusion, this study elucidates the epidemiological landscape of diarrheal pathogens affecting children aged under 5 years in Al-Musayyib District, located within Babil Governorate, Iraq. The data recorded that the highest prevalence of acute infectious diarrhea among children was within the range of 2 years of age. This could be attributed to reasons related to the weaning stage and the use of solid foods that may be contaminated with pathogens. Through differential diagnosis, it was found that bacteria were the most common pathogens of diarrhea, while fungi were the least. Although most cases of acute infectious diarrhea were completely cured after treatment with ORSs and antibiotics, other cases left physiological disorders in the immune and respiratory systems. In addition, the complications of diarrhea such as severe dehydration and malnutrition resulted in some deaths. Consequently, this study paves the way for the development of public health strategies and measures aimed at ameliorating the burden of diarrhea and controlling it within this age group.

To control the prevalence of acute infectious diarrhea cases among children, it is necessary to take into account (1) the identification of the pathogen type, (2) the application of hygiene standards at the personal and public levels, and (3) therapeutic measures, as each has a profound and long-term impact on reducing the frequency of diarrhea episodes in childhood. Further, it should be focused on increasing health awareness and surveillance programs. Where weak planning, fragility of health surveillance activities, and loss of data in many rural and remote uncivilized areas remain important factors in hindering efforts to combat diarrhea. Therefore, accurate information is essential for planning, monitoring, evaluating the spread of the disease, and taking the necessary measures to combat endemic and epidemic diseases. Accordingly, the WHO in cooperation with local and global health institutions looks forward to continuing work towards eliminating diarrhea as a public health problem.

Footnotes

Supplementary materials: Supplementary Tables 1-2 are available at https://doi.org/10.3345/cep.2024.01333.

Conflicts of interest: No potential conflict of interest relevant to this article was reported.

Funding: This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments: The authors would like to acknowledge the staff of Ibn Saif Children's Hospital and Al-Musayyib General Hospital for their assistance in providing the data required for the current study. The authors also acknowledge Al-Iraqia University for providing research facilities.

Author contribution: Conceptualization: AMIA; Data curation: AMIA; Formal analysis: AMIA; Methodology: AMIA; Project administration: AMIA; Visualization: AMIA; Writing-original draft: AMIA; Writing-review & editing: AMIA, RMD

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How to cite this article: Al-Mashahedah AMI, Dhahi RM. Enteric pathogens implicated in acute infectious diarrhea among young children in resource-limited region with rapidly growing population: a hospital-based cross-sectional study. Clin Exp Pediatr 2025;68:379-87.