

A Cross-sectional Investigation of Gastroenteritis Inflicted by *Salmonella Typhi*, *Entamoebahistolytica* and *Giardia lamblia* in Karachi, Pakistan

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ABSTRACT

Background: Gastroenteritis is a global health concern affecting individuals of all ages and regions. The disease is caused by bacteria, viruses, and parasites, and is characterized by symptoms such as diarrhea, abdominal pain, and nausea. *Salmonella Typhi*, *Entamoeba histolytica*, and *Giardia lamblia* are three prevalent pathogens worldwide responsible for causing gastroenteritis.

Aim: To provide valuable insights into the prevalence, burden, and symptomatology of gastroenteritis caused by *S. Typhi*, *E. histolytica*, and *G. lamblia* in various areas of Karachi.

Methods: To gather data, official registers of hospital wards, outpatient departments (OPDs), and relevant diagnostic laboratories were consulted. Stool microscopy, blood culture, Typhi Dot, and/or Widal tests were performed and their results recorded. The study collected data from a total of 1029 patients.

Results: The frequency gastroenteritis rates (including cases of Typhoid, Amoebiasis, and Giardiasis), Typhoid fever, Amoebiasis, and Giardiasis were found as 71%, 57%, 30%, and 13% respectively.

Conclusions: Based on the findings, the most common symptom in Typhoid cases was fever, followed by headache and abdominal pain. In Giardiasis and Amoebiasis cases, pain in abdomen was the most frequently reported symptom. By understanding the epidemiology of gastroenteritis caused by these agents, this research will add to the advancement of effective public health approaches to prevent and control gastroenteritis outbreaks in the future.

Keywords: Gastroenteritis, Typhoid, Amoebiasis, Giardiasis, *Salmonella Typhi*, *Entamoeba histolytica*, *Giardia lamblia*

INTRODUCTION

Gastroenteritis is a global health concern, affecting individuals of all ages and regions. Around 4% of gastroenteritis is associated with water and 100,000 of peoples died annually. World Health Organization (WHO) has estimated 1.7 billion cases of gastroenteritis globally every year, leading to approximately 2.2 million deaths, particularly among young children in low- and middle-income countries.¹ The disease is caused by a range of infectious agents (bacteria, viruses, and parasites). Gastroenteritis is an inflammation of the digestive tract, typically characterized by symptoms such as diarrhea, abdominal pain, and nausea^{2,3}.

Three pathogens prevalent worldwide and commonly responsible for causing gastroenteritis are *S. Typhi*, *E. histolytica*, and *G. lamblia*. *S. Typhi* is a bacterium that causes typhoid fever, which is characterized by a high fever and gastrointestinal symptoms⁴. Every year about 22 million new incidences of Typhoid emerge which culminate into 200,000 deaths.¹ *E. histolytica* causes amoebic dysentery, which is characterized by bloody diarrhea⁵. More than 55000 *E. histolytica* related fatalities are being reported every year all over the world⁶. *G. lamblia* is a parasite that causes giardiasis, which is characterized by diarrhea, abdominal pain, stressing gas or bloating, steatorrhea, and epigastric discomfort⁷. *G. lamblia* upsets >200 million persons worldwide and is persisting with high prevalence in developing countries¹. In Karachi, it was found that *G. lamblia* was the most common parasite causing diarrhea in children, and that contaminated water was the main source of infection.⁸ Studies conducted in several countries found that contaminated water and food, poor sanitation and hygiene practices are the main sources of gastroenteritis, with young adults being at the highest risk of contracting the disease^{8,9,10}.

Moreover, the distressing gastrointestinal discomfort caused by these well-known organisms poses a significant threat to the community, as these diseases often spread through the ingestion of contaminated food and untreated water, primarily via the fecal-oral route¹¹. Hence, it is imperative to prioritize immediate and reliable surveillance, diagnostic approaches, and precautionary measures to effectively control and prevent epidemics^{12,13}. This retrospective study seeks to offer valuable insights into the symptomatology and burden of gastroenteritis inflicted by *S. Typhi*, *G. lamblia* and *E. histolytica* and also determines their prevalence in various areas of Karachi. By understanding the epidemiology of gastroenteritis caused by these agents, this research will add to the advancement of effective public health approaches to prevent and control gastroenteritis outbreaks in the future.

METHODOLOGY

After IRB permission the study was conducted retrospectively among patients of different age groups, including children (1-12 years), adolescents (13-18 years), adults (19-59 years), and senior adults (≥60 years) who sought medical care in hospitals in Karachi. The patients were from various areas categorized into five districts: Malir, East, West, Central, and South. The age classification followed the system established by Nithyashri and Kulanthaivel in 2012¹⁴.

Data collection and presentation: Data collection involved retrieving information from official registers of hospital wards, outpatient departments (OPDs), and relevant diagnostic laboratories, including gender, age, home address, symptoms/complaints, and the results of relevant diagnostic tests such as stool microscopy, blood culture, Typhi Dot and/or Widal tests. The data was organized chronologically by month in 2021 based on the patients' registration dates and the reporting of test results. The prevalence Proportion was calculated by the formula: Prevalence Proportion = No. of cases / No. of individuals in the study × 100,000.

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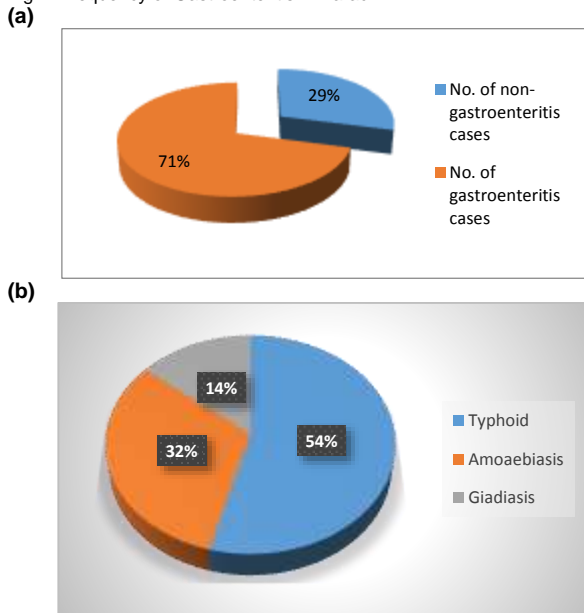
The data of 1029 patients was collected. The diagrams of Gastroenteritis (Amoebiasis, Typhoid and Giardiasis) in Karachi districts were produced by epi info software.

Statistical analysis: The n=385 sample size was estimated with 95% confidence level. The data was analyzed by the Microsoft Excel.

RESULTS

The prevalence proportion of gastroenteritis was determined by calculating the ratio of 730 cases to the total of 1029 cases, which was then multiplied by 100,000. This resulted in an estimate of 70,942 cases of gastroenteritis per 100,000 populations. The findings of this study revealed that Typhoid fever had the highest frequency with 416 cases (54%), followed by Amoebiasis with 218 cases (32%), and Giardiasis with 96 cases (14%). The frequency rates of gastroenteritis; Typhoid fever, Amoebiasis, and Giardiasis were calculated as 71%, 57%, 30% and 13% respectively (Fig. 1a and b). In Typhoid cases the most common symptom was fever, followed by headache and pain in abdomen. In Amoebiasis symptoms were pain in abdomen, vomiting, and diarrhea. The symptoms of Giardiasis were nausea, pain in abdomen, vomiting, diarrhea and bloody stool.

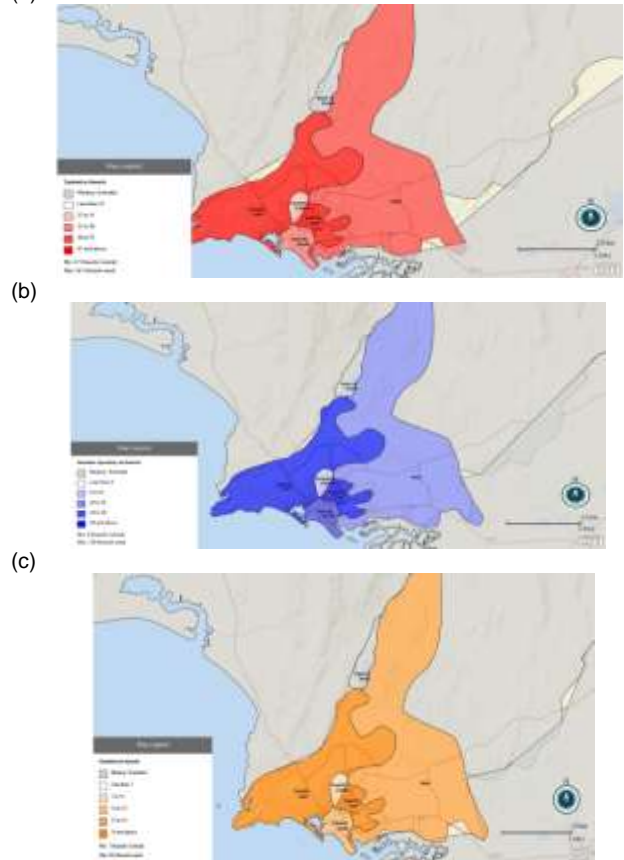
Fig. 1 Frequency of Gastroenteritis in Karachi



The distribution of Gastroenteritis cases, including Typhoid, Amoebiasis, and Giardiasis, across different regions of Karachi is illustrated in Figure 2 (a,b,c). According to the data, the west district of Karachi had the highest number of reported cases for Typhoid (n=241), amoebic dysentery (n=125), and giardiasis (n=50). Conversely, the central district of Karachi had the lowest number of cases for Typhoid (n=27), amoebic dysentery (n=8), and giardiasis (n=7). The district east ranked as the second most prevalent district for all types of Gastroenteritis. Gastroenteritis; Typhoid, Amoebiasis and Giardiasis in sequence were noticed greater in male than female, relatively (Fig. 3).

Overall cases of gastroenteritis were more frequent in adults (20-59 years of age) than any other age group. Interestingly, Typhoid cases were found more significant in adults than any other age group. But the number of Amoebiasis and Giardiasis is nearly similar in adults and old age patients. However, lower cases of gastroenteritis were reported in children and adolescents. Pattern of Gastroenteritis was significantly same (orderly, increased cases of Typhoid then Amoebiasis and Giardiasis) (Fig. 4).

Fig. 2 Gastroenteritis on the map of Karachi (a)



Keys: the color strength based representation of the number of Gastroenteritis; (a) Typhoid, (b) Amoebic dysentery and (c) Giardiasis in various districts of Karachi.

Fig. 3 Gender-wise distribution of Gastroenteritis

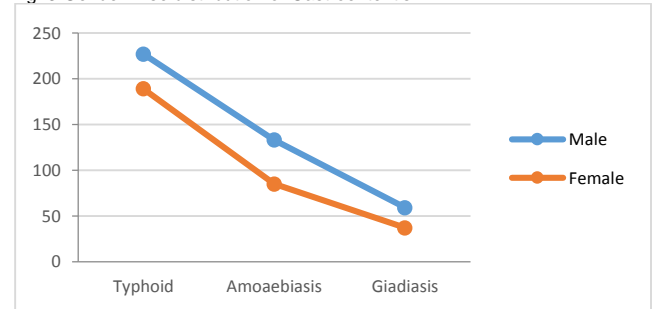
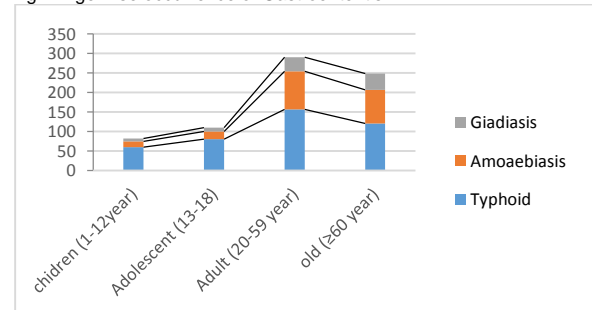


Fig. 4 Age wise occurrence of Gastroenteritis



The number of Gastroenteritis were start to raised gradually and significantly in the month of April and reached at peak in June, July, August and September, and then declined steadily (Fig. 5).

The symptoms of Typhoid, Amoebiasis and Giardiasis were recorded with significant p -value (≤ 0.05) (Table 1). Accordingly, the most common symptom was fever followed by headache, abdominal pain, vomiting, diarrhea, malaise, anorexia, nausea and rose spots in Typhoid fever. In amoebiasis, the most frequent symptom was abdominal pain followed by vomiting, diarrhea, fever, malaise, headache, bloody stool, anorexia, excessive gas, and nausea. Similarly, in Giardiasis, the most prevailing symptom was abdominal pain followed by diarrhea, vomiting, anorexia, fever, headache, malaise, nausea, and dehydration. In overall cases of gastroenteritis the most pronounced symptom was abdominal pain followed by fever, vomiting, headache, diarrhea, malaise, anorexia, nausea, bloody stool, rose spots and dehydration.

Table 1: The occurrence of various symptoms of Gastroenteritis

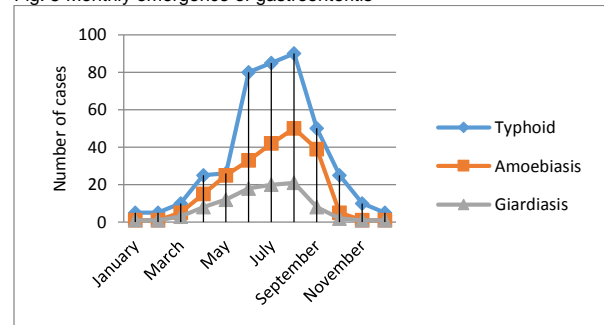
Enteric diseases	Headache	Fever	Malaise	Abdominal pain	Vomiting	Diarrhoea	Anorexia	Excessive gas	Nausea	Dehydration	Bloody stool	Rose spot
Typhoid	235	292	155	229	218	175	114	0	78	0	0	19
Amoebiasis	86	93	88	169	139	118	35	26	16	0	52	0
Giardiasis	30	33	12	72	53	55	51	0	12	10	0	0
Total	351	418	255	470	410	348	200	26	106	10	52	19
p -value	0.03	0.03	0.03	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.03

DISCUSSION

The results of the present study found a prevalence proportion of 70942 cases of gastroenteritis per 100,000 populations, are in line with previous studies conducted in similar settings. For example, a study conducted in Lahore, Pakistan reported a prevalence rate of 79,000 cases of gastroenteritis per 1 million populations.¹⁵ On the other hand, a study conducted in India reported a prevalence rate of 60,000 cases of gastroenteritis per 1 million populations.¹⁶ These results suggest that the burden of gastroenteritis is substantial in the region, particularly in Karachi, Pakistan. This is consistent with previous studies that have reported a high burden of gastroenteritis in developing countries due to a lack of proper sanitation facilities and hygiene practices¹⁷.

The results of the present study indicated that typhoid fever was the most prevalent gastroenteritis, affecting 54% of the participants ($n=416$), followed by amoebiasis with a frequency of 218(32%) and giardiasis with a frequency of 96(14%). The frequency rate of gastroenteritis (including typhoid fever, amoebiasis and giardiasis) was calculated as 71%, while the frequency rate of typhoid fever, amoebiasis and giardiasis were 57%, 30% and 13%, respectively. It is important to compare these findings with previous studies conducted in other regions to understand the magnitude of the problem and the factors contributing to the higher incidence of these diseases in certain areas. In this context, previous studies in Pakistan have also reported a high incidence of waterborne diseases, including typhoid fever, amoebiasis, and giardiasis^{18,19}. Additionally, studies conducted in other countries have shown a significant variability in the incidence of these diseases, which is influenced by various factors, including the quality of water and sanitation systems, socio-economic status, and access to health care services^{20,21}. However, it is important to note that the prevalence of gastroenteritis caused by specific pathogens such as *Salmonella Typhi*, *Entamoeba histolytica*, and *Giardia lamblia* may vary depending on the specific location and population being studied. For example, a study conducted in Bangladesh reported a higher prevalence of *Entamoeba histolytica* (40%) compared to *Salmonella Typhi* (20%) and *Giardia lamblia* (10%).²² In a study by Ali et al. (2017), the prevalence of gastroenteritis in Pakistan was found to be 63.2% and the most common causes were identified as *Salmonella*, *Shigella*, and *Giardia*. The study highlighted the need for effective intervention measures to control the spread of gastroenteritis in the country²³. A comparative analysis with global studies and studies in Pakistan showed that the prevalence of gastroenteritis, including typhoid fever, amoebiasis and giardiasis, is a significant public health concern worldwide. In developing countries, such as Pakistan, the incidence of gastroenteritis is

Fig. 5 Monthly emergence of gastroenteritis



even higher due to poor sanitation and hygiene practices, contaminated water sources, and limited access to healthcare facilities^{24,25,26}.

The symptoms of Typhoid, Amoebiasis, and Giardiasis are common in patients with gastroenteritis, and their presence can help in early diagnosis and treatment. According to a study, the most common symptoms of typhoid fever include fever, headache, abdominal pain, vomiting, diarrhea, malaise, anorexia, nausea, and rose spots. In the case of amoebiasis, the most frequent symptom was abdominal pain, followed by vomiting, diarrhea, fever, malaise, headache, bloody stool, anorexia, excessive gas, and nausea. Similarly, in patients with giardiasis, the most prevalent symptom was abdominal pain, followed by diarrhea, vomiting, anorexia, fever, headache, malaise, nausea, and dehydration. The symptoms of gastroenteritis, in general, are abdominal pain, followed by fever, vomiting, headache, diarrhea, malaise, anorexia, nausea, bloody stool, rose spots, and dehydration²⁷.

The results of the present study suggest that there is a higher incidence of gastroenteritis, including typhoid, amoebiasis and giardiasis, in males compared to females. These findings are in line with other studies that have reported a higher incidence of enteric infections in males. For example, a study conducted in India found that the incidence of typhoid fever was higher in males (52.7%) compared to females (47.3%)²⁸. Another study conducted in Bangladesh found similar results, with a higher incidence of typhoid fever in males (54%) compared to females (46%)¹⁸. However, it is important to note that the gender disparity in the incidence of enteric infections may vary depending on the region and the specific enteric pathogen²⁹.

The results of the present study suggest that adults (20-59 years of age) are the most affected age group with gastroenteritis, with a higher incidence of typhoid fever in this group as compared to other age groups. This is in line with previous studies that have reported that adults are more susceptible to gastroenteritis caused by *Salmonella Typhi*, *Entamoebahistolytica* and *Giardia lamblia*. However, the incidence of amoebiasis and giardiasis was found to be similar in both adults and elderly patients, and lower cases of gastroenteritis were reported in children and adolescents. This finding highlights the importance of considering age as a risk factor for development of gastroenteritis and targeting preventive measures accordingly³⁰.

The results of the present study show that the incidence of gastroenteritis in Karachi increases gradually and significantly starting from the month of April, reaching its peak in June, July, August, and September, before declining steadily. This observation is in line with the findings of previous studies that have shown seasonal patterns of gastroenteritis and waterborne diseases in

various regions. For example, a study conducted in Bangladesh found that the incidence of cholera, a type of waterborne disease, was higher during the rainy season, which usually starts in June and continues through September³¹. Another study conducted in India found that the incidence of enteric fever, including typhoid fever, was highest in the months of June, July and August³². These findings suggest that the seasonality of gastroenteritis and waterborne diseases may be influenced by factors such as changes in temperature, rainfall, and water quality. However, it is important to note that the exact reasons for the seasonal patterns of gastroenteritis and waterborne diseases are still not fully understood and may vary from region to region^{33,34}.

The symptoms of Typhoid, Amoebiasis, and Giardiasis are common in patients with gastroenteritis, and their presence can help in early diagnosis and treatment. According to a study by K. C. Chugh and V. K. Arora, published in the Journal of Clinical and Diagnostic Research (2013), the most common symptoms of typhoid fever include fever, headache, abdominal pain, vomiting, diarrhea, malaise, anorexia, nausea, and rose spots. In the case of amoebiasis, the most frequent symptom was abdominal pain, followed by vomiting, diarrhea, fever, malaise, headache, bloody stool, anorexia, excessive gas, and nausea. Similarly, in patients with giardiasis, the most prevalent symptom was abdominal pain, followed by diarrhea, vomiting, anorexia, fever, headache, malaise, nausea, and dehydration. The symptoms of gastroenteritis, in general, are abdominal pain, followed by fever, vomiting, headache, diarrhea, malaise, anorexia, nausea, bloody stool, rose spots, and dehydration²⁷. These findings highlight the importance of monitoring the symptoms of gastroenteritis, especially in regions where the prevalence of these diseases is high. Early detection and prompt treatment of these symptoms can prevent the progression of the disease and reduce the risk of complications.

CONCLUSIONS

In conclusion, the results of this study highlight the significant burden of gastroenteritis in the region of Karachi, Pakistan. The prevalence of gastroenteritis in the population was 70942 cases per 100,000 of population, with the most common types of gastroenteritis being typhoid fever, followed by amoebiasis and then giardiasis. The prevalence of gastroenteritis was higher in males and adults aged 20-59 years. The incidence of gastroenteritis peaked in the months of June to September, and was highest in the west district of Karachi, while the lowest incidence was observed in the central district of Karachi. The findings of this study highlight the need for effective measures to control and prevent the spread of waterborne diseases in Karachi, particularly in adults who are more susceptible to typhoid fever.

Conflict of interest: Nothing to declare

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