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Cholera trends in 2023 and 2024: A hospital-based cross-sectional retrospective study from a tertiary care center in New Delhi, India.

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Abstract:

Background:
Among Asian countries, the Indian subcontinent is the major contributor of cholera cases, but the actual global burden is still unknown. The study assessed cholera cases at a tertiary care center in New Delhi (2023–2024), including their seasonal trends, strain types, antibiotic susceptibility, and patient demographics.

Materials and methods:
Stool samples of the suspected cholera patients were included, irrespective of the age of the patient, for the years 2023 and 2024. Samples were processed according to standard protocol, and antibiotic susceptibility testing was done for *V. cholerae-positive* isolates using the Kirby-Bauer disc diffusion method.

Results:
For the years 2023 and 2024, 35 and 99 laboratory-confirmed cases of *V. cholerae* occurred, respectively. In both years, cases were clustered in a specified area of Central Delhi. In 2023, the maximum number of cases was seen in the age group of >18 to 65, while in 2024, >5 to 18 years age group had the maximum number of cases. For both years, the summer season was majorly hit by cholera cases. All the isolates from both years were *V. cholerae* O1 biotype El Tor serotype, Ogawa. A decline in antibiotic resistance was seen for all the tested antibiotics from 2023 to 2024. The resistance rate was lowest for tetracycline and was almost similar for both years. The highest resistance was noted against cotrimoxazole in both years.

Conclusion:
India, being the largest contributor to cholera cases, needs access to safe drinking water, maintenance of hygiene and sanitation, building up good laboratory facilities, and a systemic surveillance system, which are key elements for achieving cholera elimination by 2030.

Recommendation:
To strengthen preventive and control measures to reduce cholera transmission, particularly in high-risk urban slum areas, continuous antimicrobial resistance surveillance and rational use of antibiotics should be enforced.

Keywords: *Cholera, V. cholerae O1 biotype El Tor serotype Ogawa, antibiotic susceptibility testing, demographic details.*
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INTRODUCTION
Ever since the pandemic of cholera hit the world in the early 1800s, it has become a major public health concern worldwide. According to a WHO report in 2021, 1.3 to 4 million cholera cases and 21,000 to 143,000 deaths occur annually due to cholera. African countries, including Haiti, Democratic Republic of the Congo, Somalia, Tanzania, Peru, Yemen, and Vietnam, contribute 80% of the total cholera cases occurring globally.[1]. Among Asian countries, the Indian subcontinent is the major contributor of cholera cases, contributing 78%, and its outbreak is also frequently seen in India.[2]. The actual global burden of cholera is still

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unknown, and the WHO estimated that only 5-10% of cholera cases occurring annually are reported due to a lack of laboratory setup and surveillance systems.[3].

Cholera is caused by the ingestion of bacteria *Vibrio cholerae* O1 or O139, leading to acute diarrhoeal illness. Often, the patients suffer from asymptomatic or mild infections, but can have severe infections in children or if left untreated. Limited access to safe drinking water, basic sanitation facilities, and a lack of sewage treatment plants are the main reasons for cholera being endemic in low-income countries.[1]. Now, in India, cholera cases are not limited to the Gangetic Delta but have a wider geographical distribution. Good knowledge of spatial epidemiology is required because cholera cases usually tend to cluster in certain areas during an outbreak[4]. This study aimed to evaluate the number of cholera cases coming to a tertiary care center in New Delhi during the years 2023 and 2024, the seasonality of cases, prevalent biotypes and serotypes of *V. cholerae*, their antibiotic susceptibility pattern, and the demographic profile of the patients.

MATERIALS AND METHODS:

Study design

This was a hospital-based cross-sectional retrospective study conducted in the Department of Microbiology, Lady Hardinge Medical College, New Delhi, for the years 2023 and 2024. Stool samples of the suspected cholera patients coming from Lady Hardinge Medical College and Kalawati Saran Hospital, New Delhi, to our department were included in this study, irrespective of the age of the patient. Stool samples in this study were obtained from patients attending Lady Hardinge Medical College and Kalawati Saran Hospital, New Delhi. The catchment population was extensive and heterogeneous, comprising urban, peri-urban, and migrant populations from Delhi as well as neighbouring states (e.g., Uttar Pradesh, Haryana, Bihar). The high patient turnover and referral status of this hospital, along with its advanced laboratory capacity, enhanced the likelihood of capturing both sporadic and outbreak-related cholera cases.

Participants

In this study, all eligible cholera cases were included, and no sampling strategy was followed. Cholera cases were suspected in any person aged 5 years or more with acute watery diarrhoea, with or without vomiting. Leaky samples, stool samples firm in consistency, and samples not properly labelled were excluded from the study.

Variables

The outcome variable, i.e., confirmation of cholera, was defined as the presence of infection by *V. cholerae* and was confirmed by stool culture. The exposure variables were consumption of contaminated water, poor sanitation, living in overcrowded areas, and contact with infected people.

Bias

All samples received during the study period that fulfilled the inclusion criteria were included to reduce selection bias. Information bias was minimized through the use of standardized microbiological methods and uniform reporting formats. Laboratory procedures were conducted in accordance with the CLSI 2023 and 2024 guidelines to ensure consistency in antimicrobial susceptibility results.

Laboratory diagnosis

Samples were processed according to standard protocol. A hanging drop was prepared directly from the sample and then enriched with alkaline peptone water (APW) to observe darting motility. Samples were sub-cultured from APW after 4-6 hours of incubation on MacConkey agar and Bile Salt Agar (BSA). Identification of the isolates was done by MALDI-TOF-MS. For serotyping, *V. cholerae* O1 polyvalent antiserum was used first, followed by monovalent antiserum Ogawa and Inaba. The standard conventional biotyping scheme was followed for biotyping using haemolysis of sheep blood, Voges-Proskauer (VP) test, and polymyxin B sensitivity with 50 µg disc.

Antibiotic susceptibility testing (AST)

The latest Clinical and Laboratory Standards Institute (CLSI) guidelines were followed for *V. cholerae* positive isolates using the Kirby-Bauer disc diffusion method. Discs of ampicillin (10 µg), chloramphenicol (30 µg), tetracycline (30 µg), ciprofloxacin (5µg), and trimethoprim-sulfamethoxazole (1.25/23.75 µg) were used for AST, and results were noted as sensitive, intermediately sensitive, and resistant.

Statistical analysis

Statistical analysis was done by descriptive statistics using percentages and ratios, and bar graphs were prepared in Microsoft PowerPoint. Categorical variables were expressed as frequencies and percentages. Seasonal variation was assessed using time-series analysis.

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Ethical consideration

Ethical approval for the study was obtained from the Institutional Ethics Committee of Lady Hardinge Medical College, New Delhi (Approval No: IEC/LHMC/2024/92).

RESULT:

According to a hospital-based cross-sectional retrospective study conducted at Lady Hardinge Medical College in New Delhi, 35 and 99 laboratory-confirmed cases of V. cholerae were reported in 2023 and 2024, respectively (Figure 1). In both years, the cases were clustered in a specific area of Central Delhi. Very few sporadic cases emerged from other parts of Delhi and the nearby regions of Uttar Pradesh. All the patients were of low socioeconomic status, and the major risk factors were contaminated drinking water, overcrowding, and poor sanitation.

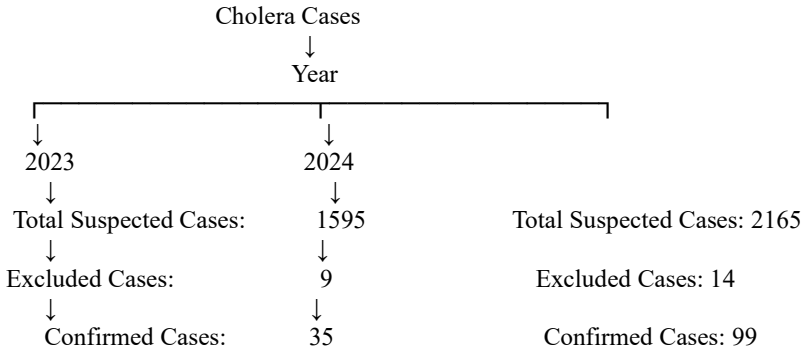

Figure 1: Flow chart depicting year-wise distribution of total suspected cholera cases, total excluded cases (due to leaky samples), and total number of confirmed cases.

Age and sex-wise distribution of cholera cases in the years 2023 and 2024 is depicted in Table 1. Male: female ratio was 0.4 for the year 2023 and 1.11 for the year 2024. Every age group was affected in the year 2023, while in 2024, those above 65 years were not affected. In 2023, the maximum number of cases was seen in the age group of >18- 65 (20), followed by >2-5years (06), an equal number of cases in 0-2 years (04), and >5-18 years (04), and least number in the above 65 years of age group (01). In 2024, the trend was maximum in the>5-18 years age group (39), followed by >2-5 years (22), >18-65 years (20), and 0-2 years (18).

Regarding the seasonality of the cases, the majority of the cases occurred in the summer season. In 2023, cases were clustered from June to October, with July being the most affected month, with 10 cholera cases, followed by 8 cases in September, 7 in October, 4 in June, and 3 in August. Three sporadic cases were seen, 1 in March and 2 in December. For 2024, April to August were the months being hit by cholera cases, and the trend was 39 cases in August, followed by 28 cases in May, 11 cases in April and July, and 10 cases in June. No sporadic case has occurred in 2024 (Figure 2).

All the isolates from both years were *V. cholerae* O1 biotype El Tor serotype, Ogawa. The antibiotic susceptibility pattern was analyzed, and a decline in resistance was seen for all the tested antibiotics from 2023 to 2024. A low level of resistance was observed against tetracycline, with 2.9% in 2023 and 1% in 2024, and a high level of resistance against cotrimoxazole, with 100% resistance in 2023 and 69.7% in 2024 (Table 2).

	No. of cholera cases	
	2023 (n=35)	2024 (n=99)
Gender wise		
Male	10	52
Female	25	47

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Age-wise		
0-2 years	04	18
>2-5 years	06	22
>5-18 years	04	39
>18-65 years	20	20
>65 years	01	00

Table 1: Age and sex-wise distribution of cholera cases in the years 2023 and 2024

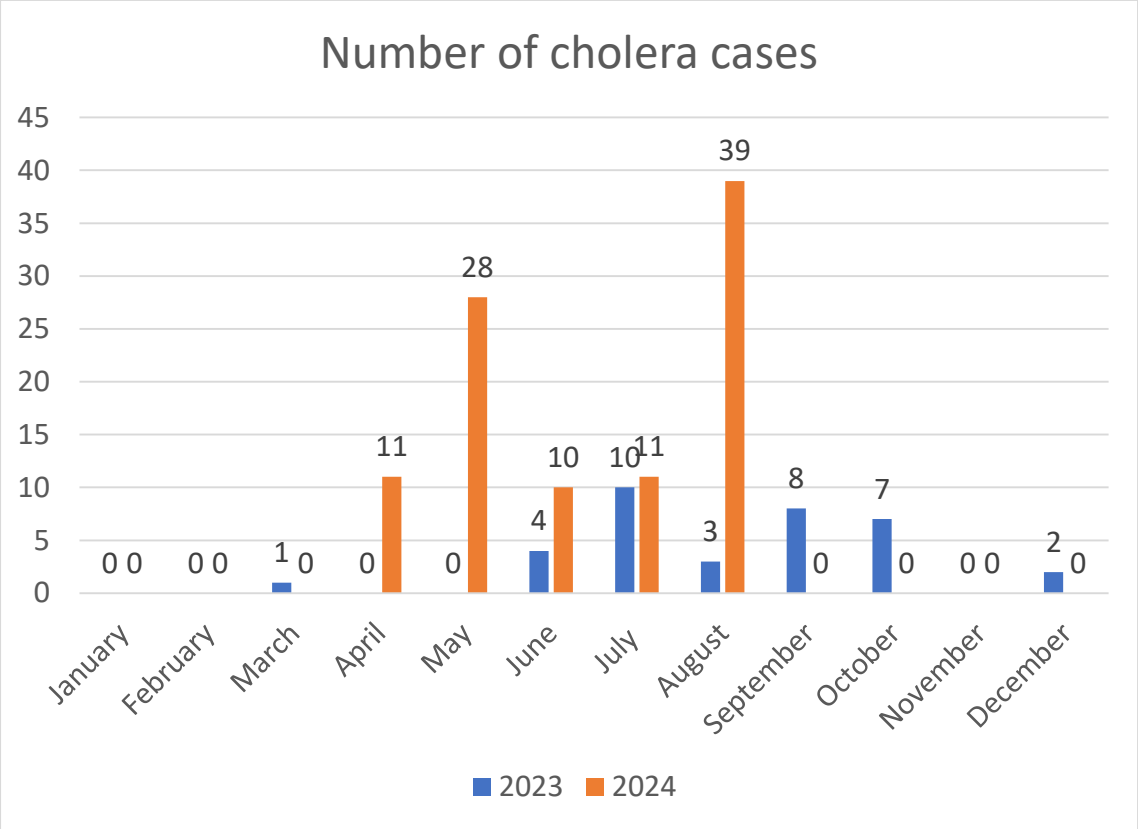

Figure 2: Month-wise distribution of cholera cases in the years 2023 and 2024

	Antibiotic susceptibility pattern									
	Ampicillin		Ciprofloxacin		Tetracycline		Chloramphenicol		Cotrimoxazole	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
Susceptible (%)	51.4	36.3	88.6	93.9	97.1	98	68.6	91.9	00	30.3
Intermediately susceptible (%)	22.8	58.6	00	04	00	01	20	07	00	00
Resistant (%)	25.8	5.1	11.4	2.1	2.9	01	11.4	1.1	100	69.7

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Table 2: Comparison of antibiotic susceptibility pattern of *V. cholerae* isolates from the years 2023 and 2024

DISCUSSION:

In India, cholera has spread to a wide geographical area, leaving behind the notion of being restricted to the Gangetic Delta. This study shows that cholera cases have been reported from Delhi in 2023 and 2024, with more than double the cases in 2024 than in 2023. Studies have reported Delhi to be a non-endemic region for cholera, and only 4-10 outbreaks have occurred between 2011 and 2020, with a smaller number of cases in each outbreak[4,5]. However, this study has shown the occurrence of a significant number of cholera cases in 2 consecutive years, which may suggest looking closely at non-endemic areas also. In this study, the majority of cases came from urban slums of Central Delhi, showing clustering of cases which correlates with the findings of other studies that during a cholera outbreak, there is a tendency for clustering of cases to occur among certain population groups. Limited access to safe drinking water and a lack of proper sanitation facilities could be the reason for the clustering of cases in this study. One study suggested that out of the 351 outbreaks, 319 (91%) were spread by drinking tainted water or coming into contact with unimproved water sources, while 32 (9%) were spread by poor sanitation or hygiene[5]. The results of the study mainly apply to analogous urban slum conditions with overcrowding, poor sanitation, and unsafe water supply in these areas, which elevate cholera outbreak risk. Yet such findings are not extrapolated to rural areas, well-developed urban regions, or endemic settings where transmission patterns differ. To that extent, their findings show potential risk to non-endemic areas, although their generalization to other populations should be made with caution. Cholera is more prevalent in hot, humid, and rainy seasons. The majority of cholera outbreaks in India are seen during the monsoon (June to September) and pre-monsoon season (March to May)[5]. Here also, in 2023, the cholera cases peaked during the monsoon season with the maximum number of cases in July, while in 2024, cases were seen both in pre-monsoon and monsoon with the maximum number of cases in August.

A greater number of female patients were affected in 2023, but there was very little gender-based difference in 2024. There is no clear-cut consensus regarding males or females being more affected. Some studies have reported a higher attack rate among males than females, some said females were more affected than males, and according to others, there was no gender-based difference[2,7,8]. Studies have shown that the development of cholera depends on host factors such as age, nutrition, and blood group[5]. The present study reported that in 2023, both paediatric and adult populations were almost equally affected, while in 2024, the paediatric population was much more affected than the adult population. Age-specific cholera risk varied significantly among studies, which could be due to population differences living in endemic and epidemic regions, where natural immunity may play a role[9].

All the isolates from both years were *V. cholerae* O1 biotype El Tor serotype, Ogawa. According to other studies, the majority of strains in India were Ogawa (96.5%), while Inaba contributed only 3.5% of strains[1].

The analysis of the antibiotic resistance pattern was revealing because the resistance rate of all the tested antibiotics was reduced from 2023 to 2024. For ampicillin, though the resistance rate declined, the percentage of susceptible strains also declined, and an increase in intermediately susceptible strains was observed. The resistance rate was lowest for tetracycline and was almost similar for both years. According to CLSI guidelines, *V. cholerae* strains that are susceptible to tetracycline are also considered susceptible to doxycycline, as there are no interpretive criteria based on zone diameter for doxycycline. So, we considered the susceptibility pattern of doxycycline similar to tetracycline. The highest resistance was noted against cotrimoxazole in both years. Various studies suggest the extent of antibiotic resistance against *V. cholerae*. According to a study, the resistance rate was found to be azithromycin 1%, erythromycin 36%, ciprofloxacin 3%, cotrimoxazole 79%, doxycycline 7%, and tetracycline 20%[10]. In another study, the resistance rate was erythromycin 10%, ciprofloxacin 5%, cotrimoxazole 27%, and tetracycline 13%[11]. Due to the lack of a stable plasmid and the plasmid-mediated mechanism as one pathway of acquiring drug resistance, *V. cholerae* usually shows fluctuation in drug resistance[12,13]. One study was done in India to determine the extent of antibiotic-resistant cholera outbreaks from 2009 to 2017. The results showed that out of 559 outbreaks, 62 were antibiotic-resistant outbreaks, with West Bengal, Maharashtra, Odisha, and Delhi contributing to two-thirds[12].

All the patients were given intravenous hydration therapy and the antibiotic doxycycline. The dose of doxycycline was

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different for each age group, but all were treated with a single dose. Less than 7 years old children were given 5mg/kg, patients between 7 and 18 years old received 100mg, and adult patients received 200mg. Antibiotics are not necessary to alleviate cholera symptoms or be used as the only treatment for the illness, but their addition to the rehydration therapy has added benefits. In order to decrease the length of illness by roughly half and to lower the amount of *V. cholerae* that is excreted in the stool, antibiotics are given. This is particularly crucial in underdeveloped nations where there is a shortage of oral rehydration treatments and restricted access to quality drinking water.[14].

CONCLUSION:

During the monsoon and pre-monsoon season, many drug-resistant *V. cholerae* O1 biotype El Tor serotype Ogawa were isolated from Central Delhi, with more than double the cases in 2024 than in 2023. Access to safe drinking water, maintenance of hygiene and sanitation, building up good laboratory facilities, and a systemic surveillance system are key elements in limiting the spread of cholera. India, being the largest contributor to cholera cases, without addressing these issues, the goal of cholera elimination by 2030 cannot be achieved.

Limitations

In this study, we considered only the cases coming to our hospital, and no correlation was done with other hospitals, which could have provided more outbreak pockets occurring in other parts of Delhi. Risk factors were noted only by taking the history, and no on-site surveillance was conducted.

Recommendation

Based on the study findings, it is recommended to take strong preventive and control measures to reduce the transmission of cholera, especially in the high-risk urban slum areas. Access to safe and treated drinking water, enhanced sanitation arrangements, and encouragement of handwashing or hygiene practices must be emphasized, in particular during the pre-monsoon and monsoon seasons when this outbreak peaks. As drug-resistant *V. cholerae* O1 strains emerge, constant surveillance of antimicrobial resistance and the rational use of antibiotics must be compulsory. It is also essential that laboratory capacity be improved to facilitate timely diagnosis and reporting, and to develop a robust, integrated system for disease surveillance with an integrated approach to monitoring and preventing outbreaks. Without addressing these crucial areas, cholera's elimination targets by 2030 will continue to be challenging.

List of abbreviations:

Abbreviation	Full Form
WHO	World Health Organisation
APW	Alkaline peptone water
BSA	Bile salt agar
MALDI-TOF-MS	Matrix-Assisted Laser Desorption/Ionization-Time of Flight Mass Spectrometry
VP	Voges-Proskauer
AST	Antibiotic susceptibility test
CLSI	Clinical and Laboratory Standards Institute

Authors' Contribution

Conceptualization was done by Preeti Thakur. Data analysis and writing of the draft were done by Sarjana Shuchi. The data collection part was performed by Sarjana Shuchi, Chavini K. Shaozae, and Kripa Tony. A review of the manuscript was done by Preeti Thakur.

Conflict of interest

The authors declare no conflict of interest.

Grant information

The authors declared that no grants were involved in supporting this work.

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Author's biography

Dr Sarjana Shuchi is a Senior Resident in the Department of Microbiology at Lady Hardinge Medical College, New Delhi. Her research interests include clinical microbiology, virology, antimicrobial resistance, and hospital-acquired infections.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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