



International Journal of Medicine

ISSN (P): 1468-3814; ISSN (e): 2667-7008

<https://www.theinternationalmedicine.com>

Volume: 7(8) 2025



Original Research

Prevalence of Multidrug-Resistant *Escherichia coli* in Drinking Water Samples from Urban and Rural Areas.

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Received: 28 July 2025 / Accepted: 04 Aug 2025

Abstract

Background: Drinking water contamination by multidrug-resistant (MDR) bacteria has become a major public health concern worldwide. *Escherichia coli* is commonly used as an indicator organism for fecal contamination and antimicrobial resistance in water sources. The present study aimed to determine the prevalence of MDR *E. coli* in drinking water samples collected from urban and rural areas. **Methods:** A cross-sectional study was conducted using 120 drinking water samples collected from urban and rural regions. Samples were processed using standard microbiological techniques for isolation and identification of *E. coli*. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method according to CLSI guidelines. MDR strains were defined as isolates resistant to three or more classes of antibiotics. **Results:** Out of 120 water samples, 42 (35%) were positive for *E. coli*. Higher contamination was observed in rural areas (45%) compared to urban areas (25%). Among the 42 isolates, 26 (61.9%) were identified as MDR. Resistance was highest against ampicillin (76.2%), cefotaxime (64.3%), and ciprofloxacin (52.4%), while lower resistance was observed against amikacin (9.5%) and imipenem (4.8%). Rural isolates showed significantly higher MDR prevalence compared to urban isolates. **Conclusion:** The study demonstrated a considerable prevalence of MDR *E. coli* in drinking water, particularly in rural areas. Continuous monitoring of water quality and implementation of effective sanitation and antibiotic stewardship programs are urgently needed to prevent the spread of antimicrobial resistance through water sources.

Keywords: *Escherichia coli*, multidrug resistance, drinking water, antimicrobial resistance, urban water, rural water.

Introduction

Safe drinking water is essential for human health and well-being. Contamination of water supplies with pathogenic microorganisms remains a significant public health challenge, particularly in developing countries. Among microbial contaminants, *Escherichia coli* is considered an important indicator organism for fecal pollution and poor sanitary conditions. The presence of *E. coli* in drinking water suggests contamination by human or animal waste and indicates the possible presence of enteric pathogens.

In recent years, antimicrobial resistance (AMR) has emerged as a global health threat. The widespread and irrational use of antibiotics in humans, animals, and agriculture has accelerated the development of multidrug-resistant bacteria. Water systems have become major reservoirs for resistant organisms and resistance genes. MDR *E. coli* strains in drinking water may transfer resistance genes to other pathogenic bacteria, increasing the burden of difficult-to-treat infections.

Urban and rural populations differ considerably in terms of sanitation, water treatment, infrastructure, and awareness regarding hygiene. Rural communities often rely on borewells, hand pumps, ponds, or untreated groundwater, which may increase the risk of microbial contamination. Urban water systems, although treated, may still become contaminated through damaged pipelines or poor storage practices.

The present study was conducted to assess the prevalence of MDR *E. coli* in drinking water samples collected from urban and rural areas and to evaluate their antimicrobial susceptibility patterns.

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DOI: 10.61336/imv26-2-05

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Materials and Methods

Study Design and Area

A cross-sectional laboratory-based study was conducted over a period of six months. Drinking water samples were collected from urban and rural areas of the study region.

Sample Collection

A total of 120 drinking water samples were collected, including:

- 60 samples from urban areas
- 60 samples from rural areas

Samples were collected aseptically in sterile bottles from different sources such as:

- Municipal taps
- Hand pumps
- Borewells
- Household storage containers
- Samples were transported immediately to the microbiology laboratory under cold conditions for analysis.

Isolation and Identification of *E. coli*

Water samples were cultured using standard bacteriological procedures. Samples were inoculated onto MacConkey agar and Eosin Methylene Blue (EMB) agar plates and incubated at 37°C for 24 hours.

Typical lactose-fermenting colonies showing metallic sheen on EMB agar were subjected to biochemical tests including:

- Indole test
- Methyl red test
- Voges-Proskauer test
- Citrate utilization test

Confirmed isolates were identified as *E. coli*.

Antibiotic Susceptibility Testing

Antimicrobial susceptibility testing was performed by Kirby-Bauer disc diffusion method on Mueller-Hinton agar according to CLSI guidelines.

The antibiotics tested included:

- Ampicillin
- Ciprofloxacin
- Cefotaxime
- Gentamicin
- Tetracycline
- Imipenem
- Amikacin
- Chloramphenicol

Zones of inhibition were measured and interpreted as sensitive, intermediate, or resistant.

Definition of MDR

Isolates resistant to at least three different classes of antibiotics were considered multidrug resistant.

Statistical Analysis

Data were analyzed using percentage and chi-square test. A p-value <0.05 was considered statistically significant.

Results

Prevalence of *E. coli*

Out of 120 drinking water samples, 42 (35%) showed positive growth for *E. coli*.

Area	Total Samples	Positive Samples	Percentage
Urban	60	15	25%
Rural	60	27	45%
Total	120	42	35%

Higher contamination was observed in rural areas.

Antibiotic Resistance Pattern

Antibiotic	Resistant Isolates (%)
Ampicillin	76.2%
Cefotaxime	64.3%
Ciprofloxacin	52.4%
Tetracycline	47.6%
Chloramphenicol	38.1%
Gentamicin	21.4%
Amikacin	9.5%
Imipenem	4.8%

Prevalence of MDR *E. coli*

Area	MDR Isolates	Percentage
Urban	7/15	46.7%
Rural	19/27	70.4%
Total	26/42	61.9%

Rural water samples demonstrated significantly higher MDR prevalence.

Discussion

The present study revealed substantial contamination of drinking water with *E. coli*, particularly in rural areas. Similar findings have been reported in previous studies from different parts of India where inadequate sanitation and improper waste disposal contributed to water contamination.

The higher prevalence of MDR isolates observed in rural water sources may be associated with indiscriminate antibiotic usage, poor sewage

management, and contamination from agricultural runoff. Ampicillin and cefotaxime resistance were notably high, suggesting widespread beta-lactam resistance among environmental isolates.

The emergence of MDR *E. coli* in drinking water poses a serious health risk because these organisms may cause gastrointestinal infections, urinary tract infections, and systemic diseases. Moreover, environmental dissemination of resistant bacteria contributes to the spread of AMR within communities.

The comparatively lower resistance against imipenem and amikacin indicates that these antibiotics remain effective against many isolates. However, the detection of carbapenem resistance, even at low levels, is alarming and requires immediate surveillance.

Regular monitoring of drinking water quality, improvement in sanitation infrastructure, and rational antibiotic use are essential measures to control the spread of resistant bacteria.

Conclusion

This study demonstrated a significant prevalence of MDR *E. coli* in drinking water samples collected from urban and rural areas. Rural regions showed higher contamination and resistance rates compared to urban areas. The findings emphasize the urgent need for proper water treatment, sanitation practices, and antimicrobial resistance surveillance to safeguard public health.

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