

ANTIBIOTIC SUSCEPTIBILITY PROFILE OF KLEBSIELLA PNEUMONIAE ISOLATED FROM URINARY TRACT INFECTIONS IN LAHORE

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ABSTRACT

Background: Urinary tract infections (UTIs) are prevalent bacterial infections often complicated by multidrug-resistant pathogens. Klebsiella pneumoniae, a key uropathogen, exhibits rising resistance to common antibiotics, highlighting the need for local susceptibility monitoring to guide empirical therapy and curb antimicrobial resistance. Objective: To assess the antibiotic susceptibility phenotype of K. pneumoniae isolates from UTI cases in Lahore. Methodology: 92 urine samples from suspected UTI patients were analysed. K. pneumoniae was isolated using conventional microbiological methods, with susceptibility tested via Kirby-Bauer disk diffusion per CLSI guidelines. MDR and ESBL production were evaluated, and statistical analyses examined associations with age and gender. Results: K. pneumoniae was isolated from 27 samples (29.3%), predominantly in females (66.7% vs. 33.3% males). Carbapenems (imipenem, meropenem) and amikacin were most sensitive; cephalosporins (ceftriaxone, ceftazidime) and fluoroquinolones (ciprofloxacin) were most resistant. 55.6% isolates were MDR, 44.4% ESBL-producing. ESBL production correlated with MDR (p=0.016); no significant associations with age or gender, though older groups showed slightly higher resistance to some antibiotics. Conclusion: Moderate K. pneumoniae prevalence in Lahore UTIs, with alarming MDR and ESBL rates. Carbapenems and amikacin remain effective treatments. Regular monitoring of resistance patterns is crucial for empirical therapy and antibiotic stewardship programs.

Keywords: *Klebsiella pneumoniae, Urinary Tract Infection, Antibiotic Susceptibility, Multidrug Resistance (MDR), Extended-Spectrum Beta-Lactamase (ESBL), Lahore*

INTRODUCTION

Urinary Tract Infections (UTIs) represent a significant global health challenge, ranking among the most common bacterial infections affecting individuals of all ages. Caused by the invasion and proliferation of pathogenic microorganisms in the urinary tract, UTIs lead to inflammation and a range of clinical symptoms, including dysuria, frequency, urgency, and suprapubic pain. *Klebsiella pneumoniae*, a Gram-negative, encapsulated bacillus from the Enterobacteriaceae

family, has emerged as a prominent foodborne pathogen responsible for UTIs, particularly in hospitalized and immunocompromised patients. As a commensal of the human gut, *K. pneumoniae* can become pathogenic in sterile sites, causing infections such as pneumonia, bacteremia, wound infections, and UTIs. Its polysaccharide capsule serves as a key virulence factor, evading phagocytosis and contributing to antibiotic

resistance, making it a formidable threat worldwide (1,2).

The global prevalence of *K. pneumoniae*-induced UTIs ranges from 6-17%, with higher rates among hospitalized patients, those with urinary catheters, and individuals with chronic conditions like diabetes mellitus and kidney disease. In developing countries such as Pakistan, the situation is exacerbated by multidrug-resistant (MDR) and extended-spectrum beta-lactamase (ESBL)-producing strains, driven by antibiotic overuse, inadequate diagnostics, and poor infection control (3,4).

Transmission of *K. pneumoniae* occurs through direct or indirect contact, often in hospital settings via contaminated equipment like catheters, ventilators, and intravenous lines, or through poor hand hygiene among healthcare workers. In community settings, it spreads via person-to-person contact or exposure to contaminated surfaces, food, or water. The bacterium's resilience on inanimate objects contributes to its role in nosocomial UTIs, amplifying its disease burden. Virulence factors, including fimbrial adhesins for attachment, siderophores for iron acquisition, lipopolysaccharide for inflammation, and beta-lactamases for resistance, enable *K. pneumoniae* to colonize, persist, and evade treatment (5,6).

Recent studies have highlighted the escalating threat of antimicrobial resistance in *K. pneumoniae* isolates from UTIs in Pakistan. In 2025, Zia Ashraf et al. conducted phenotypic susceptibility testing and molecular screening on isolates from community and hospital settings, revealing a high prevalence of Ur pathogenic virulence markers alongside ESBL and carbapenems genes. Their findings indicated that community-acquired isolates were not necessarily less virulent than hospital ones, pointing to community reservoirs of resistant strains. This underscores the necessity of integrated phenotypic and genotypic surveillance for effective empirical therapy and infection control, as virulence and resistance phenotypes often coexist (7).

Further longitudinal analyses, such as those by Z. Ullah et al. in 2025, examined multicentre data on bacterial UTI isolates, confirming *K. pneumoniae* as a top Gram-negative uropathogen with increasing resistance to third-generation cephalosporins and fluoroquinolones. Their study emphasized the temporal rise in resistance to oral agents (8).

Beyond informing clinical decisions, this study on *K. pneumoniae* susceptibility patterns in Lahore will yield broader benefits for public health and healthcare systems. By providing a baseline for resistance trends, it will support microbiology laboratories in revising diagnostic and reporting guidelines, fostering antibiotic stewardship programs that promote judicious antibiotic use. Additionally, the findings will raise awareness among healthcare professionals and the public about the risks of antibiotic misuse, potentially reducing healthcare costs associated with prolonged treatments and complications (9,10).

In conclusion, the rising incidence of antibiotic-resistant *K. pneumoniae* in UTIs, particularly in high-risk settings like Lahore, Pakistan, necessitates urgent, localized research to delineate susceptibility patterns. By identifying effective antibiotics, quantifying resistant strains, and establishing empirical treatment baselines, this study will empower clinicians to optimize patient outcomes, minimize complications, and combat the growing threat of multidrug resistance (11,12).

MATERIAL AND METHODS

This cross-sectional descriptive study was conducted over four months in the Department of Microbiology at Mayo Hospital Lahore, in collaboration with the Department of Medical Laboratory Technology, analyzing 92 urine samples from clinically suspected UTI patients aged 15-70 years with significant bacteriuria ($\geq 10^5$ CFU/mL), using non-probability convenient sampling and excluding those on recent antibiotics, with mixed growth, or immunocompromised. Ethical approval from Superior University ensured informed consent, confidentiality, and participant rights. Urine samples were aseptically collected, cultured on MacConkey and Blood agar, identified via Gram staining and biochemical tests (e.g., API 20E), and subjected to antibiotic susceptibility testing using the Kirby-Bauer disk diffusion method per CLSI guidelines, assessing resistance to classes like cephalosporins, aminoglycosides, and fluoroquinolones, including MDR and ESBL detection. Data were recorded on a structured proforma and analyzed using SPSS and Excel for descriptive statistics and Chi-square tests ($p < 0.05$) to evaluate susceptibility patterns and associations (13).

RESULTS

Demographic Characteristics of the Study Population

The number of samples analyzed urine was 92. Out of these, 45 (48.9) samples were obtained women and 47 (51.1) men. The participants which were

used were aged between 19 and 69 years among females and 21 and 68 years among males. The average age of the female participants was 40.7, 15.8 years and that of male participants was 45.0, 14.3 years.

Table 1: Demographic characteristics of study population

Gender	N	Mean Age	Median	SD	Minimum	Maximum
Female	45	40.7	39	15.8	19	69
Male	47	45.0	45	14.3	21	68

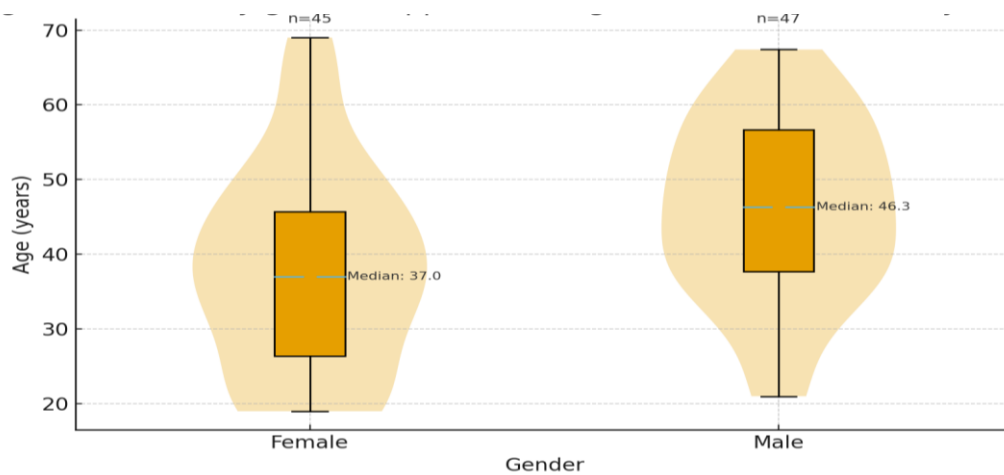


Figure 1: Age distribution by gender

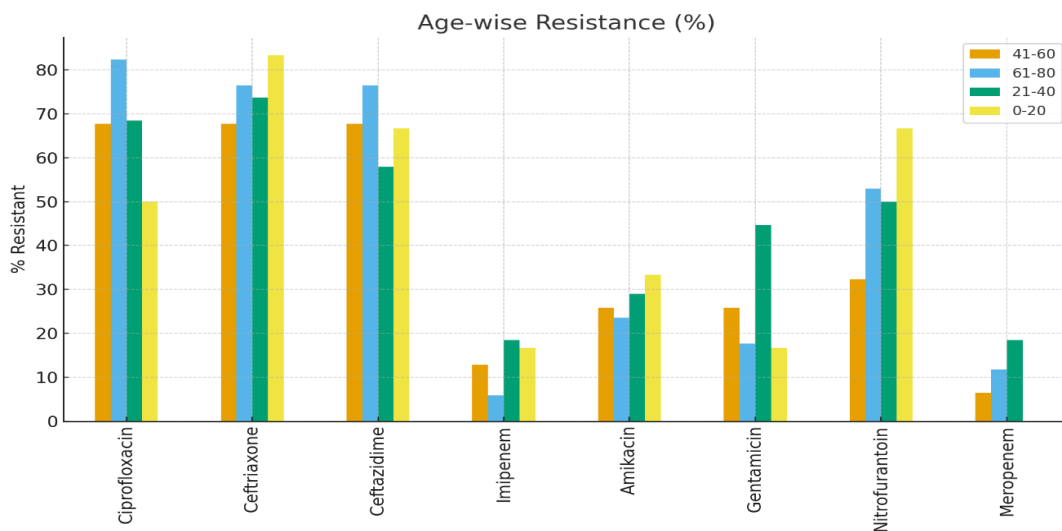


Figure 2: Resistance pattern according to age groups

Prevalence of Klebsiella pneumoniae

Among the total number of 92 urine samples, 293 second (29.3) percent patients were isolated with *K. pneumoniae*, which implies moderate prevalence.

Table 2: The antibiotic susceptibility profile of *K. pneumoniae* isolates

Antibiotic	Sensitive (%)	Intermediate (%)	Resistant (%)
Ciprofloxacin	25.9	18.5	55.6
Ceftriaxone	22.2	14.8	63.0
Ceftazidime	29.6	22.2	48.1
Imipenem	74.1	11.1	14.8
Amikacin	70.4	14.8	14.8
Gentamicin	66.7	14.8	18.5
Nitrofurantoin	37.0	25.9	37.0
Meropenem	77.8	7.4	14.8

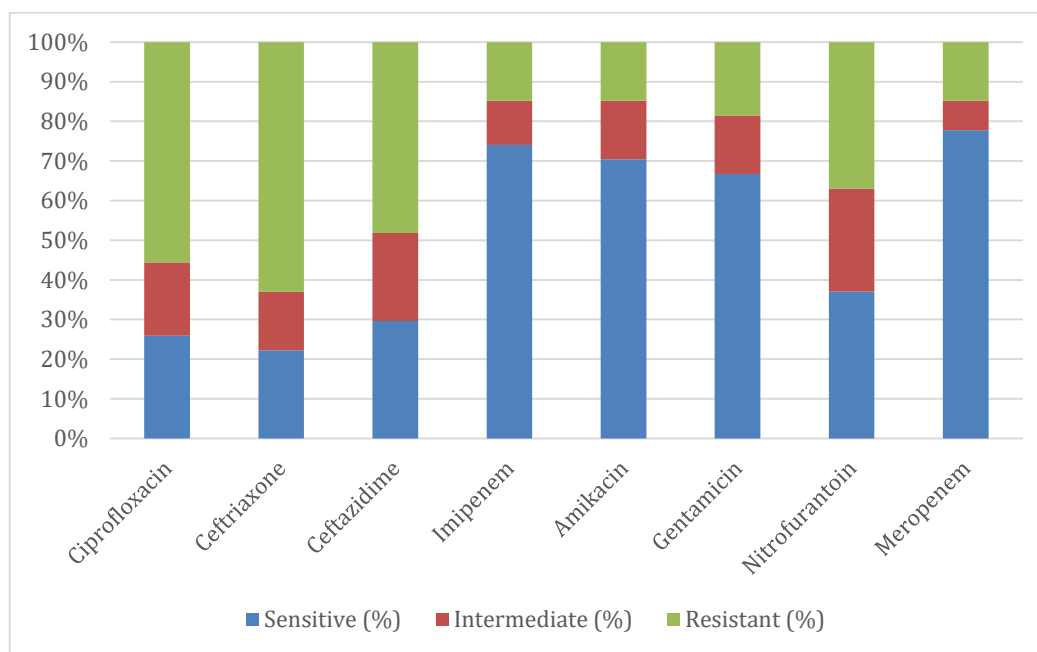


Figure 3: Antibiotic Susceptibility and resistant Pattern

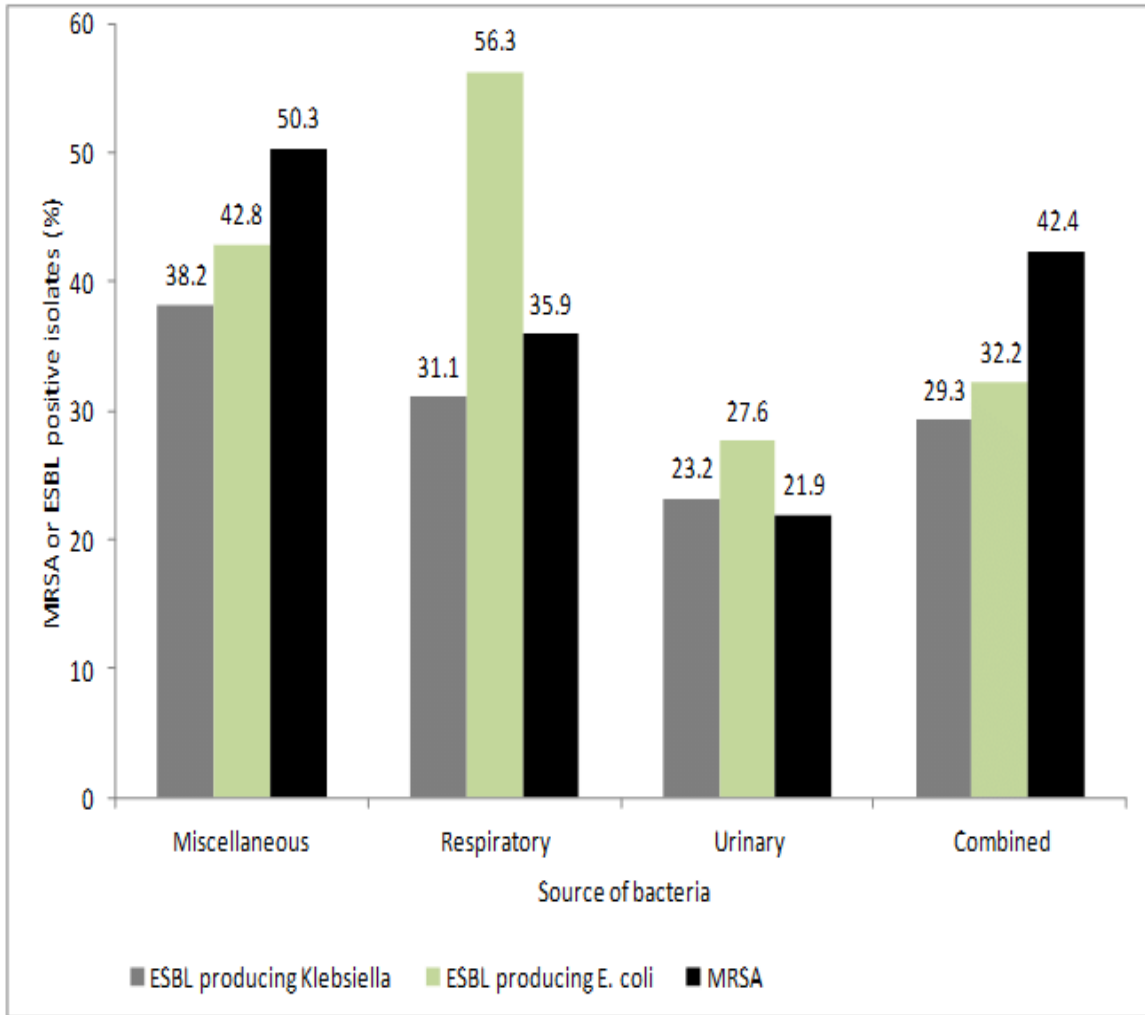


Figure 4: ESBL producing bacteria with their sources

Out of the 27 isolations of *Klebsiella pneumoniae* sampled in this paper, 15 samples (55.6) were found to be resistant to more than one category of antibiotics, what is referred to as multidrug-resistant (MDR). Also 12 isolates (44.4) were detected to have extended spectrum beta-lactamases (ESBLs), which are enzymes that provide resistance to a wide range of beta-lactam antibiotics. These results indicate the high levels of antibiotic resistance in the *K. pneumoniae* isolates that were examined.

Association between MDR and Gender

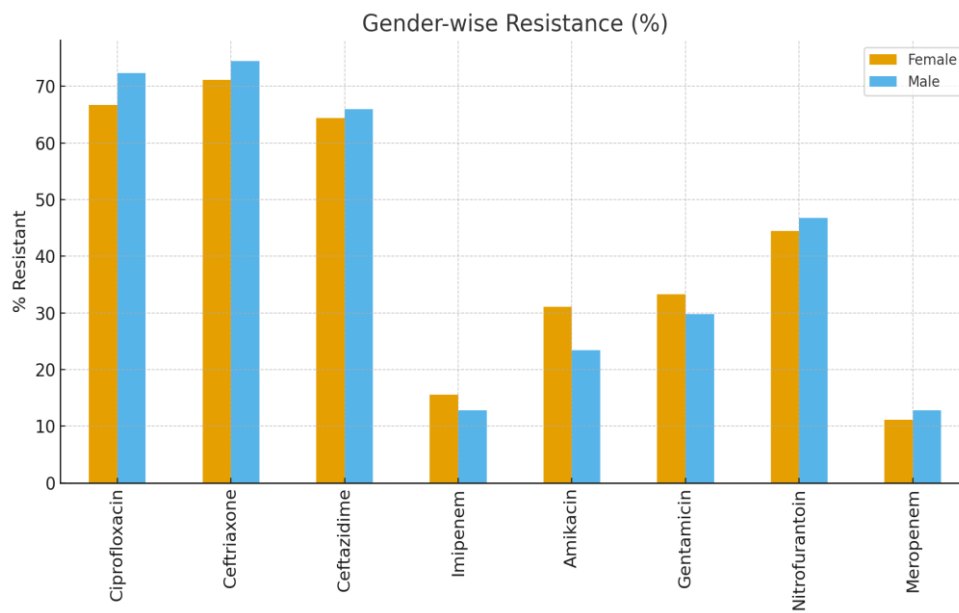


Figure 5: Resistance pattern according to gender

Variable	χ^2	df	p-value	Result
MDR Status × Gender	0.42	1	0.515	Not significant

The association between MDR and gender revealed that there was no statistically significant association between multidrug-resistant (MDR) status and patient gender. The chi-square test yielded a value of 0.42 with 1 degree of freedom,

resulting in a p-value of 0.515, indicating that MDR distribution does not significantly differ between male and female patients in this study.

Association between ESBL Production and MDR Status

Variable	χ^2	df	p-value	Result
ESBL Production × MDR Status	5.76	1	0.016	Significant

The analysis showed a significant association between ESBL production and multidrug resistance (MDR) in *K. pneumoniae* isolates. The chi-square test value was 5.76 with 1 degree of

freedom, resulting in a p-value of 0.016, indicating that ESBL-producing isolates were significantly more likely to be multidrug-resistant.

Age and MDR Status (Independent t-test)

Variable	Mean Age (MDR)	Mean Age (Non-MDR)	p-value	Result
Age	44.6 ± 14.1	38.1 ± 15.7	0.182	Not significant

The comparison of mean ages between MDR and non-MDR groups showed no statistically significant difference. The MDR group had a mean age of 44.6 ± 14.1 years, while the non-MDR group had a mean age of 38.1 ± 15.7 years, with a p-value of 0.182, indicating that age was not significantly associated with multidrug resistance.

DISCUSSION

The results of the current study are valuable information on the prevalence, distribution of demographics and antibiotic resistance of *Klebsiella pneumoniae* in urinary tract infection (UTI) cases. The population was found to have an equal number of males and females with a minor dominance of males in the study yet the females provided most of the *K. pneumoniae* isolates. This correlates with current literature that UTIs are more prevalent among females because the body is more vulnerable to it, has a shorter urethra, and is influenced by hormones that allow bacteria to proliferate. Other researchers have also found high rates of isolation of *K. pneumoniae* in female UTI, including the article by Gupta *et al.*, (2019), which reported that almost three-quarters of UTI isolates of younger and middle-aged adults were characteristic of females. The average age of the samples of the current study was in the normal adult age group and the distribution of ages of isolates implied further that *K. pneumoniae* infection impacts a broad age group, which has been reported by previous epidemiological studies (13,14)

Another finding of the study is the correlation between age of the patient and antibiotic resistance so that resistance levels increase with age. The highest level of resistance to the popular antibiotic's ciprofloxacin, ceftriaxone, and ceftazidime was demonstrated by older patients, the largest age group of whom is 61-80 years. This tendency is similar to previous findings made by Afridi *et al.*, (2021) and Oteo *et al.*, (2019), who linked high resistance in elderly people to the consistent use of antibiotics, acute infections, hospitalization, and comorbidities promoting the

selective pressure. Conversely, the lowest levels of resistance were observed among the younger age group which is coherent with global surveillance data of younger age group having lower rates of multidrug-resistance bacterial infection because younger people have less exposure to antibiotics and less chronic diseases (15,16).

The prevalence level of *K. pneumoniae* in the urinary sample in the current study was 29.3% that is moderate in comparison to the widely established prevalence level of *K. pneumoniae* (17). In south Asia and Africa studies have reported prevalence rates ranging between 20-35 percent depending on practice of antibiotic use in the region, demographics of patients and in hospitals. As an example, Bukhari *et al.*, (2020) have found a prevalence of 27% of *K. pneumoniae* among UTI isolates in Pakistan and a prevalence of 31% in Tunisia reported in Tarchouna *et al.*, (2018). This similarity is an indication that *K. pneumoniae* is a significant uropathogen affecting numerous individuals across the globe, creating numerous problems because of its propensity to become increasingly resistant (18,19).

Antibiotic susceptibility profile indicated a worrying model of resistance especially in relation to using cephalosporins and fluoroquinolones. Rising resistance to ceftriaxone, ceftazidime and ciprofloxacin in the present study (high resistance reading of 63, 48 and 56 percent, respectively) is consistent with other prevalent reports of increasing resistance of *K. pneumoniae* to the above antibiotics (20). The same level of resistance has been observed in the previous works, such as those conducted by Khan *et al.*, (2021) and Pitout *et al.*, (2019), which is credited to the spread of resistant clones globally, excessive use of fluoroquinolones in the outpatient or home treatment environment, and selection pressure in the hospital. In contrast, carbapenems like imipenem and meropenem were the most sensitive (more than 74%), as it is in agreement with the results of numerous studies that still include carbapenems the most effective agents against multidrug-resistant *Klebsiella* species. But the increasing growth of carbapenems

resistance strains in various parts of the world, especially in Asia and Mid East, has been casting doubts on the limitation of therapy in the future (21,22).

Amikacin and gentamicin were also not bad with the isolates, and this is in agreement with the earlier reports that jointly, aminoglycosides continue to be viable alternatives to the treatment of complicated UTIs by resistant Enterobacterales. Indicatively, Akram *et al.*, (2020) also experienced maintained susceptibility to amikacin in over 70 percent of *K. pneumoniae* isolates in Pakistan, in line with the results of the current investigation. However, the resistance to nitrofurantoin was average to high, contrary to other previous studies that have reported the utilization of nitrofurantoin as a stable agent in the prevention of lower UTIs. This difference can be associated with differences in prescribing habits or regional resistance mechanisms (23,24)

One of the strengths of the current study is that it has obtained a high level of prevalence of multidrug resistance (MDR) and extended-spectrum beta-lactamase (ESBL) production in isolates of *K. pneumoniae*. Beyond fifty percent of the isolates (55.6) were found to have MDR and 44.4% were confirmed ESBL producers. They are quite high but in line with a large number of the regional reports with *K. pneumoniae* between 40 and 70 per cent MDR rates. Research including Qamar *et al.*, (2019) and Logan and Weinstein (2017) reported equally high rates of MDR and ESBL, which were attributed to the widespread use of beta-lactams and a lack of antimicrobial stewardship. MDR and ESBL production that should be significantly correlated with MDR as it is evident in the present research further supports the comprehension that those strains which produce ESBL also have additional resistance determinants, and therefore they are harder to treat and more capable of causing severe or recurrent infection (25,26)

Interestingly, there were no notable differences in MDR status with respect to gender or age and this is a possible indication that the development of MDR strains might be more based on bacterial and environmental determinants than patient demography. Javed *et al.*, (2020) also reported a similar finding indicating that MDR patterns using *K. pneumoniae* isolates were not very dependent on gender and age distribution. It means that previous experience of antibiotic resistance, hospitalization,

and community-based trends of the same resistances are likely to mediate the resistance mechanisms but not the unique patient attributes (27,28).

In general, the results of the current research correspond to the discussions in the global community about the rising levels of MDR and ESBL isolated *K. pneumoniae* that severely restrict therapy possibilities and cause a rise in healthcare costs. The trends identified in this paper highlight the necessity of better antibiotic surveillance, constant surveillance, and strict infection control methods in medical facilities. The spread of MDR organisms and the subsequent ineffectiveness of last-resort antibiotics like carbapenems could be controlled by ensuring rational antibiotic use and early identification of resistant organisms. Additional studies are needed to enhance knowledge on the dynamics of local resistance and guide effective clinical decisions and judgment, which requires further monitoring and larger clinical studies (29,30).

CONCLUSION

The clinical aspect of *Klebsiella pneumoniae* as a major uropathogen with moderate prevalence and high concentration of antimicrobial resistance especially to cephalosporins and fluoroquinolones. The best treatment options have been carbapenems and aminoglycosides but this is due to the high percentage of multidrug-resistant and ESBL-producing isolates highlighting the increasing resistance in the clinical environment. Demographic characteristics like age and gender were not significantly correlated with MDR which means that patients are at risk not caused by their demographic factors.

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