

*Full Length Research Paper*

# **Antibiotic resistance profile of *Escherichia coli* isolates among patients suspected of urinary tract infections at the Sourou Sanou University Hospital Centre of Bobo-Dioulasso, Burkina Faso**

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**This study aims to describe the antibiotics resistance (antimicrobial resistance [AMR]) profile of *Escherichia coli* isolates among patients suspected of urinary tract infections (UTIs) at the Sourou Sanou University Hospital Center (SSHUC) of Bobo-Dioulasso in Burkina Faso. A descriptive cross-sectional study was conducted from June 1 to August 31, 2021 at SSUHC. An exhaustive sampling was performed and the urine samples of patients suspected of UTIs were collected and subjected to urine analysis and culture. The culture consisted of bacterial isolation, identification, and Antibiotic Susceptibility testing (AST). In this study, 41.88% (178/425) patients were confirmed cases of UTIs. *E. coli* was involved in 43.8% (78/178) of the UTIs. The frequency of extended-spectrum beta-lactamase producing *E. coli* isolates was 23% (18/178). The resistance profile of *E. coli* was 93% for Amoxicillin, 79% for Amoxicillin + Clavulanic acid, 75% for Gentamicin, 70% for Ciprofloxacin, and 53% for Cefotaxime. The study confirmed the predominance of *E. coli* isolates in ITUs at the referral hospital of Bobo-Dioulasso with high levels of resistance to beta-lactams. There is a need to reduce AMR progression in Burkina Faso by strengthening the AMR surveillance system.**

**Key words:** Resistance, antibiotics, *Escherichia coli*, urinary tract infections, Bobo-Dioulasso.

## **INTRODUCTION**

Urinary tract infections (UTIs) are one of the most common infectious diseases, accounting for the majority of hospital visits in medicine (Emonet et al., 2011). These

infections can start from asymptomatic bacteriuria and lead to severe renal infection (Thirion and Williamson, 2003). They may be categorized by some urinary tract

abnormalities such as vesicoureteral reflux, presence of kidney stones, prostatic hypertrophy or contribute to the complication of another condition (Herinirina, 2009).

It is estimated that 3% of girls and 1% of boys would develop symptomatic UTIs during their childhood (Iacobelli et al., 2009) while 20% of the adult female population would present an episode of UTIs during their lifetime (Caillaud et al., 2017). According to data reported in 2006 in the United States, UTIs were responsible for 11,000,000 hospital visits and 500,000 hospitalizations (Nielubowicz and Mobley, 2010). In Africa, particularly in Burkina Faso, the prevalence of UTIs was estimated at 69.7% (Kafando et al., 2023).

Generally, Enterobacteriaceae species are the main pathogens responsible for UTIs, and *Escherichia coli* is the most common isolates found in UTIs, particularly in mild cystitis cases (Kafando et al., 2021).

UTIs caused by *E. coli* are considered as priority infections for disease surveillance system due to the high frequency of these bacterial isolates, their virulence and resistance to antibiotics (Hassaine and Boulanoir, 2019). Given the frequency of these infections and possible overdiagnosis, there is a significant risk of antibiotics overuse (Foxman, 2010). The latter can lead to the selection of single or multi-drug resistant bacterial strains. Steady increase in antibiotic resistance in UTIs led to the realization of many studies that attempted to determine the most appropriate treatment through identification of the most active antimicrobial agent and adequate treatment duration for mild cystitis (Zalmanovici et al., 2010). It is in this perspective that this study was conducted to describe the antibiotic resistance profile of *E. coli* isolates among patients suspected of UTIs at the Souro Sanou University Hospital Center (SSUHC) of Bobo-Dioulasso from June to August, 2021.

## MATERIALS AND METHODS

### Type, period, and site of the study

This was a descriptive cross-sectional study that was conducted over a period of three months (June 1 to August 31, 2021) at the Souro Sanou University Hospital Center (SSUHC) in Bobo-Dioulasso. The SSUHC is located in Bobo Dioulasso, capital of the Hauts-Bassins region and the economic capital of Burkina Faso. The health coverage regions of the SSUHC, which include the Haut-Bassins, the Cascades, Boucle du Mouhoun, and Southwest regions with a total population estimated at 6,555,016 inhabitants in 2022. The hospital has a capacity of 656 beds, and six departments namely medicine, pediatrics, surgery, obstetrics and reproductive medicine, pharmacy, and laboratory. Bacteriological analyses were performed in the Laboratory Department of the Bacteriology-Virology Service of the SSUHC, which hosts the National Reference Laboratory for antimicrobial resistance (AMR) surveillance in

Burkina Faso.

### Sampling and data collection

An exhaustive sampling was performed by involving hospitalized patients in the different hospital wards and patients from the community who were suspected of UTIs during their stay at the SSUHC in Bobo-Dioulasso.

Urine samples were collected using the clean-catch technique. Briefly, patients were recommended to disinfect their hands before opening the container and collect the midstream urine that had been in the bladder for at least 4 h in the morning. Socio-demographic and clinical data were collected using laboratory requisition forms.

### Inclusion criteria

All patients having one of the symptoms of an infection of the urinary tract such as dysuria, pollakiuria, urinary incontinence, lumbar pain, macroscopic hematuria, and were referred to the Laboratory of Bacteriology for urine analysis and culture.

### Cytology

Cytological analysis was carried out on all urine samples using KOVA Glass cell. Prior to this analysis, the pellet of each urine sample was used for Gram staining. The type of Gram staining guided the choice of the culture medium for bacterial isolation.

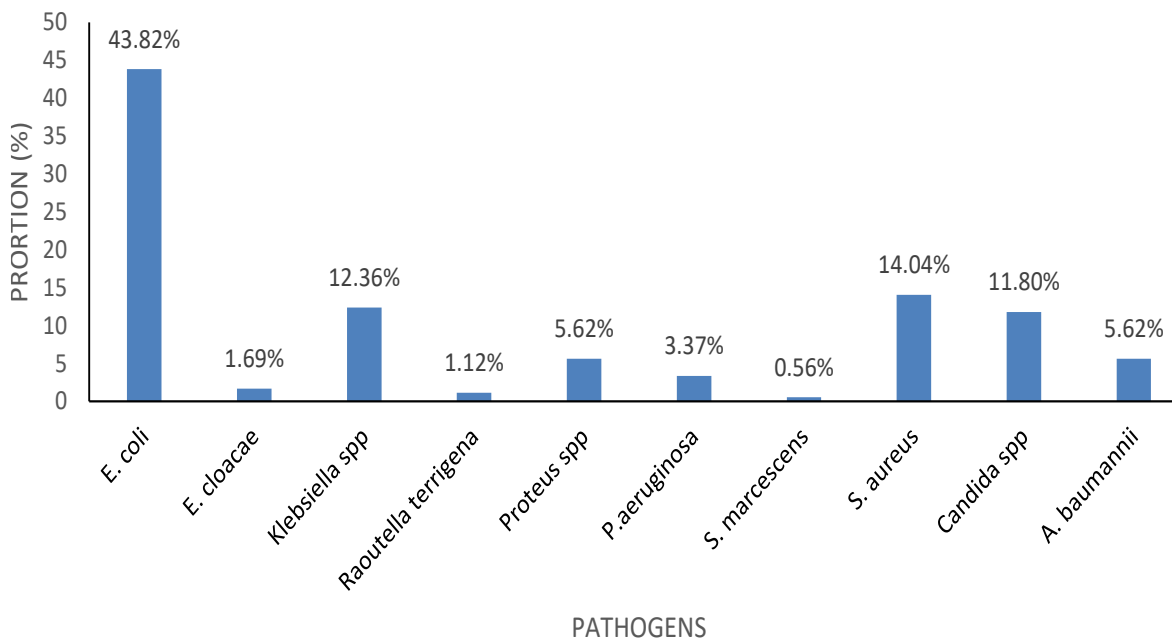
### Isolation and identification of bacteria

Bacterial count was performed by plating the urine on cystine lactose electrolyte deficient (CLED) culture media using the top-down tight striations method 10  $\mu$ l inoculating loop. Eosin Methylene Blue (EMB) agar medium was used to isolate pathogenic *E. coli* from urine samples. The plates were incubated at 35  $\pm$  37°C for 18 to 24 h. Urine samples were considered positive when the leukocyturia was higher than 10<sup>4</sup> ml<sup>-1</sup> and bacteriuria higher than 10<sup>3</sup> Colony Forming Units (CFU)/ml (Nielubowicz and Mobley, 2010). API 20E (bioMerieux SA, France) was used for the identification of *E. coli* strains.

### Antibiotic susceptibility testing

Antibiotic susceptibility testing was carried out using the Kirby-Bauer agar diffusion technique according to the recommendations of the French Society of Microbiology (CA-SFM, 2015). The bacterial suspension was prepared with sterile physiological water from a pure strain and compared to Mac Farland 0.5. Bacterial suspension was inoculated on Muller Hinton medium (Iiofilchem diagnostic) by swabbing. Antibiotic discs were deposited with sterilized metallic forceps on the surface of Mueller-Hinton agar. Strains were tested for antibiotic susceptibility testing using cefotaxime 30  $\mu$ g (CTX), the amoxicillin/clavulanic 20/10  $\mu$ g (AMC), imipenem 10  $\mu$ g (IPM), gentamicin 10  $\mu$ g (GEN), ciprofloxacin 5  $\mu$ g (CIP), amikacin 30  $\mu$ g (AK) (Iiofilchem diagnostic, Italy). The culture

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**Figure 1.** Distribution of pathogens in patients suspected of urinary tract infections at the Sourô Sanou University Hospital Center. n= Total number as 178.

plates were incubated at  $35 \pm 37^{\circ}\text{C}$  for 18 to 24 h. After incubation, the inhibition diameters were measured using a caliper and their interpretation was done according to the recommendations of the CA-SFM (CA-SFM, 2015).

#### Detection of extended spectrum beta-lactamases (ESBL)

ESBL detection was performed by the so-called "champagne cork" synergy image search between the beta-lactamase inhibitor discs AMC 20/10  $\mu\text{g}$  brought together with a CTX 30  $\mu\text{g}$  disc according to CA-SFM recommendations.

#### Quality control

The quality control of the antibiotic disks and culture media was done using the reference strains *E. coli* ATCC 25922 for susceptible bacterial strains and *Klebsiella pneumoniae* ATCC700603 for resistant bacterial strains according to the recommendations of the CA-SFM.

#### Ethical considerations

The authorization of the Director General of the SSUHC was obtained for data collection. Anonymity and confidentiality with respect to the data collected from the patients were observed throughout and after this study.

#### Data analysis

Data analysis was performed with Microsoft Excel 2016. Quantitative variables were expressed as median and qualitative variables as proportions.

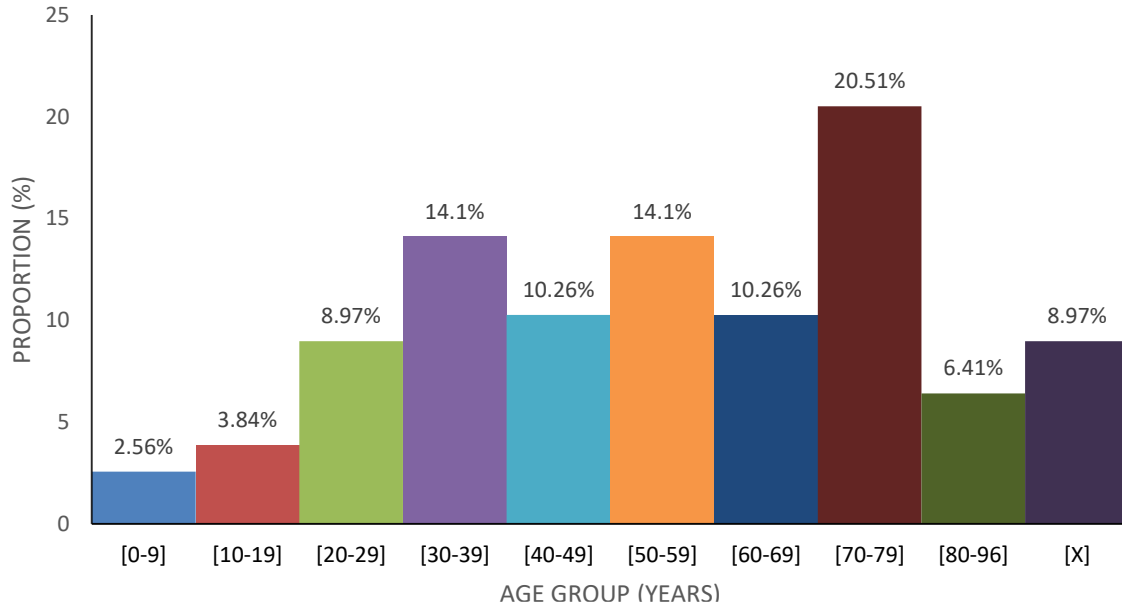
## RESULTS

### Socio-demographic characteristics of UTI caused by *E. coli*

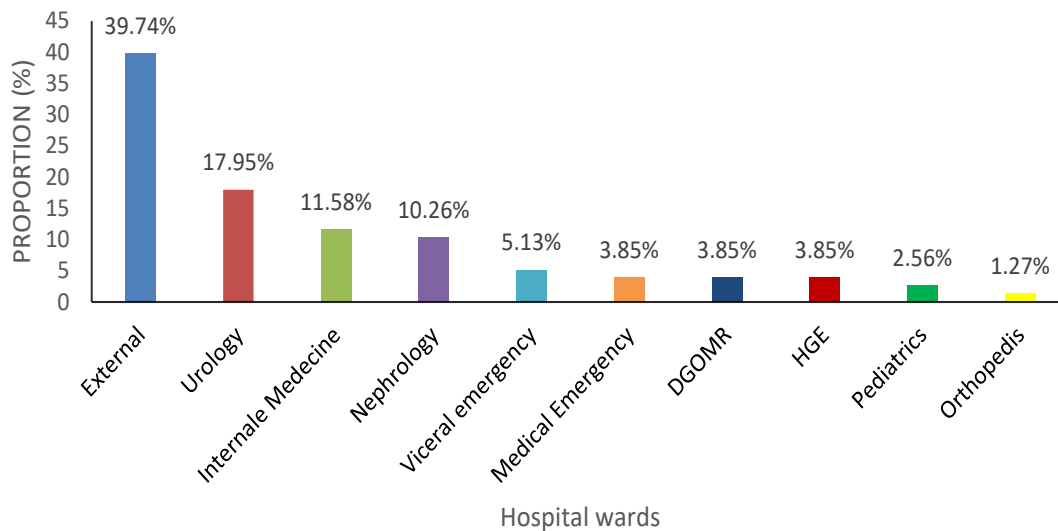
Out of the 424 patients included in this study, UTI was confirmed in 178 patients. Uropathogenic *E. coli* (Figure 1) was found in urine samples from 51% female patients. The age group between 70 and 79 years old was the most affected by uropathogenic *E. coli*, representing 20.51% (Figure 2). Regarding the hospital wards, Uropathogenic UTI caused by *E. coli* was more frequent in patients living in community settings, giving a proportion of 39.74% (Figure 3). Other identified species were as follows: *Enterobacter cloacae* (n=3), *Klebsiella* species (n=26), *Raoultella terrigena* (n=2), *Proteus* species (n=10), *Pseudomonas aeruginosa* (n=2), *Serratia marcescens* (n=1), *Staphylococcus aureus* (n=25), *Candida* species (n=21), and *Acinetobacter baumannii* (n=10).

### Antibiotic resistance profile of uropathogenic *E. coli* isolates

A total of 78 *E. coli* isolates showed a high level of resistance to beta-lactams, including amoxicillin (93%), amoxicillin + clavulanic acid (79%), cefotaxime (53%), gentamicin (25%), and ciprofloxacin (70%) whereas imipenem and amikacin were still active on uropathogenic *E. coli* isolates with an estimated resistance rate of 5% (Table 1).



**Figure 2.** Distribution of uropathogenic *E. coli* by age group in patients suspected of UTI at the Sourou Sanou University Hospital Center. X: unknown age group. n= Total number as 78.



**Figure 3.** Distribution of uropathogenic *E. coli* by hospital wards in patients suspected of UTI at the Sourou Sanou University Hospital Center. DGOMR: Department of Gyneco-Obstetrics and Reproductive Medicine, HGE: Hepato-Gastroenterology. n= Total number as 78.

**Phenotype of resistance *E. coli* strains**

As regards resistance to beta-lactam antibiotics, the penicillinase phenotype was the most common at 93%, followed by ESBL at 23% as shown in Figure 4. Aminoglycoside resistance in *E. coli* strains showed a predominance of the gentamicin-resistant phenotype at 31%. As for resistance to quinolones, 70% of strains were resistant to ciprofloxacin (Table 2).

**DISCUSSION**

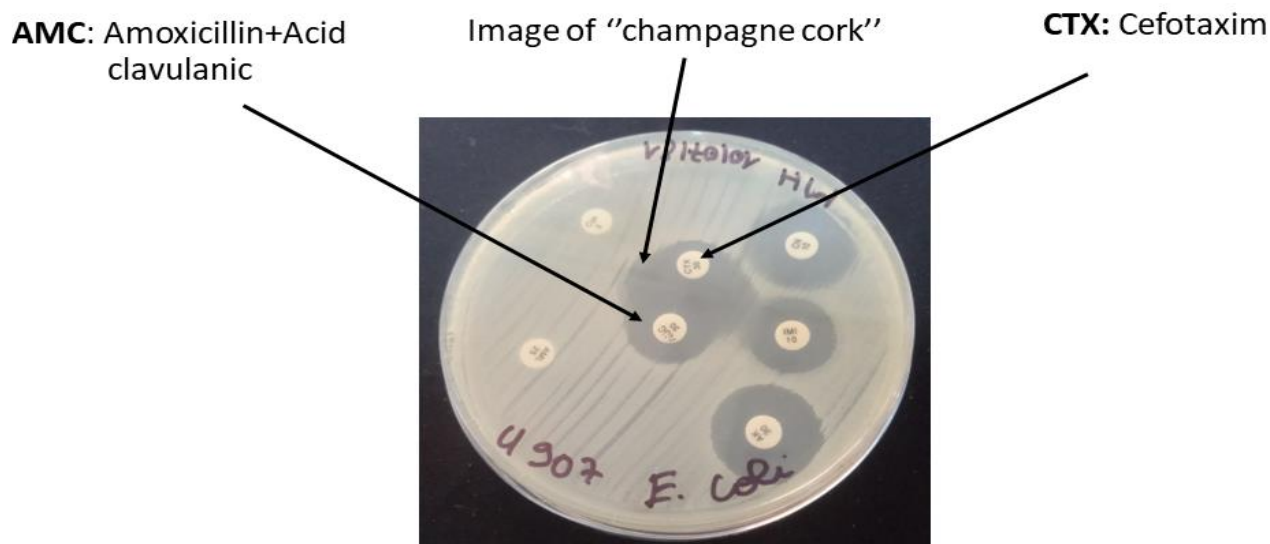
A description of the antibiotic resistance profile of *E. coli* isolates among patients suspected of UTIs at the Sourou Sanou University Hospital Center of Bobo-Dioulasso was shown in this study.

In this study, 178 (178/425) patients were UTI confirmed cases. The distribution of pathogens by species showed that *E. coli* was the most represented uropathogen

**Table 1.** Antibiotic resistance profile of uropathogenic *E. coli* isolates according to the activity of antibiotics.

Antibiotic resistance profile of <i>E. coli</i> isolates	Antibiotics						
	AX (%)	AMC (%)	CTX (%)	IMP (%)	AK (%)	CN (%)	CIP (%)
Rate of antibiotic susceptibility	00 (00)	14.1 (11)	35.8 (28)	89.7 (70)	89.7 (70)	64.1 (50)	25.6 (20)
Rate of intermediate antibiotic resistance	6.4 (05)	7.6 (05)	10.2 (08)	5.0 (04)	5.0 (04)	10.2 (08)	03.8 (03)
Rate of total antibiotic resistance	93 (73)	79 (62)	53 (42)	5.0 (04)	5.0 (04)	25 (20)	70 (55)

AX: Amoxicillin, AMC: Amoxicillin-clavulanic acid, CTX: Cefotaxime, IMP: Imipenem, AK: Amikacin, CN: Gentamicin, CIP: Ciprofloxacin, ESBL: Extended spectrum beta-lactamase.



**Figure 4.** Production of Extended-spectrum beta-lactamase by an *E. coli* isolated from urine sample of a patient at the Sourou Sanou University Hospital Center of Bobo-Dioulasso, Burkina Faso. There is a clear representation of 'champagne cork' between CTX and AMC.

(43.82%). Indeed, *E. coli* is the species most commonly isolated in UTIs. This can be explained by the pathophysiology of UTIs, which generally occurs through ascending pathway with colonization of the perineum by Enterobacteriaceae species from gastric intestinal tract, in particular *E. coli* (Dalal et al., 2009; Bruyère et al., 2013). This finding correlates with the study of Bounemour (2018) on the bacteria responsible for UTIs in Algeria in 2018, in which *E. coli* was the predominant species causing UTIs (44.01%). Lobel and Soussy (2007) reported high prevalence of *E. coli* (70-95%) in UTIs. *S. aureus* was the second most prevalent species after *E. coli*, with a frequency of 14.04% in this study. *S. aureus* is a relatively rare cause of UTI in the general population (Demuth et al., 1979). Although isolation of *S. aureus* from urine samples is often secondary to staphylococcal bacteremia occurring elsewhere (e.g., in endocarditis) in some patients, *S. aureus* causes ascending colonization and infection of the urinary tract (Lee et al., 1978).

Regarding the distribution of uropathogenic *E. coli* by age group, the age group between 70 and 79 years old

was the most affected by UTIs caused by *E. coli* (20.51%). This could be due to the high frequency of underlying diseases such as diabetes, prostate disease, indwelling catheters, bladder hypoactivity, and weakened immune system that may favor the occurrence of opportunistic infections in this age group representing the elderly patients (Gonthier, 2000; Bally and Troillet, 2008). This finding correlates with the study of Doumia (2019) on the antibiotic resistant profile of uropathogens in Mali. In this study, 60 year-old patients and above were the most affected by UTI and this accounted for 30.1% (Doumia, 2019). Other authors also confirmed the predominance of UTIs among elderly patients (Gonthier, 2000; Durand-Gasselien and Haber, 2001). It was rationalized that decrease in functional autonomy of bladder is associated with the occurrence of UTIs in elderly patients (Falcou et al., 2018).

The distribution of uropathogenic *E. coli* by age gender in patients suspected of UTIs at the Sourou Sanou University Hospital Centre indicated that women were mainly affected (51%) by UTIs caused by *E. coli* isolates.

**Table 2.** Multidrug resistance (MDR) profile of *Escherichia coli* isolates.

Phenotype	Number of <i>E. coli</i> isolates	Proportion of <i>E. coli</i> isolates (%)
Penicillinase	73	93
ESBL	18	23
Resistance to Imipenem (Carbapenem)	04	05
Resistance to Amikacin and Gentamicin (Aminoglycosides)	24	31
Resistance to Ciprofloxacin (quinolone)	55	70

This female predominance could be due to the anatomy of their urinary tract, which is characterized by the shortness of urethra and the proximity between their anus and urethra leading to frequent UTIs in women (Barrier Letertre Clémence, 2013). Indeed, it is reported that more than 30% of women and nearly 10% of men suffer from UTIs at least once in their lifetime (Zalmanovici et al., 2010). Furthermore, factors such as bacterial infection of the periurethral glands, the turbulent flow of urine over the surface of the urethra, the contiguity of the perineal orifices and sexual intercourse favor the occurrence of UTI in women (Zalmanovici et al., 2010).

The distribution of uropathogenic *E. coli* isolates by hospital wards at the Souro Sanou University Hospital Center showed a high frequency of uropathogenic *E. coli* (39.74%) which was found in patients from community settings. Indeed, *E. coli* is an ubiquitous microorganism found in both hospital and community settings (Pitout et al., 2005; Sabir et al., 2014). It is the most common species causing UTIs in community settings, and is involved in 85% of UTIs cases in some cases (Naber et al., 2008). Lack of sanitation in developing countries could contribute to the spread of uropathogenic *E. coli* strains. In addition, poor management of biomedical waste in resource-constrained countries could also be a key driver of UTIs in the community settings.

Regarding the antibiotic resistance profile of *E. coli* isolates, there was high resistance to beta-lactams at the proportions of 93% for Amoxicillin, 79% for Amoxicillin + Clavulanic acid. Similar observation was made by Bounemour (2018) in Algeria who found a resistance profile of uropathogenic *E. coli* strains at 95% for Amoxicillin.

Penicillinase resistance in *E. coli* has long been described, and is most often associated with TEM penicillinases (Rakotovao-Ravahatra et al., 2017; Abraham and Chain, 1988). This high rate of resistance is the result of the selection pressure due to the excessive prescription and sometimes misuse of these antibiotics both in hospitals and primary care centers (Sbiti et al., 2017). As for resistance to third-generation cephalosporins, around 55% of *E. coli* isolates were resistant to Cefotaxime, and in 18% of cases, this resistance was associated with ESBL production. Yandai et al. (2019) and Amady et al. (2021) reported higher rates than the present study, with 33.33 and 25.4% of

ESBL phenotypes, respectively (Yandai et al., 2019; Amady et al., 2021). Resistance to third-generation cephalosporins (3GCs) considerably reduces therapeutic options and contributes to a continued increase in carbapenem prescribing which retains good activity in most cases (Forestier et al., 2012). This high rate of resistance highlights the extent of the antibiotic resistance phenomenon, which could be favored not only by the abusive use of antibiotics in our healthcare settings but also self-medication. Uropathogenic *E. coli* strains were also producers of ESBL. ESBL-producing bacteria are a major concern in the hospital setting due to their epidemic spread and multiple antibiotic resistance (Kalambry et al., 2019). Hospital-acquired infections caused by ESBL-producing Enterobacteriaceae represent a real therapeutic problem due to multidrug resistance, and hence, the limited choice of antibiotic molecules available on the market (Paterson et al., 2000).

Resistance of *E. coli* strains to aminoglycosides was 5% for Amikacin and 25% for Gentamicin. Ouattara (2022) found 20.69% resistance to Amikacin and 41.43% to Gentamicin. The same is true of those described by Yandai et al. (2019) who found a resistance rate of 33% for Gentamycin and 15% for Amikacin. The disparity in *E. coli* resistance to gentamycin and amikacin may be linked to enzyme activity. *AAC(3)-II* spares amikacin and hydrolyzes gentamicin, while *AAC(6)-I* hydrolyzes amikacin and *AAC(6)-II* hydrolyzes gentamicin. The predominance of *AAC(3)-II* and *AAC(6)-II* enzymes is thought to be responsible for the high level of gentamycin resistance, as these are their preferred substrates (Xiao and Hu, 2012). Plasmids encoding ESBL genes often result in resistance to other antibiotics such as aminoglycosides, chloramphenicol, sulfonamide/trimethoprim combination, cyclins, and fluoroquinolones (Ouedraogo et al., 2016; Sanou et al., 2021).

As for quinolone resistance, 70% of the strains were resistant to ciprofloxacin. Similar results were reported by Sbiti et al. (2017) and El Bouamri et al. (2014) who reported in their studies, rates of ciprofloxacin co-resistance ranging from 82%. This resistance is thought to be a consequence of the high prescription of fluoroquinolones in the treatment of UTIs caused by enterobacteria, especially *E. coli* (Lahlou et al., 2009). In addition, the resistance associated with fluoroquinolones is linked to the presence of genes *qnr* (alleles A, B, S)

and in particular the *aac(6')-Ib-cr* gene which most often coexists with BLSE genes and confers dual aminoglycoside-piperazine-quinolone (Coque et al., 2008). This high rate of antibiotic resistance highlights the extent of the antimicrobial resistance phenomenon, which could be favored not only by the abusive use of antibiotics in our healthcare settings, but also self-medication (Sbiti et al., 2017).

Imipenem and Amikacin were still active on the majority of uropathogenic *E. coli* isolates in this study. It is suggested that Imipenem remains the most active antibiotic molecule on *E. coli* isolates because it is only prescribed in hospital settings and used as a last therapeutic option for UTIs treatment in our context.

## Conclusion

The objective of this study was to describe the resistance profile of *E. coli* isolates among patients suspected of UTIs at the Souro Sanou University Hospital Center of Bobo-Dioulasso from June to August, 2021. This study finding underscored that the bacterial ecology has not changed much in recent years with predominance of *E. coli* among the uropathogenic bacteria in this study. In addition, some antibiotics such as amoxicillin, amoxicillin + clavulanic acid (beta-lactams) and ciprofloxacin (fluroquinolone) are no longer required for the treatment of UTIs.

These data show the emergence of resistance to beta-lactam antibiotics, often combining several mechanisms, including ESBL production, carbapenemases, resistance, quinolones, and antibiotic resistance. In view of these findings on the resistance profiles of uropathogenic bacteria, it is therefore necessary to strengthen the AMR surveillance in order to define better therapeutic strategies adapted to the local epidemiology, optimize the probabilistic antibiotic therapy of ITU, and reduce the progression of AMR.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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