

# Prevalence of Multidrug-Resistant Bacteria Responsible for Human Infections at the Dedougou Regional Hospital Center (RHC), Burkina Faso

Hiliassa Coulibaly<sup>1\*</sup>, Oumar Traoré<sup>1,2</sup>, Dissinviel S. Kpoda<sup>3</sup>, Alix Bénédicte Kagambega<sup>1</sup>, Alassane Halawen Mohamed<sup>4</sup>, Marguerite Edith Malatala Nikiema<sup>1</sup>, Dramane Ouédraogo<sup>5</sup>, Dominique Bayala<sup>5</sup>, Abraham Ajayi<sup>6</sup>, Yakhya Dieye<sup>7</sup>, Nicolas Barro<sup>1</sup>, René Dembélé<sup>1,2</sup>

<sup>1</sup>Laboratory of Molecular Biology, Epidemiology and Surveillance of Bacteria and Viruses Transmitted by Food, University Joseph KI-ZERBO, Ouagadougou, Burkina Faso

<sup>2</sup>Training and Research Unit in Applied Sciences and Technologies, University Daniel Ouezzin COULIBALY, Dedougou, Burkina Faso

<sup>3</sup>Microbiology and Microbial Biotechnology Laboratory, Ouagadougou, Burkina Faso

<sup>4</sup>Microbiology Laboratory of the General Reference Hospital (GRH), Niamey, Niger

<sup>5</sup>Regional Hospital Centre of Dedougou, Dedougou, Burkina Faso

<sup>6</sup>Molecular Biology and Biotechnology Department, Nigerian Institute of Medical Research, Lagos, Nigeria

<sup>7</sup>Microbiology Unit, Institute Pasteur of Dakar, Dakar, Senegal

Email: \*coulibalyhiliassa0@gmail.com

**How to cite this paper:** Coulibaly, H., Traoré, O., Kpoda, D.S., Kagambega, A.B., Mohamed, A.H., Nikiema, M.E.M., Ouédraogo, D., Bayala, D., Ajayi, A., Dieye, Y., Barro, N. and Dembélé, R. (2025) Prevalence of Multidrug-Resistant Bacteria Responsible for Human Infections at the Dedougou Regional Hospital Center (RHC), Burkina Faso. *Open Journal of Medical Microbiology*, 15, 133-147.

<https://doi.org/10.4236/ojmm.2025.152011>

**Received:** April 3, 2025

**Accepted:** June 24, 2025

**Published:** June 27, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

Infections caused by bacteria that are increasingly resistant to antibiotics are a major global public health problem. This prospective study aimed to assess the prevalence of multidrug-resistant bacteria strains isolated from clinical samples collected at the Dedougou Regional Hospital Center (RHC). Bacteria were identified using conventional microbiology methods and then confirmed by mass spectrometry (MALDI-TOF). Antibiotic susceptibility testing was carried out using the disk diffusion method on agar according to the recommendations of the Antibiogram Committee of the French Microbiology Society. Of all the samples collected, 31.67% (95/300) of the cultures were positive. The analyses revealed that 56.84% (54/95) of urine samples, 25.26% (24/95) of pus samples, 13.68% (13/95) of vaginal samples, and 4.21% (4/95) of stools collected were positive. Identification of bacterial species shows that 58.95% (56/95) were Enterobacteriaceae (comprising 35.79% (34/95) *Escherichia coli* and 10.53% (10/95) *Klebsiella* sp.), 34.74% (33/95) cocci (comprising 30.53% (29/95) *Staphylococcus* sp.) and 6.31% (6/95) non-fermentative bacteria (4.21% (4/95) *Acinetobacter baumannii* and 2.11% (2/95) *Pseudomonas aeruginosa*). This study revealed a 55.79% (53/95) prevalence of multidrug-resistant bacteria

(19.64% (11/56) of ESBL among Enterobacteriaceae and 31.03% (9/29) MRSA among *Staphylococcus* sp.) with high resistance rates to beta-lactams and quinolones. Given these results, AMR surveillance needs to be stepped up. Public health efforts should focus on educating the population and healthcare professionals and promoting the correct and limited use of antibiotics to counteract the spread of multidrug-resistant bacteria.

## Keywords

Prevalence, Multidrug Resistant Bacteria, Human Infections, RHC Dedougou

---

## 1. Introduction

Bacterial infections have become widespread in recent years and are becoming increasingly difficult to prevent, diagnose and treat. This situation is particularly worrying in the hospital environment, as the number of resistant bacteria continues to rise, leading to the emergence of new drug-resistant strains [1]. Antibiotic resistance is one of the biggest threats to public health worldwide [2] [3]. This threat is also real on the African continent. Burkina Faso has undoubtedly not been immune to this multidrug resistance phenomenon. Several studies have reported variable data on the prevalence of bacteria that are multidrug-resistant to antibiotics, mainly Enterobacteriaceae producing extended-spectrum beta-lactamases (E-ESBL) [4]-[6] and methicillin-resistant *Staphylococcus aureus* (MRSA) [7] [8]. Studies carried out in urban hospitals in Ouagadougou and Bobo Dioulasso, Burkina Faso, have reported the presence of multidrug-resistant bacteria in patients with varying frequencies [9]-[13]. Recent studies in rural areas have focused on the multidrug resistance of *Salmonella enterica* and *E. coli* isolates and have also looked at resistance mechanisms through the molecular characterization of resistance genes to conventional antibiotics [14]-[17]. However, the Dedougou Regional Hospital Center (RHC) garnered our interest due to its substantial patient population and the absence of prior research addressing the issue of multidrug resistance. This study was carried out with the aim of assessing the prevalence of multidrug-resistant bacteria isolated from pathological samples in this RHC, aiming to enhance the antibiotic resistance monitoring program in Burkina Faso.

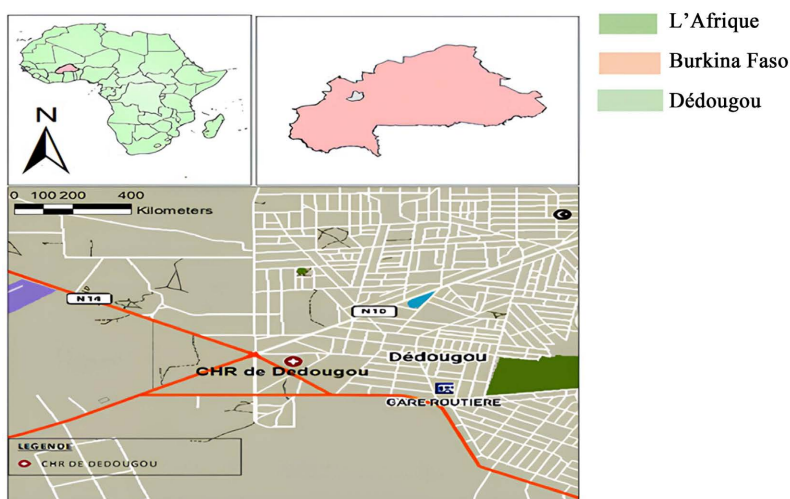
## 2. Material and Methods

### 2.1. Study Setting

This study was conducted in the Dedougou Regional Hospital Center, located in Dedougou, the capital of the “Boucle du Mouhoun” region in western Burkina Faso (Figure 1). It consists of clinical and medico-technical departments, including the biomedical analysis laboratory where this study was conducted.

### 2.2. Study Type, Period, and Sample Collection

This was a prospective study performed from October to December 2021. The



**Figure 1.** Study site.

study population comprised patients, irrespective of sex or age, seeking an etiological diagnosis of bacterial infection at the medical biology laboratory at Dedougou Regional Hospital. Each patient was sent to the laboratory by the attending clinician with a note indicating the cytobacteriological examination to be performed. For stool and urine samples, the collection method was clearly explained to the patient or their caregiver so that they could collect the samples themselves using aseptic techniques and transported them to the laboratory within two hours after collecting, to avoid contaminating the samples. On the other hand, Pus samples and vaginal swabs were collected by a health professional and were transported directly in the laboratory. Other Pus samples were collected in sterile tubes or containers by puncture. A total of 300 clinical samples, including urine ( $n = 165$ ), stools ( $n = 81$ ), pus ( $n = 38$ ), and vaginal swabs ( $n = 16$ ) were collected and analyzed in this study.

### 2.3. Inclusion and Exclusion Criteria

This study included samples from both hospitalized patients across the various departments of the Dedougou Regional Hospital Centre (RHC) and outpatients referred from surrounding health facilities, regardless of age or sex. Eligibility was determined based on the presence of a properly completed laboratory request form and the collection of samples under appropriate and standardized conditions.

Exclusion criteria comprised incomplete or poorly documented request forms, samples of inadequate quality, specimens contaminated with parasites or fungi, and those exhibiting highly heterogeneous bacterial flora (defined by the presence of multiple morphologically distinct colony types) upon initial diagnostic evaluation.

### 2.4. Isolation and Identification of Bacterial Strains

All biological samples received underwent macroscopic and microscopic exami-

nation, followed by inoculation on Cystine Lactose Electrolyte Deficient Agar (CLED; Conda-Lab, Spain), Eosin Methylene Blue (EMB; Liofilchem, Italy), Hektoen agar (HIMEDIA, India), and Chapman media (Liofilchem, Italy), incubated at 37°C for 24 hours. The oxidase test, which yielded a negative result, was performed on colonies suspected to be Enterobacteriaceae. Full identification of these suspect colonies was carried out using the API 20E identification system (BioMérieux, France). The catalase test was performed on colonies suspected to be *Staphylococcus* species. Colonies that tested catalase-positive, grew on Chapman agar, and fermented mannitol were inoculated into rabbit plasma (BIO-RAD, France) contained in a haemolysis tube and incubated at 37°C for 24 hours. The presence of *Staphylococcus aureus* was indicated by the formation of a clot at the bottom of the tube. *Staphylococcus aureus* ATCC 25923 was used as the positive control. The identification of all bacterial strains was confirmed through mass spectrometry using a MALDI-TOF system (Microflex, Bruker Daltonics, Bremen, Germany) at the Microbiology Research Unit (PMIC) of the Pasteur Institute in Dakar, Senegal.

## 2.5. Antibiotic Susceptibility Testing and Detection of Different Resistance Phenotypes

Antimicrobial susceptibility testing was performed using the standard Mueller-Hinton agar (Liofilchem, Italy) disk diffusion method and interpreted based on the 2018 guidelines of the Antibiogram Committee of the French Society of Microbiology (CA-SFM). Antibiotic discs were selected to target specific resistance phenotypes. Results were categorized as sensitive (S) or resistant (R) for each antibiotic. The antibiotics tested included ampicillin (10 µg), amoxicillin + clavulanic acid (30 µg), cefoxitin (30 µg), cefotaxime (30 µg), ticarcillin (75 µg), oxacillin (5 µg), imipenem (10 µg), gentamycin (10 µg), ciprofloxacin (5 µg), erythromycin (15 µg), lincomycin (2 µg), azithromycin (30 µg) and trimethoprim + sulfamethoxazole (25 µg).

The double synergy method was used for the systematic detection of ESBL-producing strains on Mueller-Hinton agar inoculated with a bacterial suspension adjusted to 0.5 McFarland. Antibiotic discs were placed on the agar, including an amoxicillin + clavulanic acid (AMC) disc positioned at 20 to 30 mm from third-generation cephalosporin discs (3GC = cefotaxime, ceftazidime), followed by incubation at 37°C for 24 hours. The presence of ESBLs was indicated by the appearance of a very characteristic “champagne cork”-shaped synergy image around the 3GC discs, with an expanded inhibition zone facing the AMC disc.

The detection of *Staphylococcus aureus* resistance to methicillin was carried out using cefoxitin (30 µg). A bacterial inoculum adjusted to 0.5 McFarland was seeded onto Mueller-Hinton agar. A set of antibiotic discs, including cefoxitin, was then placed on the agar, followed by incubation at 37°C for 24 hours. *S. aureus* isolates were considered methicillin-resistant when the cefoxitin inhibition zone diameters were strictly less than 22 millimetres (EUCAS-CASFM, 2018). For non-

fermentative bacteria, they were considered resistant (likely to produce a carbapenemase) in the face of any reduction in critical diameters to imipenem (diameter less than 22 mm) according to the recommendations established by EU-CAS-CASFM (2018).

In addition, any bacteria of medical interest that showed resistance to at least three antibiotics from different classes were multidrug resistant (MDR).

## 2.6. Data Processing and Analysis

The variables considered included socio-demographic factors (age group, gender, hospitalization status, and type of sample) and bacteriological parameters (bacterial species, antibiotic susceptibility, nature of multidrug-resistant bacteria, and resistance phenotypes). Data entry was performed using Epi Info 7.2.3.0, while statistical analyses were conducted using Python 3.9.1. The chi-square test was used to measure association between the different proportions, with a value of  $p < 0.05$  considered as statistical significance.

## 2.7. Ethical Considerations

The study was approved by the National Ethics Committee of Burkina Faso and the hospital authorities of the Régional Hospitalier Centre of Dedougou (Reference Code: N°2021-168/MS/SG/CHR-DDG/DG/DSIO, date: 14 September 2021). Informed verbal consent was obtained from all participants or, in the case of minors under 18 years of age, from their parents or legal guardians. The study adhered to the principles outlined in the Declaration of Helsinki.

## 3. Results

### 3.1. Socio-Demographic Characteristics of Patients

This study analyzed 300 clinical samples, 56.66% (170/300) from male patients and 43.34% (130/300) from female patients. The patients' average age was  $34.46 \pm 22.27$ , ranging from 0 to 95 years. Outpatients were the most represented 70.66% (212/300) and most affected by infections. Urine samples represented the largest proportion of samples, accounting for over half (55%, 165/300) of the total (**Table 1**).

**Table 1.** Distribution of socio-demographic characteristics.

Characteristics		Number of patients n (%)	95% CI Limits
Age range	≤5	49 (16.33)	12.12 - 20.78
	6 - 17	29 (9.67)	6.61 - 13.68
	18 - 65	186 (62)	56.31 - 67.61
	>65	36 (12)	8.61 - 16.33
Gender	Male	170 (56.66)	51.01 - 62.15
	Female	130 (43.34)	37.85 - 48.99

## Continued

<b>Patient status</b>	<b>Hospitalized</b>	88 (29.34)	23.53 - 33.68
	<b>External</b>	212 (70.66)	66.42 - 76.47
<b>Type of samples</b>	<b>Urine</b>	165 (55)	49.02 - 60.58
	<b>Stools</b>	81 (21)	22.13 - 32.51
	<b>Pus</b>	38 (12.66)	09.15 - 17.02
	<b>Vaginal swabs</b>	16 (5.34)	03.09 - 08.54

### 3.2. Overall Distribution of Bacteria Isolated

Of all the samples, 31.67% [95/300; 95% CI = 26.66 - 37.13] of the cultures were positive, including 4.21% (4/95) of stools, 13.68% (13/95) vaginal swabs, 25.26% (24/95) pus and 56.84% (54/95) of urine. Based on cultural, morphological, and biochemical characteristics, 95 bacterial strains were isolated from all samples. Of these, 65.26% (62/95) were Gram-negative bacilli while 34.74% (33/95) were Gram-positive cocci. Among the bacteria isolated, identification showed 58.95% [56/95; 95% CI = 48.38 - 68.94] of Enterobacteriaceae, 34.74% [33/95; 95% CI = 25.26 - 45.20] of cocci and 6.32% [6/95; 95% CI = 2.35 - 13.24] of non-fermentative bacilli. The most frequently species found in urine were *Escherichia coli*, *Klebsiella* sp., and *Staphylococcus* sp. with 40.74% [22/54; 95% CI = 27.57 - 54.97] and 14.81% [22/54; 95% CI = 6.62 - 27.12] respectively and 25.93% [14/54; 95% CI = 14.96 - 39.65]. Only four bacterial strains were isolated from stool samples, including three *Escherichia coli* strains and one *Salmonella* sp. Next, 13 bacterial strains were isolated from vaginal swabs, including *Escherichia coli* (30.77%) [4/13; 95% CI = 9.09 - 61.43], followed by *Staphylococcus aureus* (38.46%) [5/13; 95% CI = 13.86 - 68.42]. Furthermore, of all bacterial species isolated from pus samples, *Escherichia coli* accounted for 20.83% [5/24; 95% CI = 7.13 - 42.15], followed by 41.67% *Staphylococcus aureus* [10/24; 95% CI = 22.11 - 63.36]. **Table 2** shows the number of species isolated in each sample. As for the clinical departments requesting bacteriological diagnoses, samples from outpatient departments accounted for 25.26% of positive cases, compared with 74.74% from the CHR's in-house departments ( $p = 0.093$ ), of which 42.10% (40/95) came from surgery and 12.63% (12/95) from medical emergencies. This shows that most infections detected occurred in hospitalized patients, which may indicate a higher prevalence of nosocomial (hospital-acquired) infections. Furthermore, the surgical department appears to be the most affected, which is consistent with known risk factors such as invasive procedures, medical devices (catheters, probes, etc.).

### 3.3. Antibiotic Susceptibility

The most notable aspect of this study is the high rate of resistance to beta-lactam antibiotics. The best efficiencies in this study were obtained with the use of gentamicin and imipenem. Resistance to amoxicillin and amoxicillin + clavulanic acid was detected in 92.85% (52/56) and 78.57% (44/56) of all Enterobacteriaceae,

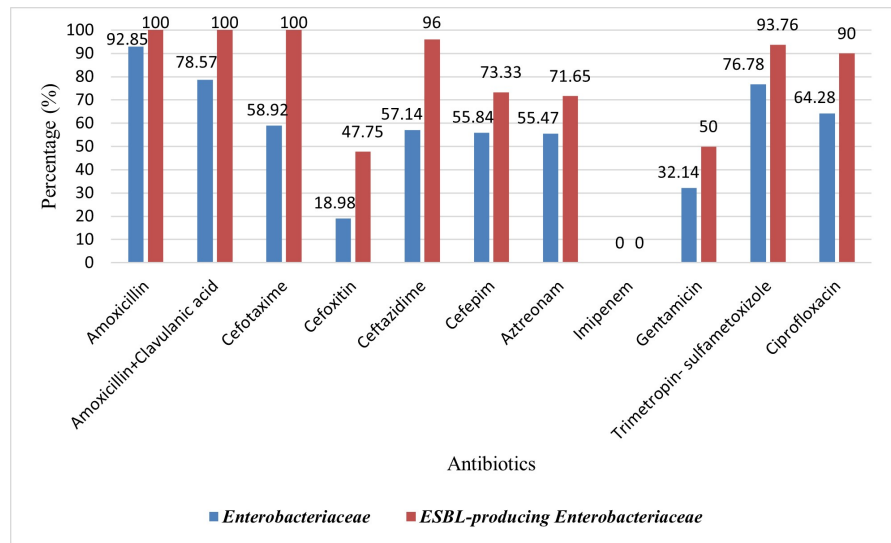
**Table 2.** Distribution of bacteria isolated by type of samples.

Samples	Bacteria	Urine n (%)	Stools n (%)	Pus n (%)	Vaginal swabs n (%)	Total n (%)	p value
Enterobacteriaceae	<i>E. coli</i>	22 (64.71)	3 (8.82)	5 (14.71)	4(11.76)	34 (35.79)	0.0194
	<i>Klebsiella</i> sp.	8 (80.00)	0 (0)	1 (10.00)	1(10.00)	10 (10.53)	
	<i>Citrobacter</i> sp.	4 (100)	0 (0)	0 (0)	0 (0)	4 (4.21)	
	<i>Enterobacter</i> sp.	2 (50.00)	0 (0)	1 (25.00)	1(25.00)	4 (4.21)	
	<i>Proteus</i> sp.	1 (100.00)	0 (0)	0 (0)	0 (0)	1 (1.05)	
	<i>Salmonella</i> sp.	0 (0)	1 (100.00)	0 (0)	0 (0)	1 (1.05)	
	<i>Serratia</i> sp.	0 (0)	0 (0)	1 (50.00)	1 (50.00)	2 (2.11)	
Cocci	<i>Staphylococcus</i> sp.	14 (48.28)	0 (0)	10 (34.48)	5(17.24)	29 (30.53)	0.0194
	<i>Streptococcus</i> sp.	1 (25.00)	0 (0)	3 (75.00)	0 (0)	4 (4.21)	
Non-fermentative bacteria	<i>A. baumannii</i>	1 (25.00)	0 (0)	2 (50.00)	1 (25.00)	4 (4.21)	0.0194
	<i>P. aeruginosa</i>	1 (50.00)	0 (0)	1 (50.00)	0 (0)	2 (2.11)	

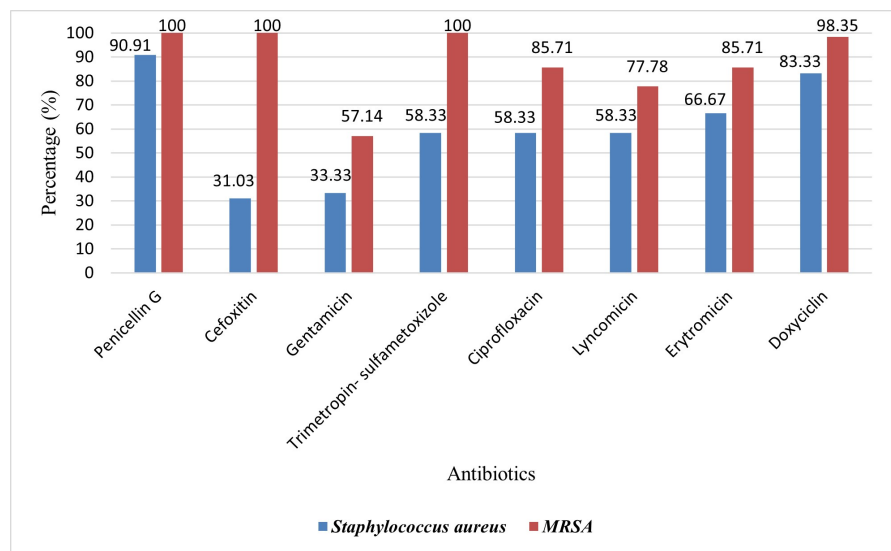
respectively. Concerning the use of third-generation cephalosporins, resistance rates of 58.92% (33/56) and 57.14% (32/56) to cefotaxime and ceftazidime were observed in all Enterobacteriaceae, respectively (Figure 2), with an appearance of 19.64% (11/56) of extended-spectrum beta-lactamase-producing Enterobacteriaceae (E-ESBL) as shown in Figure 3. Moreover, carbapenems, classified as last resort beta-lactam antibiotics, showed 0% resistance in all Enterobacteriaceae after a test with imipenem (Figure 2). As for the use of antibiotics from other families, all Enterobacteriaceae showed a high level of resistance, ranging from 76.78% (43/56) to trimethoprim-sulfamethoxazole, and from 64.28% (36/56) to ciprofloxacin (Figure 2). High resistance of 100% (4/4) and 50% (1/2) to ticarcillin were observed in *Acinetobacter baumannii* and *Pseudomonas aeruginosa* respectively. Resistance to imipenem was detected in 50% (2/4) of *Acinetobacter baumannii* and 50% (1/2) of *Pseudomonas aeruginosa* (Figure 4). Among isolated Gram-positive cocci, high resistances to penicillin G, erythromycin and doxycyclin were also observed in *Staphylococcus aureus* (Figure 2).

### 3.4. Prevalence of Isolated Multidrug-Resistant Bacteria

Out of all the microorganisms found in this investigation, 55.79 percent [53/95; 95% CI = 45.23 - 65.98] of multidrug-resistant bacteria (MDR) were isolated 64.15% [34/53; 95% CI = 49.80 - 76.86] of the total multidrug-resistant bacteria were recovered as Enterobacteriaceae, followed by 28.30% [15/53; 95% CI = 16.79 - 42.35] of cocci and 7.55% [4/53; 95% CI = 2.09 - 18.21] non-fermentative bacteria. The prevalence of extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae was 19.64% [11/56; 95% CI = 10.23 - 32.43]. *Escherichia coli* accounted for 45.45% of the extended-spectrum beta-lactamase-producing Enterobacteriaceae (E-BLSE), followed by *Klebsiella* sp. (36.36%) and *Citrobacter diversus* (18.18%), in that order. The incidence of *E. coli* was 14.71% [5/34; 95% CI



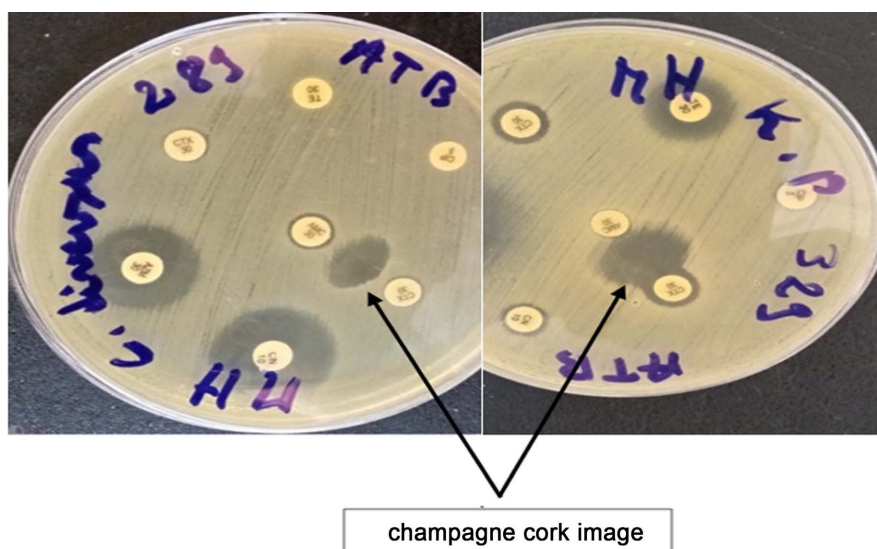
(a)



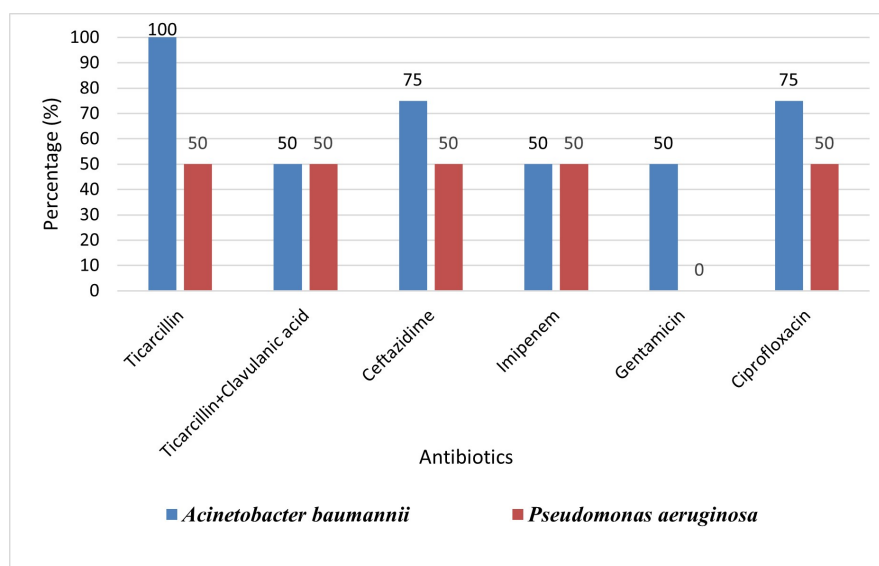
(b)

**Figure 2.** Antibiotics resistance in Enterobacteriaceae and *Staphylococcus aureus*.

= 4.95 - 31.06] and 40% *Klebsiella* sp. [4/10; 95% CI = 12.16 - 73.76], when species were taken into consideration MRSA accounted for 31.03 percent [9/29; 95% CI = 13.30 - 45.52] of the multidrug-resistant cocci that were isolated *Acinetobacter baumannii* and *Pseudomonas aeruginosa* were found to be 50% and 25% of the non-fermentative (imipenem-resistant) bacteria, respectively. Urine, which contained 100% E-BLSE and 55.56% MRSA, clearly predominated the epidemiological profile of the samples collected for our investigation Pus, which had 25% BMR isolates, including 33.33% MRSA isolates, came next. Patients between the ages of 18 and 65 and those over 65 years had higher isolation rates of multidrug-resistant bacteria, with 56.86% [95% CI = 42.25 - 70.65; 6/11 ESBL and 8/12 MRSA] and 25.49% [95% CI = 14.33 - 39.63; 5/11 ESBL], respectively.



**Figure 3.** Positive synergy test of ESBL.



**Figure 4.** Antibiotics resistance in *Acinetobacter baumannii* and *Pseudomonas aeruginosa*.

#### 4. Discussion

Today, methicillin-resistant *Staphylococcus aureus* and ESBL-producing Enterobacteriaceae are the main multi-resistant bacteria threatening public health worldwide. The fundamental aim of our study was to determine the frequency of multi-resistant bacteria involved in various infections at the Dedougou regional hospital.

All bacteria isolated from samples (most commonly vaginal swabs, urine, stools, pus, etc.) collected at the CHR's medical analysis laboratory in Dedougou were included in the current investigation. All bacteria isolated from samples (usually urine, pus, stool, vaginal swabs, etc.) taken at the medical analysis laboratory of the Dedougou RHC were included in the present survey. A total of 300 pathological samples were included. According to the socio-demographic and epidemio-

logical characteristics of the patients, 70.66% of them were outpatients, compared with 29.34% of inpatients,  $p = 0.093$ . With a sex ratio of 0.7 (F/M), males were more likely than females to be infected, with 58.95% of cases being positive,  $p = 0.587$ . The two age groups most impacted were those over 65 (20%) and those between 18 and 65 (62.11%). Our study's findings are consistent with those of research conducted in Burkina Faso by Dembélé *et al.* [18] and in Mali by Kalam-bry *et al.* [6]. Enterobacteriaceae (*Escherichia coli*, *Klebsiella* sp., *Citrobacter di-versus*, etc.) were the primary bacteria that were isolated. These findings are com-parable to those published by Kpoda *et al.* [10] and Ky *et al.* [11] in Burkina Faso, by Gadou *et al.* [19] in Côte d'Ivoire and Toudji *et al.* [4] in Togo. Other isolated bacteria, including non-fermentative bacteria (*Acinetobacter baumannii* and *Pseu-domonas aeruginosa*) and *Staphylococcus aureus* and coagulase negative *Staphy-lococcus* (CNS), were also clarified by this investigation. Our results are consistent with a study conducted in Burkina Faso and published by Ky *et al.* [11]. Addition-ally, our findings are consistent with research conducted by Bouguenoun *et al.* [20] on clinical samples in Algeria. Every antibiotic that was studied had high ac-tivity in terms of antibiotic resistance. Except for carbapenems (imipenem), beta-lactam antibiotics were actually not very inefficient against Enterobacteriaceae. All Enterobacteriaceae showed high levels of resistance to amoxicillin (92.85%) and amoxicillin/clavulanic acid (78.57%), whereas E-ESBL showed 100% resistance. These findings are comparable to those that have been documented in Burkina Faso before [10] [11]. Cefotaxime resistance was found to be 100% in E-ESBL and 58.92% in all Enterobacteriaceae. These findings are consistent with findings from Burkina Faso [10] and Morocco [21] in 2018, and Togo [4] in 2017. The quick and simple availability of these antibiotics, which are frequently provided without a prescription, may account for the Enterobacteriaceae resistance to penicillin and cephalosporins in this investigation. Additionally, the decreased activity of beta-lactamase inhibitors, such as clavulanic acid (which produces oxacillinase and high-level cephalosporinase), and the frequent and insufficient use of third-gener-ation cephalosporins (injectable ceftriaxone) by nursing staff as part of proba-bilistic treatment as soon as the patient enters the various internal clinical depart-ments of healthcare facilities may also account for this cephalosporin resistance [21]. This may be the source of the selection of resistant bacteria, which produce inactivating enzymes as one of their defense mechanisms after evading the effects of these chemicals. A low resistance rate of 0% was also seen in all Enterobacterales when imipenem was used. This overall carbapenem sensitivity was comparable to the findings of Ky *et al.* [11] and Kpoda *et al.* [10] in Burkina Faso, who discovered no imipenem resistance Morocco [21] and Togo [4] have reported comparable outcomes with low imipenem resistance rates. In terms of cocci's susceptibility to beta-lactam, our study found that *Staphylococcus aureus* had a 90.91% resistance to penicillin G and a 31.03% resistance to cefoxitin, whereas MRSA had a 100% resistance to both. In Burkina Faso, Ky *et al.* [11] reported that 32% of *Staphylo-coccus aureus* isolates were resistant to methicillin. Abdoulaye *et al.* [8] reported

similar betalactam resistance findings in other countries, including Niger, where they identified 83% resistance to oxacillin and 88.6% resistance to penicillin G. Similarly, Ould Salem *et al.* [7] and Sapkota *et al.* [22] have found 100% penicillin resistance in Mauritania and Nepal, respectively. The unregulated and insufficient use of these compounds, self-medication, and public ignorance of the issues of antibiotic resistance may all contribute to MRSA resistance to this subfamily of beta-lactam antibiotics (penicillin). All Enterobacterales and E-ESBL showed resistance rates of 32.14% and 50% to aminoglycosides (gentamicin), respectively, as compared to the other antibiotic families included in our investigation. Some studies conducted in Burkina Faso by Ouedraogo *et al.* [9] and Kpoda *et al.* [10], in Togo by Toudji *et al.* [4], and Côte d'Ivoire by Gadou *et al.* [19] showed better findings. The authors of this research reported that 89%, 82.24%, and 93.2% of E-ESBLs were resistant to gentamicin, respectively. Subsequently, ciprofloxacin and trimethoprim-sulfamethoxazole resistance were observed in 64.28% and 76.78% of Enterobacteriaceae, respectively. E-ESBL-associated resistance rates were respectively 93.76% for trimethoprim-sulfamethoxazole and 90% for ciprofloxacin. These resistance rates are consistent with those seen in Burkina Faso [9] [10], Togo [4], and Côte d'Ivoire [23], as well as other earlier investigations conducted in 2017 and 2019. The MRSA that was found had resistances to gentamycin, ciprofloxacin, and trimethoprim-sulfamethoxazole of 57.14%, 85.71%, and 100%, respectively. Results were similar in Mauritania, where some scientists [7] found that 77% of MRSA were co-resistant to trimethoprim-sulfamethoxazole. In contrast, authors [22] [24] reported reduced MRSA resistance rates in Nepal in their 2018 and 2019 research projects, respectively, in connection with these various antibiotic families. The comparatively high rate of resistance to these compounds in our study may, in fact, be explained by the fact that these antimicrobials are very inexpensively available in tablet form in our nation, which promotes self-medication. Additionally, in our nation, trimethoprim-sulfamethoxazole was added to the algorithm for opportunistic illnesses in PL-HIV. Following antibiotic sensitivity testing, the prevalence of isolation of multidrug-resistant bacteria was estimated at 55.79%. The majority of the 64.15% of Enterobacterales found were *Escherichia coli* (55.9%), followed by *Klebsiella* sp. (26.5%). Of all the Enterobacteriaceae, 19.64% were extended-spectrum beta-lactamase (E-ESBL) producing. Studies conducted in Burkina Faso [9]-[11] and Togo [4] revealed higher prevalences. However, other authors in Burkina Faso [12], Morocco [21] and Mali [6] reported low prevalences (12%, 12.2%, 12.5%). According to ESBL production by species, *Escherichia coli* accounted for 45.45% of cases, followed by *Klebsiella* sp. with 36.36% and *Citrobacter diversus* with 18.18%. Similar results were found in Togo [4] and Côte d'Ivoire [23], showing a predominance of *E. coli* followed by *Klebsiella* sp. Nevertheless, a study carried out in Mauritania [25] showed that among ESBL-producing strains, *Klebsiella* sp. led the way with 20.4%, followed by *E. coli* with 10.4%. MRSA were accounted 31.03% among for Gram-positive cocci. Slightly higher results were found in Burkina Faso and Mauritania with 32% and 34% re-

spectively [7] [11]. However, it is still less than the 83% recorded in Niger (8) 7.55% of the non-fermentative bacteria, including 75% (3/4) *Acinetobacter baumannii* and 25% (1/4) *Pseudomonas aeruginosa*, were imipenem resistant. Similar outcomes were observed in Algeria in 2017 [20]. In order to counteract the high degree of resistance to multi-drug-resistant strains in the Boucle of Mouhoun region of Burkina Faso, the phenomena need to draw the attention of local health authorities and the affected community. Urine topped the isolation matrices, containing 55.55% of MRSA isolates and 100% of ESBL-producing Enterobacterales. With 33.33 percent of MRSA isolated, Pus finished in second. Our findings contradict those of a 2017 study conducted in Togo [4], which found that ESBLs were recovered from pus more often than from urine and other samples. This runs counter to the findings of a study conducted in Burkina Faso [10], which revealed that ESBL Enterobacterales were more frequently isolated from urine (23.9%) than from pus (10.5%). Our findings are consistent with those of Mauritania [7], whose authors reported a higher prevalence (34.3%) in urine exam for MRSA Furthermore, adults between the ages of 18 and 65 and those above 65 had a noticeably greater prevalence of multi-resistant bacterial isolates. These findings align with the research conducted by Ouedraogo and colleagues [9].

## 5. Conclusion

Since multidrug-resistant bacteria have emerged and proliferated, antibiotic resistance has emerged as a significant global public health concern, especially in Burkina Faso. This study found that methicillin-resistant *Staphylococcus aureus*, imipenem-resistant *Pseudomonas aeruginosa* and *Acinetobacter baumannii*, and extended-spectrum beta-lactamase-producing Enterobacterales were all present in this reference regional health center. High levels of resistance to beta-lactams and other antibiotics (aminoglycosides, quinolones, sulphonamides, etc.) were observed in these various strains of multidrug-resistant bacteria. In order to strengthen the antibiotic resistance-monitoring program at the regional and national levels, health safety precautions and actions must be adopted in response to the high degree of antibiotic resistance found in our study. This would require informing the regional health authorities.

## Acknowledgements

We thank the hospital authorities for their agreement and the staff of the laboratory department of both the RHC-Dedougou and University Joseph KI ZERBO of Ouagadougou for their support and technical advice.

## Contributions of the Authors

The design of the study, data analysis, writing and editing of the document were all overseen by all authors, who also agreed to be responsible for all aspects of the work. The final manuscript was read and approved by all authors.

## Conflicts of Interest

The authors declare no conflicts of interest.

## References

- [1] Bergen, P.J., Bulitta, J.B., Sime, F.B., Lipman, J., McGregor, M.J., Millen, N., *et al.* (2018) Differences in Suppression of Regrowth and Resistance Despite Similar Initial Bacterial Killing for Meropenem and Piperacillin/Tazobactam against *Pseudomonas aeruginosa* and *Escherichia coli*. *Diagnostic Microbiology and Infectious Disease*, **91**, 69-76. <https://doi.org/10.1016/j.diagmicrobio.2017.12.019>
- [2] Huynh, B., Kermorvant-Duchemin, E., Herindrainy, P., Padget, M., Rakotoarimanana, F.M.J., Feno, H., *et al.* (2018) Bacterial Infections in Neonates, Madagascar, 2012-2014. *Emerging Infectious Diseases*, **24**, 710-717. <https://doi.org/10.3201/eid2404.161977>
- [3] OMS (2020) Resistance to Antimicrobials. <https://www.who.int/fr/news-room/fact-sheets/detail/antimicrobial-resistance>
- [4] Toudji, A.G., Djeri, B., Karou, S.D., Tigossou, S., Ameyapoh, Y. and De Souza, C. (2017) Prévalence des souches d'entérobactéries productrices de bêta-lactamases à spectre élargi isolées au Togo et de leur sensibilité aux antibiotiques. *International Journal of Biological and Chemical Sciences*, **11**, 1165-1177. <https://doi.org/10.4314/ijbcs.v11i3.19>
- [5] Fody, A.M., Bagré, T.S., Traoré, A.K., Yacouba, A., Dembelé, R., Boubou, L., *et al.* (2017) Molecular Characterization of Extended Spectrum Beta-Lactamase among Clinical Multidrug Resistant *Escherichia coli* in Two Hospitals of Niamey, Niger. *African Journal of Clinical and Experimental Microbiology*, **19**, 1-9. <https://doi.org/10.4314/ajcem.v19i1.1>
- [6] Kalambry, A., Gaudré, N., Drame, B.S., Poudiougo, A., Kassogué, A., Koné, H., *et al.* (2019) Profil de résistance aux bêta-lactamines des entérobactéries isolées des prélèvements urinaires à l'Hôpital du Mali. *Revue Malienne d'Infectiologie et de Microbiologie*, **14**, 6-13. <https://doi.org/10.53597/remim.v14i2.1363>
- [7] Ould Salem, M.L., Sidi, M.G., Sidi, E.W.B. and Mohamed, M.O.M. (2016) Antibiotic Susceptibility of Community-Acquired Strains of *Staphylococcus aureus* in Nouakchott Region (Mauritania). *Pan African Medical Journal*, **24**, Article No. 276. <https://doi.org/10.11604/pamj.2016.24.276.9865>
- [8] Abdoulaye, O., Harouna Amadou, M.L., Amadou, O., Adakal, O., Lawanou, H.M., Boubou, L., *et al.* (2018) Aspects épidémiologiques et bactériologiques des infections du site opératoire (ISO) dans les services de chirurgie à l'Hôpital National de Niamey (HNN). *Pan African Medical Journal*, **31**, Article No. 33. <https://doi.org/10.11604/pamj.2018.31.33.15921>
- [9] Ouedraogo, A., Sanou, M., Kissou, A., Sanou, S., Solaré, H., Kaboré, F., *et al.* (2016) High Prevalence of Extended-Spectrum Ss-Lactamase Producing Enterobacteriaceae among Clinical Isolates in Burkina Faso. *BMC Infectious Diseases*, **16**, Article No. 326. <https://doi.org/10.1186/s12879-016-1655-3>
- [10] Kpoda, D.S., Ajayi, A., Somda, M., Traore, O., Guessennnd, N., Ouattara, A.S., Sangare, L., Traore, A.S. and Dosso, M. (2018) Prevalence and Resistance Profile of Extended-Spectrum  $\beta$ -Lactamases-Producing Enterobacteriaceae in Ouagadougou, Burkina Faso. *African Journal and Microbiology Research*, **11**, 1120-1126. <https://doi.org/10.1186/s13104-018-3581-5>
- [11] Ky, B.A., Diendere, A., Sanou, M., Diallo, I., Tamini, L.T., Benin, A., Sanou, I., Traore,

- O.R. and Sangare, L. (2019) Antibiotic Resistance of *Staphylococcus aureus* Strains and Insulated Enterobacteries at the Ouagadougou LNSP (Burkina Faso). *African Journals Online*, **42**, 83-94.
- [12] Sagna, T., Diane, W., Somda, N., Christiana, A., Koné, A.C., Sagna, Y., *et al.* (2019) Antibiotic Susceptibility of *Escherichia coli* and *Klebsiella pneumoniae* Strains, Urinary Tract Infections Cases in Bobo-Dioulasso, Burkina Faso. *EC Microbiology*, **15**, 172-178.
- [13] Konaté, A., K. Guessennnd, N., Kouadio, F.K., Dembélé, R., Kagambèga, A., Kouadio, I.K., *et al.* (2019) Epidemiology and Resistance Phenotypes of Salmonella Spp. Strains Responsible for Gastroenteritis in Children Less than Five Years of Age in Ouagadougou, Burkina Faso. *Archives of Clinical Microbiology*, **10**, Article No. 90. <https://doi.org/10.36648/1989-8436.10.2.90>
- [14] Dembélé, R., Konaté, A., Soulama, I., Kagambèga, A., Kaboré, W.A.D., Cissé, H., *et al.* (2019) Prevalence of Multidrug-Resistant *Salmonella enterica* and Associated Factors among Under-Five Children with Diarrhea in Rural Burkina Faso. *Clinical Biotechnology and Microbiology*, **3**, 566-576.
- [15] Dembélé, R., Konaté, A., Kagambèga, A., Soulama, I., Kaboré, W.A.D., Traoré, O., *et al.* (2019) Class 1 Integrons, Genetic Factor for the Dissemination of Tetracycline and Chloramphenicol Resistance Genes in *Escherichia coli* Isolated from Children with Diarrhea in Rural Burkina Faso. *EC Microbiology*, **15**, 463-470.
- [16] Dembélé, R., Kaboré, W.A.D., Soulama, I., Konaté, A., Kagambèga, A., Traoré, O., *et al.* (2020) Involvement of Class 1 and Class 2 Integrons in Dissemination of tet and catA1 Resistance Genes of *Salmonella enterica* from Children with Diarrhea in Rural Burkina Faso. *African Journal of Biotechnology*, **19**, 1-7.
- [17] Dembélé, R., Konaté, A., Traoré, O., Kaboré, W.A.D., Soulama, I., Kagambèga, A., *et al.* (2020) Extended Spectrum Beta-Lactamase and Fluoroquinolone Resistance Genes among *Escherichia coli* and *Salmonella* Isolates from Children with Diarrhea, Burkina Faso. *BMC Pediatrics*, **20**, Article No. 459. <https://doi.org/10.1186/s12887-020-02342-z>
- [18] Dembélé, R., Sanou, R., Traoré, O., Ouédraogo, N., Coulibaly, H., Kagambèga, A.B., *et al.* (2022) Antibiotic Susceptibility of Enterobacterales and Cocci Uropathogens in Patients Attending Regional Hospital of Dedougou, Western Region (Burkina Faso). *EC Microbiology*, **18**, 23-32.
- [19] Gadou, V., Diene, S.M., Rolain, J.M., Djaman, J.A., Dosso, M., Guessennnd, N.K., *et al.* (2018) First Detection of Aminoglycosides Resistance Genes AAC(6)-IB, Ant(2)-I and AAD in Enterobacteriaceae Producing Extended-Spectrum Beta-Lactamases in Abidjan (Côte d'Ivoire). *International Journal of Microbiology Research*, **10**, 1171-1174. <https://doi.org/10.9735/0975-5276.10.5.1171-1174>
- [20] Bouguenoun, W., Bakour, S., Bentorki, A.A., Al Bayssari, C., Merad, T. and Rolain, J. (2016) Molecular Epidemiology of Environmental and Clinical Carbapenemase-Producing Gram-Negative Bacilli from Hospitals in Guelma, Algeria: Multiple Genetic Lineages and First Report of OXA-48 in Enterobacter Cloacae. *Journal of Global Antimicrobial Resistance*, **7**, 135-140. <https://doi.org/10.1016/j.jgar.2016.08.011>
- [21] Sbiti, M., Lahmadi, K. and Louzi, L. (2017) Profil épidémiologique des entérobactéries uropathogènes productrices de bêta-lactamases à spectre élargi. *Pan African Medical Journal*, **28**, Article No. 29. <https://doi.org/10.11604/pamj.2017.28.29.11402>
- [22] Sapkota, J., Sharma, M., Jha, B. and Bhatt, C.P. (2019) Prevalence of *Staphylococcus aureus* Isolated from Clinical Samples in a Tertiary Care Hospital: A Descriptive Cross-Sectional Study. *Journal of Nepal Medical Association*, **57**, 398-402.

<https://doi.org/10.31729/jnma.4673>

- [23] Victoire, G., Anatole, T.A., Fernique, K., Bertin, T.K., Baguy, O.M., Nathalie, G.K., *et al.* (2019) First Case of Qnr B6 and Qnr B7 Genes in Enterobacteriaceae Producing Extended-Spectrum Beta-Lactamases in Abidjan, Côte d'Ivoire. *South Asian Journal of Research in Microbiology*, **3**, 1-6. <https://doi.org/10.9734/sajrm/2019/v3i230082>
- [24] Khanal, L.K., Adhikari, R.P. and Guragain, A. (2018) Prevalence of Methicillin Resistant *Staphylococcus aureus* and Antibiotic Susceptibility Pattern in a Tertiary Hospital in Nepal. *Journal of Nepal Health Research Council*, **16**, 172-174. <https://doi.org/10.3126/jnhrc.v16i2.20305>
- [25] Hailaji, N.S.M., Ould Salem, M.L. and Ghaber, S.M. (2016) La sensibilité aux antibiotiques des bactéries uropathogènes dans la ville de Nouakchott-Mauritanie. *Progrès en Urologie*, **26**, 346-352. <https://doi.org/10.1016/j.purol.2016.04.004>