***Original Research Article***

**Comparing the antibiotic resistance profiles of *Klebsiella pneumoniae* in HIV-positive and HIV-negative individuals attending the Bamenda Station Polyclinic, Bamenda, Cameroon.**

**ABSTRACT**

The vulnerability of HIV patients to opportunistic pathogens requires measures in monitoring the spread of antibiotic resistance (ABR). ABR to *Klebsiella pneumoniae* is an urgent threat to human health. This study aimed to determine the prevalence and antimicrobial profile pattern of *K. pneumoniae* in HIV positive and negative persons in Bamenda III. The study comprised of 333 participants recruited from January 2024 to June 2024. *K. pneumonia*e was isolated from urine samples. Antibiotic susceptibility testing was done using the Kirby Bauer Disc diffusion method. The prevalence of *K. pneumonia*e was 23.4% (78/333) and was high 24.0% (48/333) in HIV positive participants though the difference was not significantly (*p*=0.761). Of the 78 positive participants, 77(98.7%) recorded resistance to any of the antibiotics used. Ampicillin recorded the highest level of resistance (61.05%, 48/77) while Nitrofurantoin was the most sensitive drug 42.3% (28/78) resistance. Multidrug resistance (MDR) was reported in 47.4% (37/78) of the participants. attaining secondary education (AOR=6.75, *p*=0.040), monthly income of <50,000frs (AOR=5.53, *p*=0.025) and being HIV positive (AOR=0.30, *p*=0.039) were identified as risk factors of MDR. This study showed that there is a need for strict the administration of ampicillin and gentamycin while encouraging the use of nitrofurantoin and levofloxacin.

**Key words**: Antibiotic, HIV patients, *Klebsiella pneumoniae,* prevalence, resistance

**INTRODUCTION**

The burden of *Klebsiella* drug resistance to antimicrobials is a major public health concern worldwide, particularly severe in developing countries1. *Klebsiella pneumoniae* is a Gram-negative encapsulated bacterium that colonizes the gastrointestinal tract, respiratory tract, urinary tract, oral cavities, and skin 2,3. It is one of the most important causes of nosocomial infections, particularly in patients with compromised immune systems4,5. These infections are 5–15 times more common in HIV patients than in HIV-negative individuals6,7. The heightened risk is largely due to the depletion of CD4+ T cells, that mount effective immune response against bacterial infections8, 9.

Epidemiologically, the prevalence of *Klebsiella* infections among HIV patients varies across different countries, with a prevalence rate ranging from 13.9% to 37.5%7, 10, 11, 12 from 29.4%- 71.15% in Cameroon 8,13.

In spite this high prevalence, most studies on HIV co-infections in Cameroon are based on TB 14, malaria, intestinal parasites15,, and viruses such as Hepatitis B and Hepatitis C16. In Cameroon, where reports on nosocomial infection are high17,18, data on HIV and *Klebsiella pneumoniae* co-infection is largely unavailable.

*K. pneumoniae* is well known for its ability to rapidly acquire resistance to multiple antibiotics, posing a significant challenge to treatment options3,19,20. The rise of resistant *K. pneumoniae* strains have complicated treatment outcomes resulting in increased morbidity and mortality as well as longer hospitalizations and reduction of the annual global gross domestic product19, 20. The mechanisms of *K. pneumoniae* acquiring resistance is mainly through plasmids and transposons encoding for various enzymes responsible for efflux pumps activation, modification of target sites, drug inactivation and reduced cell permeability to the drug 3,5. There is also mutations in different proteins, and biofilm formation2,3,22.

Factors that contribute to antimicrobial resistance (ABR) in Cameroon and elsewhere include drug factors such as over use and abuse of antibiotics, *K. pneumoniae* pathogenic virulence factors, such as capsular polysaccharide, lipopolysaccharide, fimbriae, siderophores and inadequate surveillance systems1,5. The prevalence of *K. pneumoniae* resistant isolates ranges from 36.6% to 80% 3, 23, 24. Previous research has shown that *Klebsiella* antibiotic resistance is highest against ampicillin, amoxicillin, nitrofurantoin, trimethoprim-sulfamethoxazole and cefuroxime 3,5,which are commonly used drugs in Cameroon.

Risk factors for *K. pneumoniae* resistant isolate have been described in previous studies and include age, gender, annual income, presence of urinary catheters, previous hospitalization, migration, living in an urban environment and some co-morbidities such as diabetes or immunosuppression3, 25, 26. These factors are often inconsistent taking in to consideration the study design and other genetic factors. It is for these reason that researchers are encouraged to carry out similar studies in different locations and communities in order to monitor trends in *Klebsiella* antibiotic resistance as well as identify emerging bacteria strains.

Despite the significant threat posed by ABR risks, little is known about the prevalence and antibiotic-resistant profile of *Klebsiella* in Cameroon. Thus, gaining a deeper understanding of the management of *Klebsiella* infections in HIV patients is vital for enhancing patient care, considering that HIV patients are immunocompromised and more likely to be vulnerable to opportunistic pathogens.

In spite the significant threat posed by ABR risks, little is known about prevalence and ABR profile of *Klebsiella* in vulnerable group like HIV patients Cameroon 8, 13. Thus, gaining a deeper understanding of the management of *Klebsiella* infections in HIV patients is vital for enhancing patient care. This, considering the fact that HIV patients are immunocompromised and more likely to be vulnerable to opportunistic pathogens making them a good metric for monitoring the spread of antibiotics resistance. Therefore, the objectives of this study were to determine the prevalence of *K. pneumoniae* in HIV patients and identify the risk factors associated to multidrug resistance*.* The results would be beneficial for policy maker to revise the treatment guideline as well as educate medical personnels on the empirical treatment that will minimizes the emergence of drug-resistant *Klebsiella* strains.

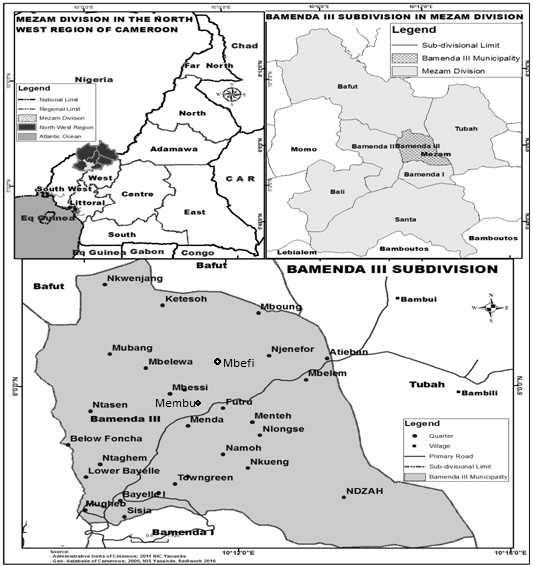
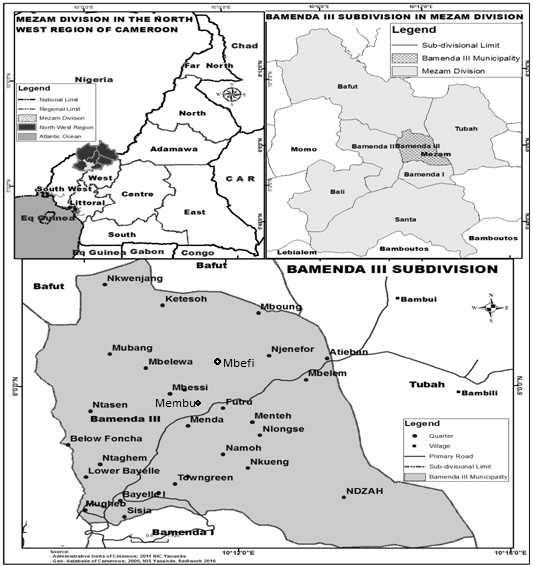
**METHODOLOGY**

**Study Design**

## The research was a cross-sectional study that included both HIV positive and negative persons that came to the Bamenda Station Polyclinic from January 2024 to June 2024. Mid-stream urine specimens were collected for the identification of bacteria using cultural and biochemical methods*.* Antimicrobial susceptibility test was carried out using the Kirby Bauer disk diffusion method. Risk factors associated with drug resistance was determined using pretested questionnaire

**Study site and population**

This cross-sectional study was carried out in the Bamenda Health District of the North West Region of Cameroon (Figure 1) on HIV positive and negative persons who came for consultations.



A B

Figure 1: Map of Cameroon (A) showing the study site Bamenda III Health District 27

**Ethics approval**

All samples were collected with respect to the study protocol as approved by the Institutional Review Board of the Faculty of Health Sciences in the University of Bamenda (number 2024/0630H/UBa/IRB). Witten informed consent was obtained from all participants. All methods were performed according to the relevant guidelines and regulations as outlined in the Helsinki Declaration.

**Sample size**

The minimum acceptable sample size was calculated using the Lorenz formula.

N = Z² \* p \* (1 - p) / i², 28

Where, Z1  = the normal distribution value for which the standard normal deviation=1.96

P =Relative prevalence or the proportion of subjects to attend to, and i = precession or sampling error, (i=0.05 for a 95% confidence interval). Using Z1-=1.96, P= prevalence of drug resistance in Cameroon (68.2%)29

A minimum sample size of about 333 HIV positive and negative persons were recruited for the study.

## **Sample and data collection**

In this cross-sectional hospital-based study, clean-catch midstream urine samples were collected samples in sterile clean bottles from both HIV positive (n=133) and negative (n=200) persons reporting at the Bamenda Station Polyclinic from January to June 2024. Capillary blood was collected by a trained laboratory technologist and used to detect the presence the HIV. Risk factors associated with drug resistance were capture using a pretested questionnaire.

## **Laboratory procedure: Sample processing and analysis**

**HIV Serology**

HIV test was done using the Abbot HIV (1&2) determine Alere kit as describe by the manufacturer. Capillary blood is transfer into a capillary tube. The blood is then transferred to the sample pad and a drop of the chase buffer is added to the sample pad. The strip is read between 20 and 30 minutes. The presence of a single red line at the control spot was considered negative for HIV30.

**Isolation and identification of *Klebsiella pneumoniae***

Urine samples were centrifuged and cultured on Cystine Lactose Electrolyte Deficient Agar (CLED). Standard microbiology techniques were performed and urine samples were then centrifuged and cultured on CLED. All samples were cultured at 370 C for 24–48 hours. Preliminary identification of bacterial isolates was based on the colony morphology (*Klebsiella* species typically appear as large, mucoid, yellow to whitish-blue colonies and the CLED agar turn yellowish)31 and Gram staining reaction (*Klebsiella* species appears as pink, thick gram-negative rods)32.

The biochemical identification of *Klebsiella pneumoniae* was performed using API 20E for Enterobacteriaceae following the manufacturer’s procedure. First, a pure culture was obtained and a suspension prepared in sterile water and the API 20E strips inoculated with the suspension. The necessary reagents were added and incubated 37°C for 18 to 24 hours, and the results were interpreted by comparing the reaction pattern to a reference chart to identify *Klebsiella* species33.

The susceptibility of the *K. pneumoniae* isolates to antibiotic disks impregnated with ampicillin (10 μg), amoxicillin/clavulanic acid[amoxiclav] (20/10μg), Cefixime (5μg)ceftriaxone (30 μg), vancomycin (5 μg) azithromycin (30 μg), clarithromycin(15μg) doxycycline (30 μg), erythromycin (15 μg), minocycline (min) (30 μg), gentamicin (10 μg), ciprofloxacin (5 μg), levofloxacin (5 μg), nitrofurantoin (50 μg) and ofloxacin (5 μg) (Becton, Dickson, Fisher Scientific, USA) was done using the Kirby-Bauer disc-diffusion technique as recommended by the Clinical and Laboratory Standard Institute (CLSI)34. A suspension of the test organism was prepared in peptone water and matched to 0.5 McFarland standard for AST. After incubating a pure *K. pneumoniae* culture at 37°C for 16 -18 hours on Mueller-Hinton agar (Murex Biotec Ltd, UK), the antibiotic inhibition zone diameters were measured and results obtained used to classify isolates as being resistant, intermediate or susceptible to a particular antibiotic using standard reference values by the CLSI. The quality control strain used was *K. pneumoniae* American Type Culture Collection (ATCC) 25922. The choice of the antibiotics was based on local prescription, availability, and potential public health importance recommendations from the guideline of antimicrobial susceptibility testing from CLSI.

## **Statistical Analysis**

Descriptive statistic was used to determine the mean and standard deviation. Categorical data were expressed in frequency and percentage. Relation between Categorical data and prevalence were compared using Chi square. Risk factors were determined using bivariate and multivariate logistic regression analysis. All analysis was done at 95% confident interval using SPSS 23.0. and *p*-value < 0.05 was considered significant.

## **Results** Socio-demographic characteristics of participants

The study comprised of 333 participants of which 60.1% (200/333) were HIV positive and 39.9% (133/333) were HIV negative participants. The age range of the participants was 18-71 years with mean (SD) age of 35.5 (10.71) years. Most of the study participants belong to the age 25-35 years (34.8%, 116). were female (57.1%, 190), married. (77.2%, 256), had attained tertiary education (55.9%, 186), had monthly income >100,000frs (43.8%, 146) and were Christians (90.7%, 302). Participants who practice the Baptist faith constituted the highest number (28.8%, 96) of Christians. Most of the participants (97.0%, 323) did not present with any underlining disease, however participants with diabetes recorded the highest number (1.2%, 4) of persons with underlining disease (Table 1).

**Table 1: Demographic characteristics of patients enrolled in the study (n=333)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Variables** | **Frequency** | **Percentages** |
| **Age groups (years)** | <25 | 57 | 17.1 |
| **25-35** | **116** | **34.8** |
| 36-45 | 108 | 32.4 |
| >45 | 52 | 15.6 |
| **Sex** | Males | 143 | 42.9 |
| **Females** | **190** | **57.1** |
| **Marital status** | Singles | 55 | 16.5 |
|  | Co-habiting | 9 | 2.7 |
|  | **Married** | **256** | **77.2** |
|  | Divorced | 5 | 1.5 |
|  | Widows | 7 | 2.1 |
| **Level of education** | Primary | 24 | 7.2% |
|  | Secondary | 58 | 17.4 |
|  | High school | 65 | 19.5 |
|  | **Tertiary** | **186** | **55.9** |
| **Income (CFA francs)** | <50000 | 90 | 27.0 |
|  | 50,000-100,000 | 97 | 29.1 |
|  | **>100,000** | **146** | **43.8** |
| **Religion by faith** | **Baptist** | **96** | **28.8** |
|  | Muslims | 31 | 9.3 |
|  | Pentecostal | 47 | 14.1 |
|  | Presbyterian | 64 | 19.2 |
|  | Catholic | 95 | 28.5 |
| **Underlining Disease Condition** | **None** | **323** | **97.0** |
|  | Diabetes | 4 | 1.2 |
|  | Hypertensive and Diabetes | 2 | 0.6 |
|  | Hypertensive | 2 | 0.6 |
|  | Sickle cell | 1 | 0.3 |
|  | Tuberculosis | 1 | 0.3 |

**The prevalence of *Klebsiella pneumoniae***

Out of the 333 samples cultured, 23.42% (78/333) were positive for *K. pneumoniae* (Figure 2). The prevalence of *K. pneumoniae* was slightly higher in HIV-positive participants (24.0%, 48/200), although the difference was not statistically significant (*p* = 0.761) (Figure 3).

**Figure 2: Prevalence (%) of *K*. *pneumoniae* among the study participants**

χ2 =0.093 *p*=0.761

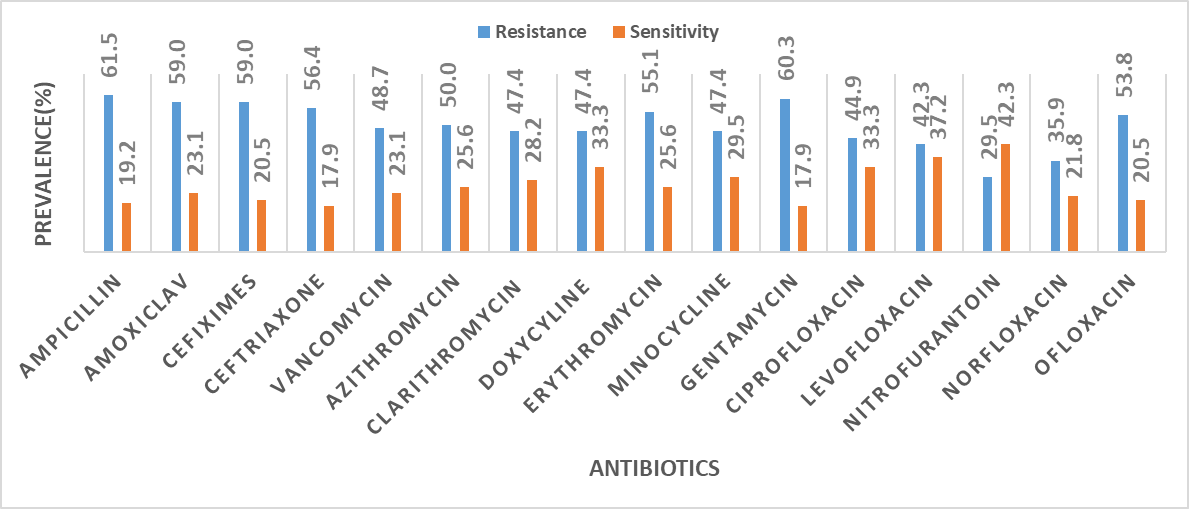
F**igure 3: Evaluating the presence of** *K****. pneumoniae* isolate with respect to HIV status**

## **Antibiotic resistance *K. pneumoniae* isolate**

The drugs used in the study comprised of antibiotics that span 3 major classes; Bacterial cell wall inhibitors, protein synthesis inhibitors and nucleic acid synthesis inhibitors. The data set of this study revealed that of the 78 positive isolate, 77 (98.7%) recorded one or more resistance to any of the antibiotics used. The drug class that recorded the highest number of resistances was the cell wall inhibitors 66 (84.6%), while nucleic acid inhibitors 26 (33.3%) were the most sensitive drugs class (Table 2). Overall, Ampicillin recorded the highest resistance 61.5%, (48/78) followed by gentamycin 60.3% (47/78) while Nitrofurantoin was the most sensitive drug 42.3% (28/78) followed by levofloxacin 37.2%, (29/78) (Figure 4).

**Table 2: Assessing number of different drug classes with resistance**

|  |  |  |
| --- | --- | --- |
| **Class of drug** | **Sensitive** | **Resistance** |
| Cell wall inhibitors | 12(15.4) | 66 (84.6) |
| Protein synthesis inhibitors | 14 (17.9) | 64 (82.1) |
| Nucleic acid inhibitors | 26 (33.3) | 52 (66.7) |

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**Figure 4. Antibiotic sensitivity profile of *Klebsiella pneumoniae* from the studied samples**

Multi drug resistance (MDR) and associated factors

MDR (which is resistance to at least three classes of antibiotics) was recorded in 47.4% (37/78) of the participants (Figure 5).

**Figure 5: Antibiotic resistance per number of antibiotics classes**

**Factors associated with multidrug resistance**

Bivariate analysis showed that young people (<25years) had the highest prevalence of MDR (55.6%, 10/18) [COR=1.264, 95%CI=0.332-4.806, *p*=0.731]; males (50.0%, 10/20) [COR=1.264, 95%CI=0.332-4.806, *p*=0.731]; participants with an average monthly income between [50,000 -100,000CFA ($80.14-$160.28)] (54.5%, 12/22); participants who attended tertiary level of education (56.8%, 25/44) [COR=0.159, 95%CI=0.022-1.129 *p*, =0.066]; HIV negative persons (63.3%, 19/30) [COR=3.280, 95%CI=0.948-11.355, *p*=0.061]also. But all these were not statistically significant (Table 3).

**Table 3: Assessing the risk factors of MDR using multivariate logistic regression in Bamenda Health district (n=78)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | |  | **Univariate analyses** | | **Multivariate analyses** | |
| **Variables** | **Categories** | **N0 n (%)** | **MDR n (%)** | **COR (95% C.I)** | ***p-*values** | **AOR (95% C.I)** | ***p-*values** |
| **Age groups**  **(years)** | <25 | 18(23.0) | 10(55.6) | 2.96(0.295-29.781) | 0.356 |  |  |
| 36-45 | 26(32.0) | 18(23.68) | 1.57(0.177-14.251) | 0.680 |  |  |
| >45 | 8(10.3) | 3(50.0) | 1.59(0.239-14.756) | 0.548 |  |  |
| 25-35 | 26(32.0) | 11(42.3) | **Ref** |  |  |  |
| **Sex** | Male | 20(25.6) | 27(46.6) | 1.26(0.332-4.806) | 0.731 |  |  |
| Female | 58(74.4) | 10(50.0) | **Ref** |  |  |  |
| **Level of education** | Primary | 2(2.6) | 1(50.0) | 0.59(0.143-2.419) | 0.463 | 1.94(0.101-37.241) | 0.660 |
| Secondary | 10(12.8) | 6(60.0) | 0.65(0.026-14.841) | 0.771 | 6.75(1.091-41.803) | 0.040 |
| High school | 22(28.2) | 9(40.9) | 0.159(0.22-1.129) | 0.066 | 2.23(2.234-7.224) | 0.179 |
| Tertiary | 44(56.4) | 21(47.7) | **Ref** |  |  |  |
| **Average monthly income** | <50,000 | 25(32.0) | 9(36.0) | 0.485(0.113-2.079) | 0.330 | 5.526(1.24-24.61) | 0.**025** |
| >100,000 | 31(39.7) | 16(51.6) | 0.188(0.033-1.063) | 0.059 | 1.820(0.508-6.520) | 0.358 |
| 50,000-100,000 | 22(28.2) | 12(54.5) | **Ref** |  |  |  |
| **Marital status** | Co-habiting | 3(3.8) | 1(33.3) | 0.841(0.040-17.489) | 0.911 |  |  |
| Divorced | 1(100) | 1(100.0) | 2.838E9 | 1 |  |  |
|  | Married | 57(73.1) | 28(49.1) | 1.179(0.351-4.040) | 0.217 |  |  |
|  | Singles | 17(21.8) | 7(41.2) | **Ref** |  |  |  |
|  | Baptist | 18(23.1) | 6(66.7) | 0.41(0.90-1.827) | 0.240 | 2.00(0.509-7.890) | 0.320 |
| **Religion** | Muslims | 7(9.0) | 5(71.4.9%) | 2.01(0.241-16.763) | 0.519 | 0.46(0.062-3.327) | 0.438 |
|  | Pentecostal | 12(15.4) | 7(58.3%) | 0.93(0.157-5.451) | 0.932 | 1.14(0.246-5.331) | 0.864 |
|  | Presbyterian | 13(16.7) | 6(46.2%) | 1.36(0.230-8.075) | 0.733 | 0.66(0.139-3.152) | 0.603 |
|  | Roman catholic | 28(35.9) | 13(46.4%) | **Ref** |  |  |  |
| **HIV status** | Positive | 48(61.5) | 19(63.3) | 3.28(0.948-11.355) | 0.061 | 0.30(0.96-0.940) | 0.039 |
| Negative | 30(38.5) | 18(37.5) | **Ref** |  |  |  |
| **Co-morbidities** | No | 75(96.2) | 36(48.0) | 2.512(0.128-49.239) | 0.544 |  |  |
| yes | 3(3.8) | 1(3.3) | **Ref** |  |  |  |

*Note: p < 0.05 was taken as significance, Ref stands for reference category.*

All variables with a *p*-value of 0.25 or lower in the bivariate analyses were entered into multivariable logistic regression analyses. Participants who attained secondary education had an ODD of 6.75, more than 2.23 for those who attained tertiary level, and 1.94 for those who stopped in primary school. Attaining secondary education gave 3.02 times chances to have multidrug resistant than those of tertiary education; and 3.5 times chances than those who stopped in primary school (*p* = 0.040). Furthermore, participants with monthly income <50,000 FCFA had an odd ratio of 5.53 when those earning >100,000 FCFA had an odd ratio of 1.82, earning <50,000 FCFA gave 3.02 times chances of having multidrug resistance than earning >100,000 FCFA. (*p* = 0.025). In addition, participants who were HIV-positive were 0.30 times more likely to be multidrug resistant than HIV negative individuals (AOR = 0.30, 95% CI: 0.96-0.940, *p* = 0.039) (Table 3).

**Discussions**

This study generated data for HIV-seropositive patients in this part of the country where information on bacteriuria among HIV-seropositive patients is scarce. The findings of this study highlight several factors associated with multidrug resistance (MDR) among participants.

In this study, the overall prevalence of *Klebsiella* *pneumoniae* was 23.4% (78/333). This value is lower compared to the 27.0%-53.75% reported in other countries1, 7, 23 but higher compared to the <18% prevalence reported in different studies24, 35. These differences can be attributed to the differences in the study design, geographical or sociodemographic variation.

*K. pneumoniae* was higher in HIV positive participants (24. % vs 23.42). Similarly, higher prevalence of [*Klebsiella*](https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/klebsiella) sp. in HIV positive participant has been reported in another town in the Western region of Cameroon8 and in another count36. Contrary reports have been reported by Mutsami *et al.,* 37 in Kenya. The high prevalence in HIV persons could be attributed to the fact that most HIV patients are immunosuppressed as such visit the hospital frequently. It has been reported that *K. pneumoniae* isanosocomial infections5. The prevalence 98.7% (77/78) of *K. pneumoniae* antibiotic resistance was high as compared to the global average of 45% in health care settings20. This high prevalence trend is similar to projections which suggest antibiotic resistance is on the rise in Cameroon38 and it is largely due to the misuse and over use of antibiotics in both agricultures, veterinary medicine and health care settings39.

Secondly it can also be that *Klebsiella* displayed diverse resistance patterns5, 40. However, lower prevalence rate (18%-53.7%) has been recorded in another studies3, 11, 41, 42. This discrepancy in prevalence might be ascribed to differences in the study design, study population, sample size terrestrial variation, and socioeconomic conditions.

Overall, ampicillin recorded the highest resistance 61.5%, (48/78) followed by gentamycin 60.3%, (47/78) while nitrofurantoin 42.3% (28/78) followed by levofloxacin 37.2%, (29/78) were the most sensitive drugs.

Similarly, Jalal et al., 2 andAyatollahi et al 5; also reported high *Klebsiella* resistance to ampicillin; Oguche et al., 23 reported high resistance to gentamycin and Worku et al., 5 reported high sensitivity to nitrofurantoin.

On the contrary nitrofurantoin was resistant in another study as reported by Samje *et al*. 40, amoxicillin, ceftriaxone and ciprofloxacin by Mustafa et al., 32 while gentamycin was the most sensitive drugs Oguche et al.,23.

Other studies have reported higher drug resistance with cefotaxime, ceftriaxone, cefepime, ceftazidime meropenem aminoglycosides quinolones carbapenem and cephalosporin1, 5, 24-24. These differences can be attributed to the difference in the study population, study design, patient clinical case, and differences in infection prevention policies and implementation between countries and institutions.

Data from this study showed that cell wall inhibitors 66 (84.6%) recorded the highest number of resistances. Similar findings have been recorded elsewhere1. The most probable reason is the frequent use and misuse of cell wall inhibitors as empirical treatment40, 42.

The emergence of multidrug‑resistant (MDR) is making the management of these infections more challenging. Our study recorded a MDR prevalence of 34.2% (26/76). The prevalence was lower as compared to the 54-82.0% prevalence range in other studies in Cameroon8, 7, 44 and elsewhere 3, 7, 23, 42, 45. However, lower MDR rate have also been reported in other countries by CDC45. The high level of resistance is as a result of frequent empirical use of antibiotics in clinical practice, poor infection control strategies, limited therapeutic options and misuse of antibiotics. Secondly it could be due to insufficient regulation on antibiotics use and the frequently available polypharmacy with over-the-counter in many countries. On the other hand, the MDR findings in this study is higher than the 15% to 30% prevalence recorded in developed countries 46.

Our findings indicate that young people (<25years) exhibited the highest MDR prevalence (55.6%) although the association was not statistically significant (*p* = 0.356). This trend aligns with previous research suggesting that younger individuals may have lower treatment adherence and higher engagement in risky behaviors like taking of alcohol, smoking that contribute to resistance47.

Other studies suggest that MDR is high in neonates, and elderly people due to their frequent hospital visits, longer hospital stays, and the use of medical devices like catheters24, 48. This high prevalence could be as a result that people within the age group are very mobile as such; they are more expose to risk factors likely to use public latrines to urinate during their travels or movements. Thereby increasing the chances of coming down with infections and thus frequently receive antibiotic treatment.

Similarly, MDR prevalence was high among males (50.0%) though not significant. Mirroring patterns observed in other studies where men often exhibit lower healthcare-seeking behaviour and adherence to medication regimens49, 50. It has been reported that men have worse treatment outcomes than women that may be linked to their poor adherence to treatment compared to women23.

Education level was a significant predictor of MDR, with individuals having only a basic education being 6.75 times more likely to be resistant compared to those with high and tertiary education (AOR = 6. 75, *p* = 0.006). Notably, MDR was more prevalent among participants with secondary education (60.0%). This high prevalence is similar a study carried out by Torres *et al* 50 which found out that antibiotic resistance is higher in those with basic level of education as opposed to those who had attained higher levels of education. This suggests that health literacy plays a crucial role in treatment adherence and infection control.

Monthly income level also appeared to influence MDR prevalence, with participants earning between 50,000–100,000 CFA ($80.14–$160.28) exhibiting high resistance (54.5%). This could be attributed to economic constraints that affect access to healthcare services, leading to suboptimal treatment adherence, use of sub-standard drugs for the many polypharmacy common in the study area.

Being HIV positive was identified as a risk factor for multidrug resistance. HIV positive individuals had a higher MDR prevalence (AOR = 0.30, 95% CI: 0.96-0.940, *p* = 0.039) compared to their HIV-negative counterparts. It has been reported that HIV patients use antibiotics frequently to prevent mammoth threat of opportunistic infection23. Frequent and inappropriate use of antibiotic, as well as over-the-counter medication access, and self-medication all common contributors to antimicrobial resistance among HIV patients.

**Conclusions**

Drug resistance is a public health problem and necessitate improvements in routine screening.This high MDR prevalence in this study among HIV-infected patients requires that antibiotic sensitivity test be done in all HIV patients before the commencement of treatment. It is therefore important to interminably carry out antimicrobial surveillance study on HIV patients across different setting in order to monitor antibiotic resistance trends and to also identify drugs that can be used for empirical treatment in resource limiting countries. There is a need for strict measures in the administration of ampicillin and gentamycin while encourage the use of nitrofurantoin and levofloxacin.

**Abbreviations**

ABR: antibiotic resistance. API 20E: Analytical Profile Index 20E*,* AOR: adjusted odd ratio, CL: confidence interval, CLED: Cystine Lactose Electrolyte Deficient Agar, CLSI: Clinical and Laboratory Standard Institute, COR: crude odd ratio. K: *Klebsiella*, HIV: human immunodeficiency virus, MDR: Multi drug resistance

**Ethics approval and consent to participate**

All samples were collected with respect to the study protocol as approved by the Institutional Review Board of the Faculty of Health Sciences in the University of Bamenda (number 2024/0630H/UBa/IRB). Witten informed consent was obtained from all participants. All methods were performed according to the relevant guidelines and regulations as outlined in the Helsinki Declaration.

**Data availability**

The datasets generated during the study are available with the corresponding authors upon reasonable request.

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