***Antibiotic-Resistant Escherichia coli and Associated Risk Factors in Dialysis Patients with Urinary Tract Infections in the Bamenda Health District: A Comparative Analysis with Non-Dialytic Participants***

**ABSTRACT**

**Background:** Urinary tract infections are a public health problem affecting all individuals. However, its impact on patients with kidney failure needs to be determined. The main aim of this research was to investigate the prevalence and antibiotic-resistant pattern of *Escherichia coli* causing urinary tract infection in patients on dialysis and non-dialyzing participants in the Bamenda Health District.

**Method:** This was a cross-sectional study conducted from January to June 2024, and involved collection of urine samples from dialytic (45) and non-dialytic (59) participants. The urine samples were cultured on Cysteine-Lactose-Electrolyte-Deficient agar and MacConkey agar. Positive cultures typical of *E. coli* were identified using API20E. Antibiotic susceptibility testing was done using Kirby-Bauer Disc diffusion method. The data was analysed using the Statistical Package for Social Sciences software.

**Results:** The age of the participants ranged from 17 to 78 years with a mean (std) age of 37.95(10.86) years. The prevalence of *E. coli* was 25% (26/104) and was insignificantly (*p* = 0.732) higher in patients on dialysis (26.7%) than in non-dialyzing participants (23.7%). All isolates were resistant to two or more antibiotics. Drug resistance was highest with ofloxacin (83.3%) and ciprofloxacin (77.8%) in dialysis patients while nitrofurantoin was the most active drug (19; 73.08%). Multidrug resistance was recorded in 18 (69.2%) of the isolates and was significantly higher (*p*=0.011) in patients on dialysis 12(92.3%). The age groups of less than 30 years (AOR; 0.042, *p*=0.000] and 30-40 years (AOR; 0.120, *p*=0.01) and being on dialysis (AOR 5.488, *p*=0.017) were identified as risk factors for antibiotic resistance.

**Conclusion:** This study showed that the prevalence of drug resistance is high and there is need for policy makers to establish policies for the prudent use of antibiotics in dialysis units.

**Keywords:** Antibiotic Resistance, Dialysis, *E. coli,* infections, Non- Dialysis, Risk Factors.

**INTRODUCTION**

Chronic kidney disease (CKD) represents a global health problem that affects patients of all ages and has been on the rise (Mejía and Zarza, 2022; Vacaroiu *et al*., 2022) CKD requires renal replacement therapy procedures known as hemodialysis (Mejía and Zarza, 2022). Patients receiving hemodialysis are highly susceptible to nosocomial infections due to their weakened immune systems attributable to frequent exposure to healthcare settings and also because the dialysis procedure is invasive (Hosseinpour *et al*., 2023).

Urinary tract infection (UTI) caused by Uropathogenic *Escherichia coli* (UPEC) poses a significant health threat and is a common cause of morbidity and mortality with severe complications including bacteraemia and sepsis especially in dialysis patients (Mejía and Zarza, 2022, Kumar *et al*., 2023; Mancuso *et al*., 2023).

Antibiotic resistance is a growing global concern, driven by factors such as overuse and misuse of antibiotics with consequences of prolonged illnesses, increased healthcare costs, increased therapeutic difficulties, longer hospitalizations, worse clinical and economic outcomes and even death (Massongo *et al*., 2021; Nwobodo *et al*., 2022). The increasing prevalence of antibiotic-resistant UPEC strains both in community and hospital infections has exacerbated the prognosis in patients with CKD (Krajewska and Laudy, 2021; Mejía and Zarza, 2022; Sah *et al*., 2023).

Studies have shown that the prevalence of antibiotic resistance in dialysis patients ranges from 5% to 70% (Mouiche *et al*., 2019; Kadri, 2020; Kaleem *et al*., 2022; Djuikoue *et al*., 2023). In Cameroon, while there is no data on antibiotic resistance among dialysis patients, previous studies suggest antibiotic resistance prevalence of 47.1% to 96.0% depending on the type of antibiotic and infection (Mouiche *et al*., 2019; Massongo *et al*., 2021 Matakone 2021).

Cameroon, like many countries, faces challenges in combating antibiotic resistance. Factors such as limited surveillance systems, inadequate antibiotic stewardship programs, and gaps in diagnosis and infection control measures contribute to this problem (Gulumbe *et al*., 2022; Djuikoue *et al*., 2023). Several studies have shown that antibiotic resistance is influenced by several risk factors. These include antibiotic use and misuse, such as over-prescription, non-compliance and agricultural use of antibiotics (Gupta *et al.,* 2011; Llor and Bjerrum, 2014; Salam *et al.,* 2023). Patient-related factors such as previous antibiotic use, hospitalization, underlying health conditions (diabetes, renal disease), age, pregnancy and lifestyle factors (poor nutrition, hygiene), also increase the risk of antibiotic resistance (Foxman, 2014; Eyoh *et al.,* 2018). It has been reported that vulnerable populations, such as patients on dialysis, are at increased risk due to repeated exposures to healthcare settings and frequent antibiotic use (Opatowski *et al.,* 2021; Hosseinpour *et al.,* 2023; Bunduki *et al*., 2024). However, the risk factors vary between and within countries and requires recent updates.

The objective of this study was to determine the prevalence of UTIs caused by Uropathogenic *Escherichia coli in* dialysis and non-dialysis patients and examine the risk factors, for antibiotic-resistance in participants within the Bamenda Health District. The outcome of this study will help policy makers in Cameroon to evaluate the treatment guidelines for better treatment outcomes and to improve the participant’s health care.

**METHODOLOGY**

**Study design and setting**

This study was a cross-sectional study conducted in the Bamenda Health District during the period of January 2024 to June 2024. Mid-stream urine samples were collected to determine the presence of *E. coli* and pretested, open-close questionnaires were used to identified possible risk factors of antibiotic resistance.

**Study Patients/participants**

The sample size was calculated using formula for comparing two proportions as described by Armitage *et al., (*2002). A conservative estimate of 50% prevalence of participants on dialysis (p1 = 0.5) and a 30% prevalence (for non-dialytic participants: p2 = 0.3) was used for the sample size calculation. As such, a minimum of 45 participants were enrolled in each group. This study included both outpatients and inpatients on dialysis and non-dialytic patients who came to the hospitals or clinics during the study period. Participants of both sexes and all ages who gave their consent or with parental consent were recruited for the study.

## Data Collection for Risk factors identification

Risk factors associated with antibiotic resistance were determined using a pretested, open-ended questionnaire. The questionnaire was divided into two sections consisting of socio demographic information (occupation, age, sex, level of education, religious affiliation) of participant, knowledge on the cause of drug resistance and participant’s history concerning the usage of antibiotics. Participants who could not read or write were assisted in filling the questionnaire. There were seven options that highlighted knowledge on antibiotic usage and a score of 4 on 7 was considered good knowledge.

**Laboratory procedure**

Participants with suspected urinary tract infections (UTIs) were instructed on how to collect midstream urine in labelled sterile, screw-top containers by certified laboratory technicians. Collected samples were transported to the laboratory and stored at 4°C until analysis same day.

The urine samples were centrifuged at 3,000 RMP for 3 minutes. The sediments were used to inoculate the Cysteine Lactose Electrolyte Deficient (CLED) media. Colonies that were yellow and opaque were presumptively isolated as *E. coli*. The presumptive *E. coli* isolates were Gram stained as previously described by Smith and Hussey, (2005). Gram-negative (pink or red coloured), rod-shaped bacteria were identified as *E. coli.* The cultures were confirmed using API (Analytical Profile Index) 20E (BioMerieux, Inc) as prescribed by the manufacturer (https://www.biomerieux.com/us/en.html).

Antibiotic susceptibility testing was performed on confirmed *Escherichia coli* isolates using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar plates as following the guides of the Clinical and Laboratory Standards Institute [CLSI] (https://clsi.org/standards/products/microbiology/, 2023). The antibiotic selected were those commonly used for the treatment of UTI in the Bamenda Health District (MINSANTE, 2024). These included azithromycin (15ug), clarithromycin (15ug), doxycycline (30ug), erythromycin (15ug), gentamicin (10ug), minocycline (30ug), ciprofloxacin (5ug), levofloxacin (5ug), norfloxacin (10ug), ofloxacin (5ug), amoxi-clav (30ug), ampicillin (10ug), cefixime (5ug), ceftriaxone (5ug), nitrofurantoin (300ug). The zone of inhibition around each antibiotic was compared to standardized interpretive criteria established by the Clinical and Laboratory Standards Institute to categorize isolates as susceptible, intermediate, or resistant to each antibiotic. Multidrug-resistant (MDR) isolates were defined as those resistant to at least one antibiotic in three or more classes (Magiorakos *et al.,* 2012).

**Statistical analysis**

The data was analysed using statistical product and service solutions (SPSS) software version 23 (IBM SPSS Inc. Chicago, IL, USA). The Pearson chi-square analysis was done to the determine the proportion between categorical variables between groups and disease prevalence. Risk factors influencing drug resistance were analysed using logistic regression models. However, due to limitations in the positive sample size, only variables with p-values <0.25 in the univariate analysis were supported for inclusion in the multivariate analysis. All probabilities were two-tailed and statistical significance was set at a p-value <0.05.

**RESULTS**

## Socio-Demographic and health characteristics of the study population

A total of 104 individuals aged 17 to 78 years with a mean (SD) age of 37.95 (10.86) years were examined. Majority of the participants belonged to age group >40 years (46; 44.2%). More than half of the participants were females 53 (51%). Similarly, majority of the participants (88; 84.6%) had attained tertiary education. A total of (96; 93.3%) were Christians and of these the majority (38; 36.5%) were Catholics as shown on table 1. As concerns their biomedical data, 19 (18.3%) of the participants had one or more medical conditions, of which majority (7; 6.7%) had hypertension. A total of 45 (43.3%) participants were undergoing dialysis and of these majority of them had undergone dialysis for 3-5years (20; 19.2%) as shown on table 1.

**Table 1: Characteristics of the study population**

|  |  |  |
| --- | --- | --- |
| Characteristic Variable | No Examined | Percentages (%) |
| Age (years) | <30 | 27 | 26 |
| 30-40 | 31 | 29.8 |
| >40 | 46 | 44.2 |
| Gender  | Males | 51 | 49 |
| Females | 53 | 51 |
| Education  | Primary  | 14 | 13.5 |
| Secondary  | 2 | 1.9 |
| Tertiary  | 88 | 84.6 |
| Religion | Christians  | 96 | 92.3 |
| Muslims  | 8 | 7.7 |
| Denomination | Catholic  | 38 | 36.5 |
| Baptist  | 23 | 22.1 |
| Pentecostals  | 21 | 20.1 |
| Presbyterian  | 9 | 8.7 |
| Muslim  | 8 | 7.7 |
| underlining medical condition  | No | 85 | 81.7 |
| Yes | 19 | 18.3 |
| Type of Medical condition | Hypertension  | 7 | 6.7 |
| Diabetes and hypertension  | 6 | 5.8 |
| Diabetes  | 3 | 2.9 |
| Asthma  | 3 | 2.9 |
| Dialysis  | No | 59 | 56.7 |
| Yes | 45 | 43.3 |
| Duration on dialysis (year) | 1-2 | 15 | 33.3 |
| 3-5 | 20 | 44.4 |
| >5 | 10 | 22.3 |

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## Prevalence of urinary tract infection in the study population

The overall prevalence of UTIs associated with Uropathogenic *E. coli* among the study population was 25.% (26/104) as in figure 1.

Figure 1: Prevalence of urinary tract infection in the study population

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## Prevalence of *E. coli* among dialysis and non-dialysis participants

In figure 2, a higher prevalence of UTIs was observed amongst participants on dialysis (12/45; 26.7%) as compared to non-dialytic participants (14/59; 23.7%). However, this difference was not significant (*p* = 0.732).

$χ^{2}$ = 0.118 p=0.732

Figure 2: Prevalence of *E. coli* among dialysis and non-dialysis patients

## Antibiotic resistance profile among study population

All the 26 *E. coli* isolates (100%) showed resistance to two or more of the antibiotics used. The isolates were resistant from 2 to 8 different drugs. The highest resistance was observed in Ceftriaxone (13; 50%) followed by Amoxiclav (10; 38.46%) while Nitrofurantoin was the most active drug (19; 73.08%) followed by Gentamicin (13; 50.00%) as shown in table 2.

Table 2: Antibiotic susceptibility patterns of all antibiotics used

|  |  |  |
| --- | --- | --- |
| Class | Antibiotic | Frequency (%) |
| Sensitive(S) | Intermediate(I) | Resistant(R) |
| Inhibition of protein synthesis  | Azithromycin\_ 15µg | 8(30.77) | 9(34.61) | 9(34.61) |
| Clarithromycin\_ 15µg | 5(19.23) | 16(61.54) | 5(19.23) |
| Doxycycline\_ 30µg | 6(23.07) | 11(42.31) | 9(34.61) |
| Erythromycin\_ 15µg | 8(30.77) | 10(38.46) | 8(30.77) |
| Gentamicin\_ 10µg | 13(50) | 6(23.07) | 7(26.9) |
| Minocycline -30µg | 8(30.77) | 10(38.46) | 8(30.77) |
| Inhibition of nucleic acid synthesis | Ciprofloxacin\_ 5µg | 8(30.77) | 9(34.61) | 9(34.61) |
| Levofloxacin\_ 5µg | 7 (26.9) | 13(50) | 6(23.07) |
| Norfloxacin\_ 10mcg | 12(46.15) | 9(34.61) | 5(19.23) |
| Ofloxacin\_ 5µg | 9(34.61) | 11(42.31) | 6(23.07) |
| Inhibition of cell wall | Amoxi-clav\_30µg (20/10) | 7 (26.9) | 9(34.61) | 10(38.46) |
|  | Ampicillin\_ 10mcg | 4(15.38) | 14(53.85) | 8(30.77) |
| Cefixime\_ 5µg | 8(30.77) | 9(34.61) | 9(34.61) |
| Ceftriaxone\_ 5µg | 4(15.38) | 9(34.61) | 13(50) |
| Nitrofµrantoin\_ 300µg | 19(73.08) | 5(19.23) | 2(7.69) |

**Comparing the level of resistance between dialysis and non-dialytic patients**.

The highest number of resistance was recorded among isolates from patients on dialysis 26.7% (12 /45) compared to isolates from non-dialytic patients 23.7% (14/59). This difference was however statistically insignificant (*p*=0.732). Further analysis of individual antibiotic resistance patterns demonstrated that dialysis patients had higher resistance rates (11/16; 68.75%) in the number of antibiotics being used. Ofloxacin (83.3%), followed by ciprofloxacin (77.8%) recorded the highest resistance rate. On the contrary, there was no resistance to Nitrofurantoin in isolates from this group (figure 3).

Figure 3: **Antibiotic resistance level (%) between dialysis and non-dialytic patients**

## Multi drug resistance

Our data showed that MDR was registered in 69.2% (18/26) of the isolates. MDR was significantly higher (*p*=0.011) in isolates from dialysis patients (92.3%; 2/13) compared with isolates from non-dialytic participants (Figure 4).

$χ^{2}$ = 6.500 *p*=0.011

Figure 4: Assessing MDR among dialysis and non-dialytic patients

### **Evaluating multi drug resistance according to age group and Sex**

The highest multi drug resistant cases (8; 88.9%) were seen in isolates from the age group 30-40 years and the lowest in isolates from the age group of more than 40 years (table 3). This was statistically insignificant (*p*=0.286). Similarly, insignificant difference was seen among gender (*p*=0.42) though it was high in females (12; 75.0%).

Table 3: Evaluating MDR according to age group and gender

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Categories | Number of participants | MDR Frequency (%) | Chi square  | P value |
| Age Group(years) | < 30 | 12 | 7(58.3) | 2.502 | 0.286 |
|  | 30-40 | 9 | 8(88.9) |  |  |
|  | >40 | 5 | 3(60.0) |  |  |
| Gender | Female | 16 | 12(75.0) | 0.650 | 0.420 |
|  | Male | 10 | 6(60.0) |  |  |

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## Evaluation of risk factors associated with antibiotic resistance

In univariate analysis the data showed that the prevalence of drug resistance was high in isolates from the age group 30-40years (12; 44.4%). With exception of age that was significant (*p*< 0.05), all the other variables were insignificant (*p*>0.05). In multivariate analysis, variables in univariate analysis that had *p*<0.5 were taken to the multivariate logistic regression model accordingly. Some of the associated risk factors that showed significant association were age group <30 AOR (0.42; 95% CI: 0.007-0.249; p=0.000), and 30 – 40years AOR (0.120; 95% CI:0.24 – 0.597; p=0.010). Similarly, patients on dialysis were at high risk of developing resistance AOR (5.488; 95% CI: 1.361 – 2.2137; p=0.017) compared to those not on dialysis (Table 5).

Table 4: Assessment of the risk factors of antibiotic resistance *E. coli* amongst the study population using univariate logistic regression

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristics** | **Indicator** | **Frequency n %** | **Positive cases n (% of resistance)** | **Univariate analysis** |
| **COR (95.0% C.I.)** | ***P* - value** |
| **Age (Years)** | < 30 | 27(26) | 12(44.4) | Ref | 0.004 |
| 30 – 40 | 31(29.8) | 9(29.0) | 50.976(4.886 - 531.795) | 0.001 |
| Above 40 | 46(44.2) | 5(10.5) | 17.026(2.356 - 123.024) | 0.005 |
| **Sex** | Female | 53(51) | 16(30.2) | 0.814 (.245 - 2.699) | 0.736 |
| Male | 51(49) | 10(19.6) | Ref |  |
| **Education** | Primary | 14(13.5) | 0(0) | Ref | 0.998 |
| Secondary | 2(1.9) | 1(50) | 0.49(.130 - 1.852) | 0.998 |
| Tertiary | 88(84.6) | 25(28.4) | 0.250(.023 - 2.694) | 0.998 |
| **Religion** | Christianity | 96(92.3) | 26(27.1) | 1.076x10-9 | 0.999 |
| Muslim | 8(7.7) | 0 | Ref |  |
| **Medical Condition** | No | 85(81.7) | 23(27.1) | 0.318(.049 - 2.086) | 0.233 |
| Yes | 19(18.3) | 3(15.8) | Ref |  |
| **Dialysis** | No | 59(56.7) | 14(23.7) | 0.160(0.015 - 1.665) | 0.125 |
| Yes | 45(43.3) | 12(26.7) | Ref |  |
| **Duration dialysis (Years)** | 1 – 2 | 15(14.4) | 11(73.3) | Ref | 0.203 |
| 3 – 5 | 20(19.2) | 3(15.0) | 2.499(0.252 - 24.815) | 0.434 |
| >5 | 10(9.6) | 0(00.0) | 0.329(0.029 - 3.674) | 0.366 |
| **Awareness about antibiotic resistance** | No | 71(68.27) | 19(26.8) | 6.454(0.485 - 85.912) | 0.158 |
| Yes | 33(31.7) | 7(21.2) | Ref |  |
| **Knowledge on antibiotic** | Poor | 81(77.88) | 21(25.9) | 0.249 (0.017 - 3.735) | 0.315 |
| Good | 23 (22.12) | 5(21.7) | Ref |  |
| **Practice on antibiotic usage** | Bad | 72(69.23) | 18(25.0) | 0.504(0.089 - 2.842) | 0.438 |
| Good | 32(30.776) | 8(25.0) | Ref |  |

Table 5: Assessment of the risk factors of antibiotic resistance *E. coli* amongst the study population using multivariate logistic regression

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristics** |  | **Univariate Analysis** | **Multivariate Analysis** |
| **COR (95.0% CI)** | ***P* – value** | **AOR (95.0% CI)** | ***P* - value** |
| **Age (Years)** | < 30 | Ref | 0.004 | .042(0.007 - 0.249) | **0.000** |
| 30 - 40 | 50.976(4.886 - 531.795) | 0.001 | .120(0.24 - 0.597) | **0.010** |
| Above 40 | 17.026(2.356 - 123.024) | 0.005 | Ref |  |
| **Underlying medical Condition** | No | 0.31 (0.049 - 2.086) | 0.233 | 1.399(0.288 - 6.801) | 0.678 |
| Yes | Ref |  | Ref |  |
| **Dialysis** | No | 0.160(0.015 - 1.665) | 0.125 | 5.488(1.361 - 22.137) | **0.017** |
| Yes | Ref |  | Ref |  |
| **Awareness about antibiotic resistance** | No | 6.454(0.485 - 85.912) | 0.158 | 0.270(0.36 - 2.022) | 0.202 |
| Yes | Ref |  | Ref |  |
| **Knowledge on antibiotic** | Poor | 0.249(0.017 - 3.735) | 0.315 | 1.978(0.256 - 15.272) | 0.513 |
| Good | Ref |  | Ref |  |
| **Practice on antibiotic usage** | Bad | 0.504(0.089 - 2.842) | 0.438 | 1.854(0.403 - 8.521) | 0.428 |
| Good | Ref |  | Ref |  |

## Ref: Reference

**DISCUSSION**

Urinary tract infections (UTIs) remain a significant health concern worldwide affecting millions of individuals annually. Among vulnerable populations such as patients undergoing dialysis, UTIs can lead to complications, prolonged hospital stays and increased morbidity. Moreover, the emergence of antibiotic-resistant bacteria poses a big challenge in managing UTIs effectively. In this study, we focused on the prevalence of *Escherichia coli* as a common causative agent of UTI, compare the prevalence in both groups, verify the antibiotic-resistant patterns and investigate risk factors associated with antibiotic resistance. An overall prevalence of 25.0% was recorded for uropathogenic *E. coli* among the study population. This is similar to other African studies by Dadi *et al.*, (2020) and Bunduki *et al.,* (2024) where they observed a prevalence of 25.6% and 24.8% respectively. However, this finding is lower than that of Mlugu *et al*., (2023) and Amadu *et al*., (2019) who reported a prevalence of 47% and 55.0% respectively for UPEC. These variations may be due to differences in the study design and healthcare practices.

A higher prevalence of UTIs was observed amongst participants on dialysis (26.7%) with no significant association. This finding is in line with Hamza *et al*., (2023) who reported a prevalence of 27.1% for UTIs caused by *E. coli* among dialytic patients. In contrast, higher prevalence of the range 45-55% have been recorded in other studies elsewhere (Yamashita *et al*., 2022; Sumon *et al.,* 2023; Thapa *et al.,* 2023). On the other hand, a relatively lower prevalence of 15.5% was observed in 2021 (AL-Aboudy *et al.,* 2021). This difference in UTI prevalence among dialysis patients may be due to differences in geographical and environmental conditions, healthcare infrastructure, patient demographics, dialysis procedure and duration, study design and socioeconomic factors. Regions with poor sanitation and healthcare practices may report higher UTI rates, while patient factors such as age and dialysis duration also play a role (AL-Aboudy *et al.,* 2021; Yamashita *et al*., 2022; Hamza *et al*., 2023; Sumon *et al.*, 2023; Thapa *et al.,* 2023). In addition, it can also be due to healthcare practices such as frequent hospitalization in these patients.

All *E. coli* isolates demonstrated resistance to at least two or more of the antibiotics that were used. Recent research reports revealed same and similar antibiotic resistance in *E. coli* associated UTI in Pakistan, Egypt and India (Sabir *et al*., 2014; Abdel-Wahed *et al.,* 2018; Gupta *et al*., 2019) and 98.5% in Ethiopia (Tadesse *et al*., 2022). On the contrary, Hitzenbichler *et al.* (2018) observed lower resistance prevalence rate of 75.0%. The variation in E. coli antibiotic resistance across regions can be linked to several factors. Higher resistance rates are likely due to the overuse and misuse of antibiotics that promotes the emergence of resistant strains. Differences in healthcare practices, antibiotic availability and public health infrastructure also play a role. In contrast, lower resistance rate may result from more controlled antibiotic use and different prescribing habits. The high resistance rates observed in this study, in addition to the previously mentioned factors, may also be attributed to the high prevalence of UTIs, which likely leads to frequent antibiotic use among patients, thereby initiating the development of resistance. In addition, the presence of nosocomial strains that have emerged because of drug resistance and can also spread to patients on dialysis in hospitals because of poor hygiene in the dialysis process.

As concerns the different drugs used in the study. The highest prevalence of resistance was in Ceftriaxone (50%) while the least was recorded in Nitrofurantoin (7.69%). Similar trends have been observed in other studies, such as Niranjan and Malini, (2014) where E. coli resistance to Ceftriaxone was 71.4%, and Tadesse *et al*., (2022), who reported a 55% resistance rate. In contrast, Abongomera *et al*. (2021) found lower resistance to Ceftriaxone at 35%, while Nitrofurantoin resistance was 0%. However, Abdel Wahed *et al*. (2018) reported a significantly higher resistance to Nitrofurantoin at 20%. In other works, unlike the case of this study, high and varying resistance rates were observed in other antibiotics like Amoxicillin-Clavulanic Acid with 40% in Bizimungu *et al*., (2024) to 45% in Gupta *et al.* (2019). The results here could be due to regional antibiotic practices, the prevalence of antibiotic-resistant strains and local healthcare conditions. High resistance rates may result from overuse and misuse of antibiotics, while lower rates might reflect better prescribing practices or high cost of the drug in the market. Ceftriaxone is one of the most available and commonly used antibiotics in treating UTI in Bamenda which accounts for the high prevalence. The low resistance to nitrofurantoin is due to the fact that it’s contraindicated in patients with kidney failure hence most doctors prescribe with restrictions and always as a last resort.

Though statistically insignificant the highest number of resistances was recorded among patients on dialysis (26.7%) in contrast to non-dialytic patients (23.7%). In line with our studies several past studies revealed high resistant prevalence in dialytic than non-dialytic patients. For instance, Thapa *et al.* (2023), founded 38% in dialytic higher compared to 22% in non-dialytic. Similar to our findings past resistance prevalence rates of 38.7% versus 20% (Oikonomou and Alhaddad, 2017), 30% versus 23%% (Vacaroiu *et al*., 2022) has been recorded in dialytic and non-dialytic patients respectively. No past study revealed higher resistance prevalence in non-dialytic compared to dialytic patients. The higher resistance rates in dialysis patients as in our study are likely due to frequent antibiotic use, ongoing infections and repeated medical procedures which encourage high prevalence rate and thus higher tendency of transmitted resistant bacteria. Also, differences in infection control and antibiotic use in dialysis centers can lead to higher resistance.

Among the *E. coli* positive cases, 69.2% participants had multiple drug resistance (MDR). MDR was in significantly higher in dialysis patients (20.0%) compared to non-dialysis patients. Our study's findings are similar to Tadesse *et al.* (2022), who observed high levels of resistance to multiple drug classes in *E. coli* with rates of 68%. In contrast, Ali *et al*. (2016) reported a lower rate of 59%. Additionally, Gupta *et al.* (2021) showed MDR rates of 36% which differ from our results. Moreso, Madrazo *et al.* (2021), Jauhar and Abbas, (2024) and Maldonado-Barragán *et al*., (2024), reported MDR rates of 41.4%, 47.3% and 52.2% respectively. There is very limited data on the prevalence of MDR rates in dialysis compared with non-dialytic. This difference in MDR rates could be because of variations in local antibiotic use, infection control practices and underlying health conditions across different regions. The highest number of multidrug-resistant cases, (8; 88.9%), were found in the 30-40 age group, while the lowest were in another age group. Multidrug resistance was also higher in females with (12; 75.0%) cases compared to 6 (60.0%) in males. However, these differences in resistance by age and sex were not significant. Jauhar and Abbas, (2024)reported a similar high MDR among *E. coli* isolates from UTI cases in 30-50years age group, with females showing higher rates than males. On the other hand, Maldonado-Barragán *et al.* (2024) reported 50.6% MDR in similar age group and the highest rate (61.9%) of multidrug resistance in *E. coli* UTIs was found in the age group of 75years and above. Moreover, the study showed a higher prevalence of MDR in males (60.2%) compared to 48.9% in females across Kenya, Tanzania and Uganda in east Africa, with significant differences by sex. The high MDR in age group 30-40 and in females could be due to the prevalence of UTI in this sexually active and youthful age. Also, the anatomical structure of the female sexual organ exposes them to UTI infections more than men.

For the risk factors associated with antibiotic resistance, participant less than 30 years recorded the highest prevalence (44%). Those above 40 years also recorded a significant (*P* = 0.005) prevalence for resistance, AOR (17.026; 95% CI: 2.356, 123.024). This result is similar to Maldonado-Barragán *et al.* (2024) who reported 45.5% and 46.8% resistance prevalence in age groups 18-24 years and 25-34 years respectively. However, this finding is in contrast with that of Shaker *et al.,* (2024) who reported the highest significant resistance of 88.1% in older age group of 60years and above. The highest resistance in the younger age group could be because young people are most often exposed to antibiotics and misuse them especially as UTI is more prevalent in this age group. Also, the discrepancy in findings may be due to difference in sample size and study area. Regarding gender, a higher resistance (30.2%) was recorded among the females but with no significance. This is in line with Shaker *et al*. (2024) who observed a higher resistance among females though with a significance. Similarly, Sojo-Dorado *et al*. (2022) found higher antibiotic resistance in female patients (35.4%, significant) with multidrug-resistant *Escherichia coli* UTIs. However, contrasting results were reported by a study in Antibiotics (2022), which found no significant gender difference (males 28.7%, females 29.1%) in antibiotic resistance among community-acquired UTI cases and another study (Maldonado-Bar *et al.,* 2023), which observed higher resistance in male patients (32.5%, significant). The variations in gender differences in antibiotic resistance among *E. coli* UTIs could be as a result of anatomical differences. Additionally, differences in study populations might be reason for contrasting results. For educational level, the highest resistance rate (50%) was recorded among participants who attended secondary education which was not significant. Educational level is not directly linked to drug resistance. Similar findings were reported that educational level did not significantly impact antibiotic resistance rates (Mallah *et al.,* 2022; World Health Organization, 2023; Centers for Disease Control and Prevention, 2024). On the contrary, a study found that higher educational levels were associated with lower rates of antibiotic resistance in *E. coli* UTIs, suggesting that better education may lead to more prudent antibiotic use and thus reduce antibiotic resistance rates in community-acquired UTIs (Mallah *et al*., 2022). The differences in results could be due to differences in study populations, healthcare practices, and the presence of targeted educational interventions. However, educational level can indirectly affect antibiotic use such that better literacy may lead to more informed antibiotic use.

Participants who were Christians recorded an insignificant higher resistance of 27.1%. Similar findings were observed in a study where 28.2% of *E. coli* isolates from Christian participants showed resistance, which was not significant (Mallah *et al*., 2022; World Health Organization, 2023). Another study reported a 25.4% resistance rate among Christian participants, also not significant (Centers for Disease Control and Prevention, 2024). In contrast, a study found that Christian participants had a significantly lower resistance rate of 15.3% (Davies *et al*., 2017). Another contrasting study indicated that educational interventions among Christian communities significantly reduced resistance rates to 12.7% (Taylor *et al*., 2019). The varying results could be due to differences in healthcare access, antibiotic use practices, and the effectiveness of educational interventions among different Christian communities. Additionally, cultural or religious beliefs and varying levels of health knowledge might also influence antibiotic resistance rates. Furthermore, among these Christians, the highest number of resistances was recorded among Pentecostal Christians. While this demographic distribution was statistically insignificant, it suggests that there might be particular practices or beliefs within the Pentecostal faith that could influence antibiotic resistance. Specifically, Pentecostal Christians are often known for advocating faith-based healing practices, which sometimes include advice to stop taking prescribed medications based on spiritual beliefs (Yong, 2020). This practice of halting medication prematurely could contribute to suboptimal antibiotic use and thus promote resistance. This observation contrasts with some literature suggesting that religious affiliation alone does not significantly impact antibiotic resistance. For instance, Kasahun *et al*., (2022) found that religious and cultural beliefs could shape attitudes toward medication and adherence, potentially influencing antibiotic usage patterns but did not isolate specific denominations or practices. On the other hand, Borges *et al.,* (2021) indicated that while religious beliefs might affect general health behaviors, they do not significantly impact antibiotic resistance outcomes. The findings of this study suggest that while broad religious affiliation may not directly influence resistance, specific practices within denominations, such as those seen in Pentecostal Christianity, might contribute to resistance issues. This highlights the need for targeted public health strategies that address specific beliefs and practices to handle antibiotic resistance more effectively (Davies *et al*., 2017).

With respect to medical condition, participants with no medical conditions recorded a higher resistance of 27.1% compared to those who had underlying medical conditions, 15.8%. However, this higher resistance had no significance. Similar findings were reported in a study where 29.3% of participants without medical conditions showed resistance, which was not significant (Bryce *et al*., 2016). Another study found a 26.5% resistance rate among participants without medical conditions, also not significant (Centers for Disease Control and Prevention, 2024). In contrast, a study found that participants with no medical conditions had a significantly lower resistance rate of 18.4% (Ku *et al.,* 2024). Another contrasting study indicated that participants with underlying medical conditions had a significantly higher resistance rate of 32.1% (Hernández-Chiñas *et al.,* 2021). The results could be due to the fact that underlying medical conditions might lead to more frequent healthcare interactions, potentially increasing exposure to resistant *E. coli* (Damm and Cameron, 2023).

A higher resistance was recorded among participants on dialysis, (26%), with no significance. Similar findings were observed in a study where 27.5% of *E. coli* isolates from dialysis patients showed resistance, which was not significant (Kaye *et al*., 2021). Another study reported a 25.8% resistance rate among dialysis patients, also not significant (Centers for Disease Control and Prevention, 2024). In contrast, studies found that dialysis patients had a significantly lower resistance rate of 18.9% (Abongomera *et al*., 2021). The reason for the results could be because dialysis patients frequently visit the hospital, thereby exposing themselves to *Escherichia coli* and also with their health situation, they frequently take antibiotics.

Regarding awareness, knowledge, and practice on antibiotic usage, participants with no awareness recorded a higher resistance rate of 26.8% while those with poor knowledge equally recorded a higher rate of resistance in that category, 25.9%. Participants with good and those with poor practice on antibiotic usage both recorded the same resistance rate of 25%. Despite the resistance rate recorded for these categories, none was statistically significant. Similar findings were reported in a study where 27.3% of participants with no awareness showed high resistance rate (Dopelt *et al.,* 2023). As concerns knowledge, another study found a 26.1% resistance rate among participants with poor knowledge (Nemr *et al*., 2023). In contrast, a study indicated that educational interventions significantly reduced resistance rates to 15.4% among participants with poor practice (Kosiyaporn *et al*., 2020). The different results might be because some people understand and use antibiotics better than others, based on their awareness and knowledge. Also, how well educational programs work and other health factors can affect resistance rates.

This study therefore identified age and dialysis status as significant factors associated with antibiotic-resistant UTIs. Younger participants (< 30 years) showed a higher prevalence of resistance 44.4%, which may be linked to higher exposure to antibiotics and other risk behaviors. This finding is supported by Huang *et al.,* (2022), whose work noted that younger populations often exhibit higher resistance rates due to overprescription and misuse of antibiotics. Dialysis participants also showed a higher prevalence of antibiotic resistance (26.7%), consistent with findings from studies highlighting the increased risk of resistant infections in immunocompromised participants (Nicolle, 2014; Abongomera *et al*., 2021).

**Conclusions**

This work has provided evidence of the prevalence of antibiotic resistance patterns of *E. coli* causing UTI in dialysis and non-dialysis patients at Bamenda health District. The results of this study support the fact that Nitrofurantoin, Ofloxacin, vancomycin and Ciprofloxacin should not be used as empiric drug. Our study demonstrates that dialysis patient can be an important source of antibiotic resistance genes. The results of this study provide a better understanding of the presence of antibiotic-resistant bacteria among dialysis patients. The emergence of multidrug-resistant organisms, makes managing these infections more challenging.

**Ethical Approval and Consent:**

Ethical clearance was obtained from the Institutional Review Board of the Faculty of Health Sciences in the University of Bamenda (Ref: 2024/0629H/UBa/IRB). The participants were informed of the study’s objectives, the procedure involved, potential risks involved, benefits of the study and the importance of strict confidentiality of their current health status using an information sheet. Written informed consent (participants 18 years and above) or parental consent (participants less than 18 years) was obtained from each participant.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, manuscript.

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Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

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