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Prevalence and Associated Risk Factors of Uropathogenic *Klebsiella* Species in Port Harcourt

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Abstract

Background: Urinary tract infection (UTI) is a severe public health issue that affects a wide range of people around the world with *Klebsiella pneumoniae* accounting for up to 25% of all urinary tract infections. The higher rate of UTI associated with uropathogenic *Klebsiella* species has been associated with the emergence of hypervirulent and antibiotic-resistant strains facilitated by the misuse and overuse of antibiotics as well as other sociodemographic and behavioural practices of susceptible individuals. This study was aimed at investigating the prevalence and associated risk factors of uropathogenic *Klebsiella* species in Port Harcourt, Nigeria. **Methodology:** The study employed a descriptive cross-sectional study design comprising 300 subjects clinically suspected of having urinary tract infections attending the Rivers State University Medical Centre and the Rivers State University Teaching Hospital between March to August 2022. A standard urine culture procedure was used to ascertain significant bacteriuria after which *Klebsiella* colonies were isolated and identified using standard bacteriological techniques. The data generated from this study was represented as frequency and percentages, and inferential statistics were carried out using Chi-square with the aid of GraphPad Prism Software Version 9. Statistical significance was defined as a p-value of less than 0.05 at a 95% confidence interval. **Result:** The prevalence of uropathogenic *Klebsiella* species. was 16%, with sex, pregnancy status, and religion of the individuals substantially linked ($p < 0.05$) with the incidence of the infection. Frequent antibiotic usage, a prior UTI infection, hospitalisation within the last six months, and a greater number of previous pregnancies were also identified as significant ($p < 0.05$) risk factors for infection with uropathogenic *Klebsiella* species. **Conclusion:** This study reports a relatively high prevalence of uropathogenic *Klebsiella* species at 16%, with the sex and pregnancy status of the subjects being significantly associated ($p < 0.05$) with the prevalence of the infection. Frequent antibiotic use, previous UTI infection, hospitalization in the last 6 months as well as a higher number of previous pregnancies were also found to be significantly associated with the prevalence of uropathogenic *Klebsiella* species in the current study. Health promotion and awareness efforts should be prioritised to inform susceptible demographics about their risks for urinary tract infections associated with uropathogenic *Klebsiella* species via targeted educational campaigns, collaboration with healthcare providers, use of social media and online platforms, workplace wellness programs, and community outreach programs amongst others. Antimicrobial susceptibility testing before prescriptions and treatment should be emphasized and upheld in all clinical settings.

Keywords

Uropathogenic, UTI, *Klebsiella*, Prevalence, Risk Factors

1. Introduction

Urinary tract infections (UTIs) are a common health concern caused by microbial pathogens within the urinary tract [1]. *Escherichia coli* (*E. coli*) is the most common cause of UTIs, accounting for 75% of all bacterial UTI cases [1]. Other bacteria such as *Klebsiella pneumoniae*, *Proteus mirabilis, Staphylococcus aureus, Pseudomonas aeruginosa, and Enterococcus faecalis* have also been reported as causative agents [1]. Uropathogenic *E. coli* and *Klebsiella* species are the most common cause of UTIs in both community and healthcare settings [2]. These species are successful pathogens in the urinary system, as they possess the relevant virulence factors required to successfully survive on and adhere to the urinary epithelium, cause tissue damage, and evade host immune responses [2]. There has been an increase in the incidence of antimicrobial resistance by uropathogenic bacteria responsible for UTIs [3]; with the misuse and overuse of antibiotics often associated with the emergence of these antibiotic-resistant bacteria, making UTIs more difficult to treat effectively. In Nigeria, where antibiotic stewardship may be inadequate, the prevalence of drug-resistant UTIs remains a significant concern.

Socioeconomic factors play a crucial role in UTI risk [4] [5]. Poverty and overcrowded living conditions often prevail in certain regions of Nigeria, increasing the likelihood of bacterial transmission [6]. Limited access to healthcare services and delayed medical intervention further compound the risk, as untreated or poorly managed UTIs can lead to more severe complications [7]. Furthermore, certain demographic factors can make individuals more vulnerable to UTIs. Women, for instance, are generally at a higher risk due to anatomical differences, such as a shorter urethra, which allows bacteria to ascend more easily into the bladder [8]. Pregnancy and menopause further increase the susceptibility of women to UTIs [9] [10]. In men, structural abnormalities of the urinary tract, such as an enlarged prostate, can increase the risk [11] [12].

Klebsiella species are a common cause of urinary tract infections (UTIs), accounting for 3% - 20% of cases [13] [2]. In a study conducted in Dhaka city, *Klebsiella* species were the most common bacteria causing UTIs [13]. Another study found that *Klebsiella* was the second most prevalent uropathogen after *Escherichia coli*, representing 42.29% - 56.75% of isolates [2]. These bacteria possess virulence factors that enable them to survive and adhere to the urinary epithelium, causing tissue damage [2]. *Klebsiella quasipneumoniae*, a relatively newly defined species of *Klebsiella*, has also been shown to cause UTIs [14]. The absence of the C-terminal phosphodiesterase domain of FimK in *K. quasipneumoniae* may lead to a loss of type 3 fimbrial cross-regulation, which is critical for bladder epithelial cell attachment in vitro [14].

Infection with uropathogenic *Klebsiella* (UPK) species has been significantly associated with risk factors such as being over the age of sixty, history of renal stone, urinary tract anatomical or physiological disorder, urologic intervention, history of urinary tract surgery, history of urinary catheterization, hospitalization for the last year, and antibiotic usage in the last 3 months [15]. Another study conducted in Iraq found that the age group of 40 - 49 years was the highest group at risk for *K. pneumoniae* infection [16]. The female sex has been associated with a higher prevalence of UTIs caused by *K. pneumoniae* than males, and the males were more susceptible to *K. pneumoniae* with higher prevalence in the age group of 40 - 49 years [16].

According to research, the incidence of community-acquired urinary tract infections caused by uropathogenic *Klebsiella* (UPK) species is rising in Nigeria, with rates as high as 18% in southern Nigeria [17]. A Nigerian tertiary institution was reported to have an even higher prevalence (25.5%) of urinary tract infections caused by *Klebsiella pneumoniae* in another study [18]. These findings imply that UPKs are a significant cause of UTIs in Southern Nigeria and are quite common among UTI patients. In order to comprehend the epidemiology of UTIs in the region and to direct the proper care and preventive measures for UTIs, this study was aimed at investigating the prevalence and associated risk factors of uropathogenic *Klebsiella* species in Port Harcourt Nigeria.

2. Materials and Methods

2.1. Study Design

The investigation was carried out using a cross-sectional study design with systematic random sampling from March to August 2022. Subjects were assigned random numbers for systematic random sampling and the sample interval was set at 5 with the index number chosen at random.

2.2. Study Area

The study was carried out in the Rivers State University Medical Centre as well as the Rivers State University Teaching Hospital, Port Harcourt. Port Harcourt is the capital of Rivers State, Nigeria (**Figure 1**), it lies along the Bonny River and is located in the Niger Delta with a population of 1,148,665. Rivers State University Medical Centre is a public facility located within the premises of the Rivers State University Campus. It is the primary healthcare facility tasked with catering to the medical needs of the staff and students of the university community. The Rivers State University Hospital is a tertiary hospital owned by the government of Rivers State, located at 6 - 8 Harley Street, Old GRA Port Harcourt. It has well over 375 licensed beds and 731 medical staff with departments including Medicine, Pediatrics, Laboratory Services, Radiology, Family Medicine, Pathology, Obstetrics & Gynecology, Surgery, Pharmacy, Accidents and Emergency and General Administration.

2.3. Study Population and Sample Size Determination

The study population comprised patients clinically suspected of having urinary tract infections attending the Rivers State University Medical Centre and the Rivers State University Teaching Hospital. Patients suspecting urinary tract infections (UTIs) may experience a unique set of symptoms related to the urinary

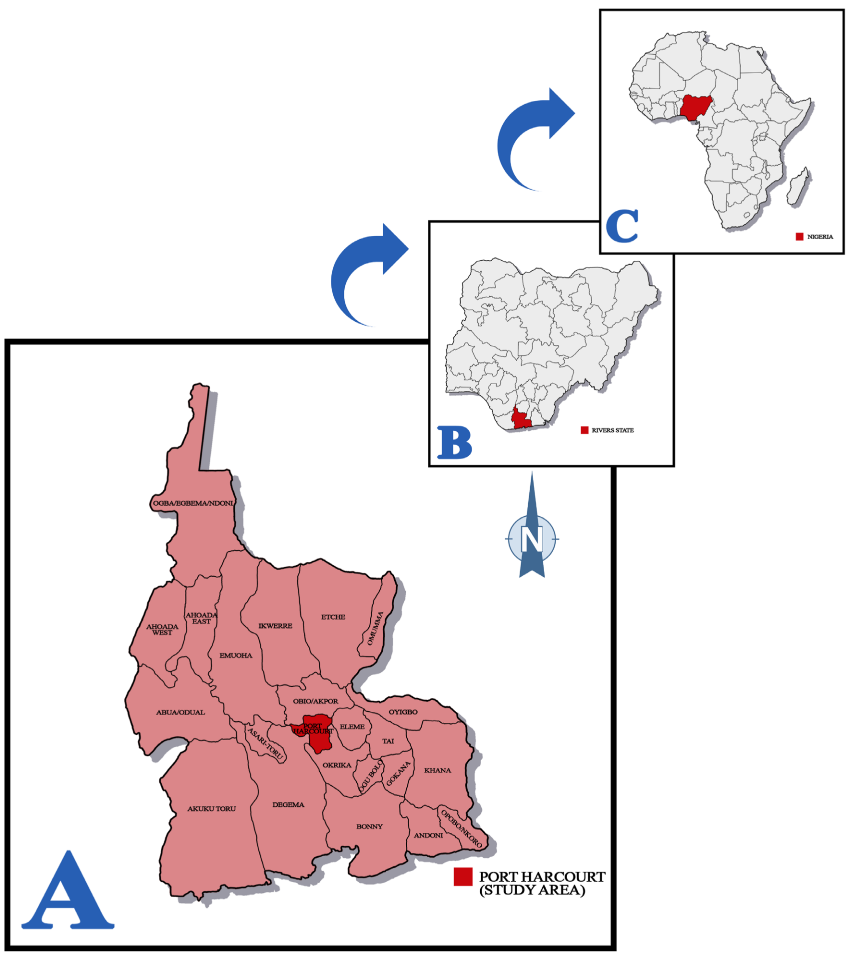

Figure 1. (A) Map of Rivers State highlighting Port Harcourt (Study Area); (B) Map of Nigeria highlighting Rivers State; (C) Map of Africa highlighting Nigeria [19]

system such as a frequency, urgency, dysuria, pain or burning sensation during urination, cloudy or strong-smelling urine, haematuria, pain or pressure in the lower abdomen or back, and fever or chills if the infection has spread to the kidneys. The sample size of 300 was obtained using a sample size calculator for prevalence studies [20], based on the expected prevalence of uropathogenic *Klebsiella* species in Port Harcourt as reported by Kinika *et al.* [18] which revealed a prevalence of 25.5%.

2.4. Inclusion and Exclusion Criteria

An indication of the signs and symptoms of UTI as well as willingness to provide informed consent were the basis for inclusion in the study while terminally ill patients, as well as females currently in their menstrual period, were excluded from participating in the study.

2.5. Ethical Considerations

The aim of the study was duly communicated to the subject prior to obtaining informed consent. The investigation was conducted in compliance with international ethical norms and the study protocol was approved by the Research Ethics Committee of the Rivers of the State University Teaching Hospital (RSUTH/REC/2021109) and the Rivers State University Medical Centre (RSU/MED/HSD/87).

2.6. Data Collection

A structured and validated questionnaire adapted from previous studies [4] [5] [6] [7] was administered to subjects to obtain sociodemographic and other information. The questionnaire had a total of 13 items with two sections; the first section assessed sociodemographic characteristics while the second assessed other risk factors. Serial numbers were used to tally responses and results to ensure subjects' anonymity.

2.7. Specimen Collection and Processing

Three hundred (300) urine samples were collected either by midstream clean-catch, catheterization, or urine bags using an aseptic technique, and were then promptly conveyed to the microbiology laboratory for processing. Where delay was envisaged, samples were stored in the refrigerator at 4˚C. Samples were inoculated onto blood agar and cysteine lactose electrolyte deficient (CLED) agar. After inoculation, 10 ml aliquots of each sample were centrifuged at 300 rpm and deposits were examined for bacteria, parasites, and other cellular bodies. Cultures were incubated at 37˚C for 24 hours and urinary tract infection was defined as bacterial growth of 10^5 CFU/ml. Isolates were identified by morphological and biochemical characteristics.

2.8. Data Analysis

Descriptive and inferential statistics were conducted using Graph Pad Prism version 9. The data were presented as frequencies and percentages in tables and charts. Chi-square was utilised to identify statistically significant relationships between the prevalence of uropathogenic *Klebsiella* species and sociodemographic and other risk factors. The level of significance was defined as $p < 0.05$ at a 95% confidence interval.

3. Results

A total of 300 subjects aged between 16 to 69 (mean age = 29.42 years) participated in the study. Most of the subjects were between the ages of 21 - 30 years (44.7%), mostly females (57.7%), single (72.3%) and with at least secondary school education (43.7%) and students predominated the study (40%) (**Figure 2**).

The most prevalent sign/symptom reported by the subjects in the current study was frequent urination (28%), followed by itching (15.7%) and yellowish discharges (8.7%). Painful urination (6.3%), nocturia (5.7%) and lower abdominal pain (5.7%) were also reported (**Figure 3**).

Samples obtained from the subjects were analysed for the presence of uropathogenic bacteria. The prevalence of *Klebsiella* infection was 16% as only 48 subjects yielded *Klebsiella* isolates out of 300 subjects. The most prevalent uropathogenic bacteria was *Escherichia coli* with a prevalence of 18.7% while the least was *Proteus* species (1.3%). *Staphylococcus aureus* and *Enterococcus faecalis* were also reported in the study at 7% and 1.3% respectively as shown in **Figure 4**.

The female subjects had a significantly ($p < 0.001$) higher prevalence of 24.3% in comparison to their male counterpart (4.7%). A significantly higher prevalence of 41.3% ($p = 0.0017$) was reported among the pregnant female subjects while 18.1% was recorded among females who are not pregnant. A higher prevalence of uropathogenic *Klebsiella* species was observed among subjects aged 41 - 50 years (28.1%), widowed subjects (25%), subjects separated/divorced (25%), subjects with no formal education (33.3%) and the unemployed (25.6%); however, the age of the subjects, marital status, level of education and occupation were not significantly associated with the prevalence of uropathogenic *Klebsiella* species ($p > 0.001$) (**Table 1**).

As regards the pattern of antibiotic use, a prevalence of 4.3% was recorded amongst subjects who rarely used antibiotics, 16% was recorded amongst those who occasionally used antibiotics while a higher prevalence of 23.1% was recorded amongst subjects who frequently used antibiotics. The observed distribution based on the pattern of antibiotic use was statistically significant ($p = 0.0178$). A higher *Klebsiella* prevalence of 40.3% was found among subjects who have had previous UTI infection while those who have not had previous UTI infection recorded a prevalence of 21.1% resulting in a statistically significant difference ($p = 0.0037$). There was a significantly higher prevalence ($p = 0.0190$) of uropathogenic *Klebsiella* species in subjects who have been hospitalised in the

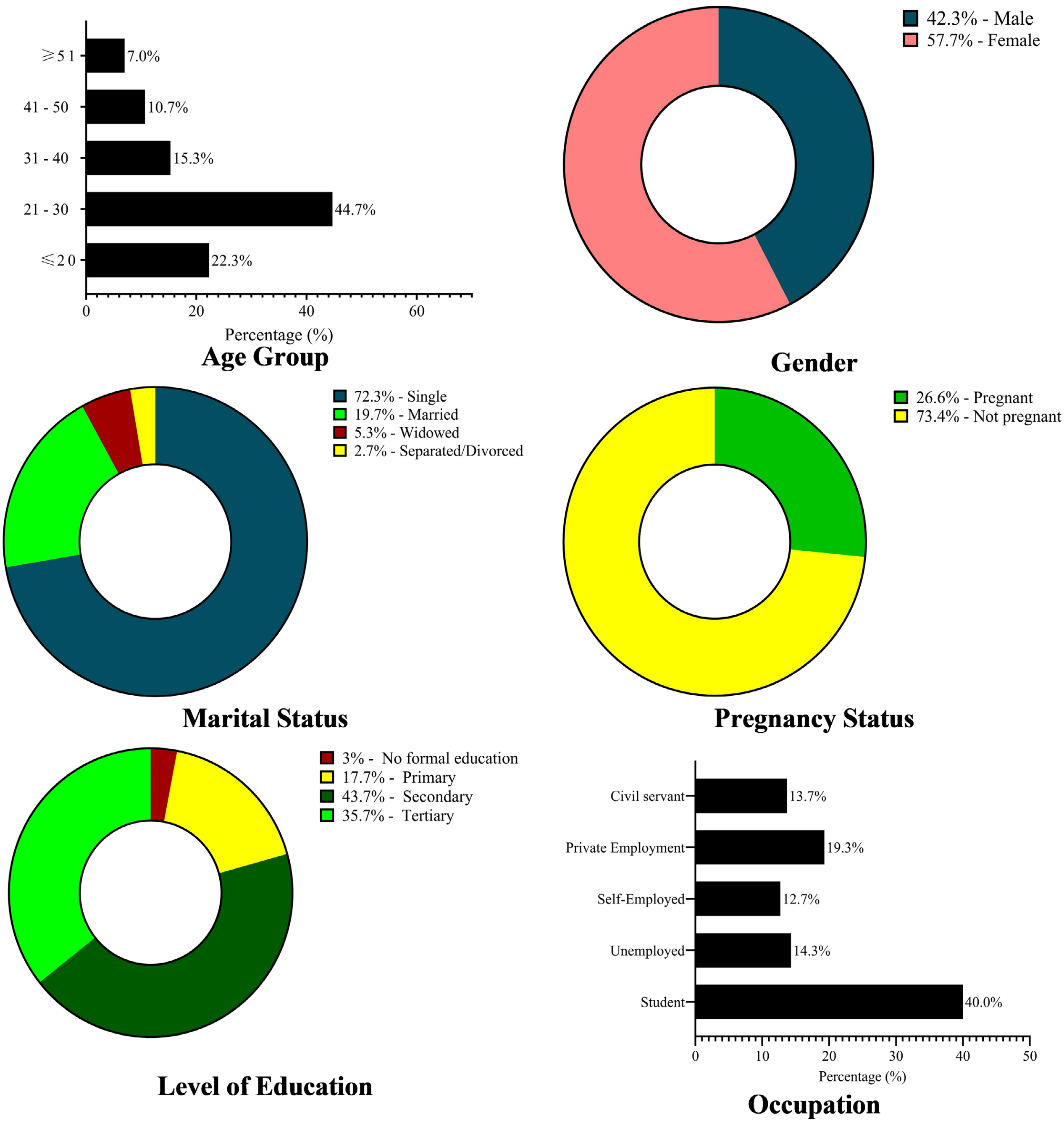

Figure 2. Sociodemographic characteristics of the sampled population.

last 6 months (37%) than those who have not (20.1%). Females who have had three or more previous pregnancies reported a significantly higher prevalence of uropathogenic *Klebsiella* species (36.1%) than those who have had less than three previous pregnancies (17.9%). A higher prevalence of uropathogenic *Klebsiella* species was observed among subjects who used antibiotics only for severe infections (21.4%), individuals who engaged in three or more sexual intercourse per week (18.6%), and those without multiple sexual partners (13.9%); however, the rationale for antibiotic use, number of sexual intercourse per week and multiple

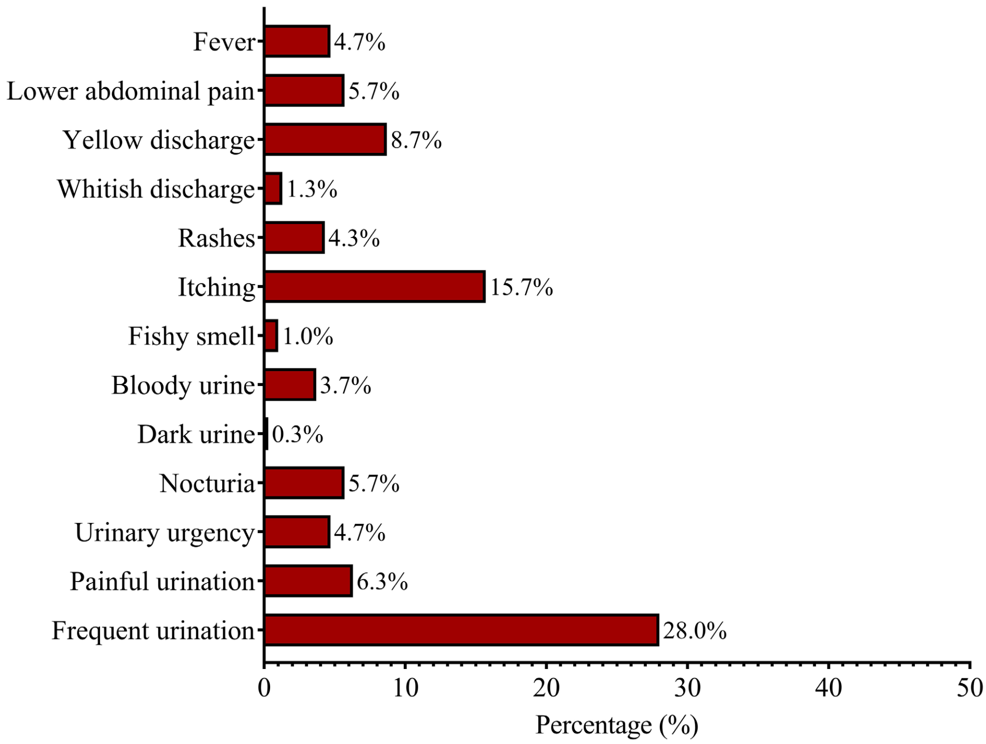

Figure 3. Signs and symptoms reported by subjects.

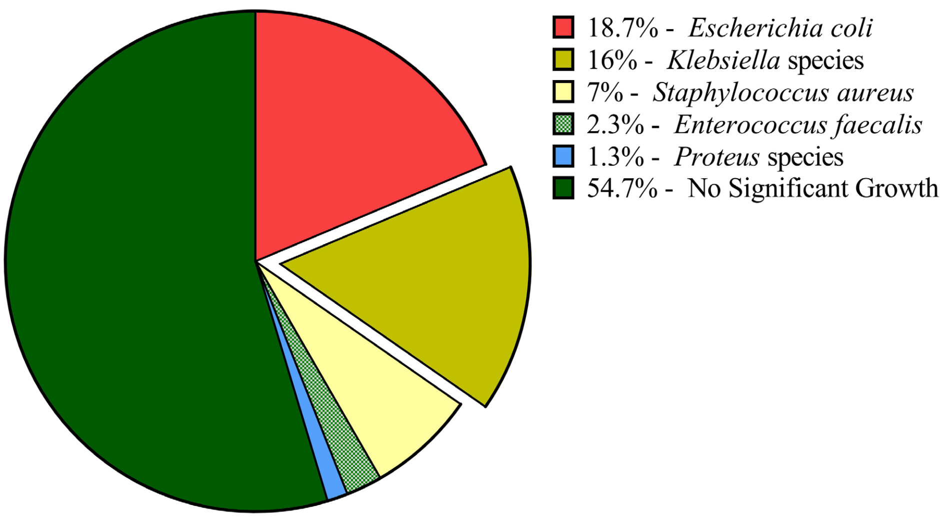

Figure 4. Prevalence of uropathogenic bacterial species highlighting *Klebsiella spp*.

sexual partners was not significantly associated with the prevalence of uropathogenic *Klebsiella* species ($p > 0.001$) (Table 2).

4. Discussion

Urinary tract infection continues to be one of the most prevalent causes of morbidity in people of all demographics and one of the leading causes of hospital visits [21] [22], with *Klebsiella* species being the second most frequently implicated pathogen for urinary tract infections, trailing only *E. coli* [23] [24]. The

Table 1. Prevalence of uropathogenic *Klebsiella* species and sociodemographic characteristics.

Variable	Positive (%)	Negative (%)	Total (%)	χ^2	Df	*p*-value
Age						
≤20	8 (11.9)	59 (88.1)	67 (100)			
21 - 30	19 (14.2)	115 (85.8)	134 (100)			
31 - 40	7 (15.2)	39 (84.8)	46 (100)	5.6	4	0.2288
41 - 50	9 (28.1)	23 (71.9)	32 (100)			
≥51	5 (23.8)	16 (76.2)	21 (100)			
Total	48 (16)	252 (84)	300 (100)			
Sex						
Male	6 (4.72)	121 (95.3)	127 (100)			
Female	42 (24.3)	131 (75.7)	173 (100)	21	1	<0.0001*
Total	48 (16)	252 (84)	300 (100)			
Marital Status						
Single	31 (14.3)	186 (85.7)	217 (100)			
Married	11 (18.6)	48 (81.4)	59 (100)			
Widowed	4 (25)	12 (75)	16 (100)	2.2	3	0.5265
Separated/Divorced	2 (25)	6 (75)	8 (100)			
Total	48 (16)	252 (84)	300 (100)			
Pregnancy Status (N = 173)						
Pregnant	19 (41.3)	27 (58.7)	46 (100)			
Not pregnant	23 (18.1)	104 (81.9)	127 (100)	9.9	1	0.0017*
Total	42 (24.3)	131 (75.7)	173 (100)			
Level of Education						
No formal education	3 (33.3)	6 (66.7)	9 (100)			
Primary	9 (17)	44 (83)	53 (100)			
Secondary	24 (18.3)	107 (81.7)	131 (100)	4.4	3	0.2216
Tertiary	12 (11.2)	95 (88.8)	107 (100)			
Total	48 (16)	252 (84)	300 (100)			
Occupation						
Student	22 (18.3)	98 (81.7)	120 (100)			
Unemployed	11 (25.6)	32 (74.4)	43 (100)			
Self-Employed	4 (10.5)	34 (89.5)	38 (100)			
Private Employment	7 (12.1)	51 (87.9)	58 (100)	6.1	4	0.1899
Civil servant	4 (9.8)	37 (90.2)	41 (100)			
Total	48 (16)	252 (84)	300 (100)			

*Statistical significance $p < 0.05$.

Table 2. Prevalence of uropathogenic *Klebsiella* species and risk factors.

Variable	Positive (%)	Negative (%)	Total (%)	χ^2	Df	*p*-value
Pattern of antibiotic use						
Rarely	2 (4.3)	45 (95.7)	47 (100)			
Occasionally	26 (16)	136 (84)	162 (100)	8.1	2	0.0178*
Frequently	21 (23.1)	70 (76.9)	91 (100)			
Total	48 (16)	252 (84)	300 (100)			
Rationale for antibiotic use						
Whenever available	11 (16.4)	56 (83.6)	67 (100)			
Mild infection	16 (12.4)	113 (87.6)	129 (100)	2.7	3	0.4321
Severe infection	12 (21.4)	44 (78.6)	56 (100)			
On prescription	9 (18.8)	39 (81.3)	48 (100)			
Total	48 (16)	252 (84)	300 (100)			
Previous UTI infection						
Yes	29 (40.3)	43 (59.7)	72 (100)			
No	27 (21.1)	101 (78.9)	128 (100)	8.4	1	0.0037*
Total	48 (16)	252 (84)	300 (100)			
Hospitalisation in the last 6 months						
Yes	17 (37)	29 (63)	46 (100)			
No	31 (20.1)	123 (79.9)	154 (100)	5.5	1	0.0190*
Total	48 (16)	252 (84)	300 (100)			
Number of Sexual Intercourse per week						
<3	29 (14.6)	169 (85.4)	198 (100)			
≥3	19 (18.6)	83 (81.4)	102 (100)	0.79	1	0.3729
Total	48 (16)	252 (84)	300 (100)			
Multiple sex partners						
Yes	12 (10.6)	101 (89.4)	113 (100)			
No	26 (13.9)	161 (86.1)	187 (100)	0.69	1	0.4073
Total	48 (16)	252 (84)	300 (100)			
Number of Previous Pregnancy (N = 173)						
< 3	20 (17.9)	92 (82.1)	112 (100)			
≥ 3	22 (36.1)	39 (63.9)	61 (100)	4.4	1	0.0368*
Total	42 (24.3)	131 (75.7)	173 (100)			

*Statistical significance $p < 0.05$.

present study investigated the prevalence of uropathogenic *Klebsiella* species, recording a prevalence of 16% as 48 out of 300 subjects had significant growth of *Klebsiella* species in their urine samples. The observed prevalence is comparable to the 17% prevalence of *Klebsiella* species in urinary tract infections reported by Lin *et al.* [23]. A similar prevalence of 18% was reported in a study conducted in southern Nigeria [17], which is comparable to the current study. Dada *et al.* [25] reported a slightly higher prevalence of 21.1% of uropathogenic *Klebsiella* species in Ondo state, Nigeria, while Kinika *et al.* [18] reported an even higher prevalence of 25.5% in a tertiary institution in Port Harcourt. The current study differed from the findings of Ndako *et al.* [17], who reported a lower prevalence of 9.1% for uropathogenic *Klebsiella* species. The observed variation may be attributable to the demographic differences of the study population.

Urinary tract infections can be classified as symptomatic or asymptomatic depending on the presence or absence of symptoms, which aids in the diagnosis [26] [27]. In the current study, the signs and symptoms of urinary tract infections observed by the subjects were also put into consideration. The most predominant symptom reported by the subjects was frequent urination (28%) followed by itching (15.7%) suggestive of lower urinary tract infection. Painful urination and urinary urgency were recorded in smaller percentages of 6.3% and 4.7% respectively. A smaller percentage of the subjects also reported lower abdominal pain (5.7%) and yellowish discharges (8.7%). The findings from the current study as regards reported signs and symptoms are comparable with those of Okonko *et al.* [28] where symptoms like itchy sensation, abdominal pains as well as discharges were reported in the sampled population. The subjects' observations of frequent urination as the most common symptom, followed by itching, painful urination, and urine urgency, are consistent with the typical symptoms of a lower urinary tract infection (UTI). UTIs can cause urinary tract inflammation and bladder irritation, resulting in frequent urine and pain during urination [27]. Lower abdominal discomfort with yellowish discharges reported by a lesser number of respondents might suggest a more serious illness, such as pyelonephritis or sexually transmitted diseases. These symptoms indicate that the infection has moved to the upper urinary tract or has affected other areas of the genital region.

In the current study, the age group with the highest prevalence (28.1%) was 41 – 50 years followed by subjects aged 51 years and above (23.8%); the least prevalence was recorded amongst those aged 20 years or younger (11.9). The distribution was not found to be statistically significant ($p = 0.2288$). This observation varied from the report by Sule & Kumurya (2016) [29] where the highest prevalence of *Klebsiella* species in urine was found amongst subjects aged between 21 - 30 years. The study by Obiogbolu *et al.* [30] also reported a higher prevalence in the younger age group of 21-25. The current study however is similar to the findings of Devrari and Pai [31] who reported a higher prevalence of *Klebsiella* species amongst older subjects within age groups of 41 - 50, 51 - 60 and 61 - 70 years old; the study by Ndako *et al.* [18] was also comparable with the present study as the authors recorded a higher prevalence amongst the older age group in their study. While the age distribution of *Klebsiella* infection in the current study may not be statistically significant ($p > 0.05$), it is important to note that

Klebsiella infections occur in people of all ages; however, the highest risk groups appear to be the elderly, infants, and the immunocompromised [31], indicating that infection with the bacteria is associated with decreased immunocompetence; the observed prevalence of 28.1% among those aged 41 - 50 years may also be due to hormonal changes that occur during menopause, which can increase the risk of UTIs in women. As oestrogen levels fall, vaginal and urethral tissues weaken and dry, rendering them more vulnerable to infection [32]. Individuals in this age bracket are more likely to have comorbid diseases such as diabetes, which increases the risk of UTIs.

Female subjects in the current study recorded a significantly higher prevalence of *Klebsiella* infection than their male counterparts at 24.3% and 4.7% respectively ($p < 0.001$). Different studies have reported female predominance in urinary tract infections over the years [33] [34] [35] [24]. Females have a greater prevalence rate due to the closeness of the urethral meatus to the anus, a shorter urethra, contraception, pregnancy, and sexual intercourse, which introduces Bacteria into the female urinary system [35]. Furthermore, poor anal cleanliness may result in the transmission of normal flora in faeces from the anus to the vagina, from where it may climb to the bladder [36]. In contrast, Otajevwo and Amedu [37] found a prevalence rate of 57.1% among males; though the authors stated that the reason for this was not clear, they did list the probable causes as lack of circumcision, receptive anal intercourse, and HIV infection among their study participants.

The current study recorded no statistically significant difference in the distribution of *Klebsiella* infection based on the marital status of the subjects. However, it was observed that singles had the least prevalence followed by married subjects and a higher prevalence was reported amongst widowed subjects as well as separated/divorced subjects. This observation may be related to the subjects' age, as those who are or have been married are more likely to be older than those who have never been married, and as such may be more vulnerable to infection due to reduced immunocompetence [30]; it is also possible that being married, separated, or widowed is associated with factors that increase the risk of UTI, such as sexual activity or changes in hormonal levels. The findings from this study as regards the distribution of *Klebsiella* infection is comparable to the study by Odoki *et al.* [38] who reported that married individuals were 2.2 times more likely to be infected with UTI than singles, a more sexually active lifestyle observed amongst these groups of subjects are also likely to be associated with higher infection rates [24].

Pregnancy was significantly associated ($p = 0.0017$) with a higher prevalence of *Klebsiella* infection in the current study as a 41.3% prevalence was reported among pregnant women while 18.1% was observed amongst those that are not pregnant. Pregnant women are more vulnerable to UTIs due to physiological changes brought on by pregnancy, which are associated with an increased risk of maternal-fetal problems [39]. The urinary tract alterations during pregnancy include ureter and renal pelvic dilatation, which can induce urine stasis and increase the risk of bacterial development [40]. Furthermore, hormonal changes during pregnancy can promote ureteral smooth muscle relaxation, which can cause urine reflux and raise the risk of UTI [40]. This observation is comparable to the findings of Okonko *et al.* [28], who found a 47.5% prevalence of UTI in pregnant women in a South-Western Nigerian state; Ndako *et al.* [41] found a 45% prevalence of UTI in pregnant women, which is also comparable to the findings of the current study.

The level of education of the subjects in the current study was not significantly associated ($p = 0.2216$) with the distribution of *Klebsiella* infection in the current study, however, it was observed that those with no formal education had the highest prevalence of 33.3% while the least prevalence of 11.2% was recorded amongst those with tertiary education, indicating that a better education and enlightenment level can better inform individuals about preventive measures against UTI as opined by Tehrani *et al.* [42]. This finding is contrary to the findings of Ndako *et al.* [17] where a higher prevalence was observed amongst the more educated subjects, however, the current study was comparable to the report by Shaheen *et al.* [43] where a lower prevalence was recorded amongst subjects with higher education.

As regards the occupation of the subjects in the current study, a higher prevalence was recorded amongst students and the unemployed, while those in one form of employment or the other were observed to have the least prevalence of uropathogenic *Klebsiella* species, this distribution was not statistically significant ($p = 0.1899$). The distribution reported in the current study as regards occupation contrasted with the study of Okonko *et al.* [28] where employed subjects were found to be more infected than students, Markland *et al.* [44] found that women in the workforce frequently experience urinary incontinence and lower urinary tract symptoms and that they modify their behaviours to manage their symptoms, noting that women in manual occupations had higher rates of urinary incontinence and overactive bladder than unemployed women or women in non-manual occupations. The discrepancy between the cited literature and the present study remains unexplained; the discrepancy might be attributable to the specifics of the subjects' occupations, which were not examined in the current study.

A prevalence of 4.3% was recorded amongst subjects who rarely used antibiotics, 16% was recorded amongst those who occasionally used antibiotics while a higher prevalence of 23.1% was recorded amongst subjects who frequently used antibiotics. The observed distribution based on the pattern of antibiotic use was statistically significant ($p = 0.0178$); the rationale for antibiotic use was however not significantly associated ($p = 0.4321$) with the prevalence of *Klebsiella* in the current study. This high *Klebsiella* prevalence among those who used antibiotics occasionally and frequently is not uncommon, as antibiotic abuse or misuse can lead to resistance via the emergence of mutant strains [45], as unresolved or relapsed UTIs tend to be more resistant to previously used antibiotics [46].

A higher *Klebsiella* prevalence of 40.3% was found among subjects who have had previous UTI infection while those who have not had previous UTI infection recorded a prevalence of 21.1% resulting in a statistically significant difference ($p = 0.0037$). UTIs have been identified as a risk factor for future cystitis in both young adult and postmenopausal women [47] [48] [49]. The current study confirmed that a previous UTI may predispose individuals to subsequent UTIs through behavioural and microbiological factors. These findings are consistent with other studies [49] [50] [51] [52] but contrasted with the findings of Hamdan *et al.* [53] as well as the results of Kovavisarach *et al.* [54].

A significantly higher prevalence of uropathogenic *Klebsiella* infection was reported among subjects who have been hospitalised in the last 6 months *i.e.*, 17 (37%) than those who have not been hospitalised in the last 6 months *i.e.*, 31 (20.1%) ($p = 0.0190$). Antibiotics are more likely to be given to hospitalised patients, which may contribute to the development of antibiotic-resistant bacteria such as *Klebsiella* species [55]. Furthermore, hospitalisation might deplete the immune system, rendering patients more vulnerable to infections [55]. In addition, hospitalised patients are more likely to have invasive medical procedures such as catheterization, which increases the risk of UTI [56]. This study's results are similar to those of Khan *et al.* [57], who reported a prevalence of 39% for uropathogenic bacteria, including *Klebsiella* species, among clinically diagnosed patients.

As regards the number of sexual intercourses per week, those who had less than 3 sexual intercourse per week had a reported *Klebsiella* prevalence of 14.6%, while those who had more than 3 sexual intercourses in a week had a prevalence of 18.6%, though not statistically significant ($p = 0.3729$). This finding is comparable with the study by Amiri *et al.* [49] where sexual intercourse of ≥ 3 times per week was associated with a greater frequency of UTI. The findings of Emiru *et al.* (2013) [52] also agree with the findings of the current study as they reported a higher prevalence in those with 3 or more sexual intercourses in a week (25%) than those who had less than 3 (8.7%); the study by Haider *et al.* [51] also corroborates the results of the current study. This association has been observed in both sporadic and chronic cystitis [58] [59]. Since sexual intercourse disrupts the usual lactobacillus-dominant vaginal flora and facilitates enteric bacterial colonisation of the vagina, the mechanical motion of sexual intercourse may encourage the passage of uropathogens into the urethra and bladder causing UTIs in the process [28] [60] [61] [62].

Subjects with multiple sex partners in the current study recorded a prevalence of 10.6%, while those who do not have multiple sex partners recorded a prevalence of 13.9%. The observed distribution was not a statistically significant difference ($p = 0.4073$). This finding varied from the study by Amadi *et al.* [63] who attributed a higher prevalence of UTI to promiscuous subjects. The review by Arnold *et al.* [64] highlights new or multiple sex partners as independent risk factors for recurrent UTIs in premenopausal women.

Among the females in the sampled population, the number of previous pregnancies was found to be significantly associated with the prevalence of *Klebsiella*, a prevalence of 17.9% was recorded among those who have had less than 3 previous pregnancies while 36.1% *Klebsiella* prevalence was reported among subjects who have had 3 or more previous pregnancies. Multiparity has been linked to considerable bacteriuria in pregnancy, with a two-fold increase in the risk of asymptomatic bacteriuria in pregnant women [65] [66]. The association between multiparity and UTI is owing to extensive physiologic changes affecting the whole urinary system during pregnancy, which have a considerable influence on the natural history of UTI during pregnancy. These modifications differ from patient to patient and are more common in women who have multiple consecutive pregnancies [67]. This finding is consistent with previous research that has shown an association between multiparity and UTI, including studies on UTI in Nigeria [28], asymptomatic pregnant women in Iran [68], and UTI in Pakistan [51]. The findings contrasted with other studies, such as those conducted in Ethiopia [52], Sudan[53], Tanzania [69], Ghana [70], and Iran [71].

5. Conclusion

This study shows that the prevalence of uropathogenic *Klebsiella* species was 16%, with the sex and pregnancy status of the subjects being significantly associated ($p < 0.05$) with the prevalence of the infection. Frequent antibiotic use, previous UTI infection, hospitalization in the last 6 months as well as multigravidity were also found to be significant risk factors for uropathogenic *Klebsiella* species in the current study. Health promotion and awareness efforts should be prioritised to inform susceptible demographics about their risks for *Klebsiella* associated with urinary tract infections via targeted educational campaigns, collaboration with healthcare providers, use of social media and online platforms, workplace wellness programs, and community outreach programs amongst others.

6. Limitations of the Study

A limitation of the study is that it relied solely on standard bacteriological techniques for the identification and characterization of uropathogenic *Klebsiella* species. While these techniques are commonly used and provide valuable information, they have certain limitations. Standard bacteriological techniques typically focus on culturing and identifying microorganisms based on their phenotypic characteristics, such as morphology and biochemical properties. However, they may not capture the full genetic diversity and potential subtypes within the uropathogenic *Klebsiella* species.

Moreover, the study utilized Chi-square analysis to associate risk factors with the infection. While Chi-square analysis is a commonly used statistical method for analyzing categorical data, it may oversimplify the complex relationships between risk factors and Uropathogenic *Klebsiella* infection. This analysis assumes independence between variables and does not account for potential confounding factors or interactions among variables, which could limit the accuracy and comprehensiveness of the findings.

Further studies incorporating advanced molecular techniques and multivariable analysis methods could provide a more comprehensive evaluation of this bacterial infection and its risk factors.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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