

Article

Prevalence and Factors Associated with Uropathogenic *Klebsiella* spp. Among Women Attending a Tertiary Hospital in Libreville, Gabon: A Single-Center Experience

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Abstract

Urinary tract infections (UTIs) are a significant global health concern, with women being disproportionately affected. As the clinical importance of *Klebsiella* spp. as uropathogens continues to rise, this study aimed to determine their prevalence and associated factors among women attending a tertiary hospital in Libreville, Gabon. Bacteriological urine analyses were conducted on 791 women (inpatients and outpatients) at the Omar Bongo Ondimba Army Instruction Hospital between April and December 2024. Bacterial identification was performed using Analytical Profile Index (API 20E) strips and the VITEK[®] 2 Compact system. The overall UTI prevalence was 43.6% (345/791). *Klebsiella* spp. accounted for 14.4% (114/791) of all cases, representing an isolation rate of 33.0% (114/345) among infected participants. *Klebsiella pneumoniae* species complex (KpSC) was the predominant species (84.2%), followed by *K. aerogenes* (9.6%) and *K. oxytoca* (6.1%). Marital status was significantly associated with *Klebsiella* spp. UTIs; compared to single/divorced women, widows (OR = 2.1; 95% CI: 1.0–4.5) and those in married or cohabiting unions (OR = 1.7; 95% CI: 1.1–2.6) exhibited a significantly higher risk of infection. These findings highlight a substantial proportion of UTIs caused by *Klebsiella* spp. in Libreville and underscore the influence of sociodemographic factors on infection risk, emphasizing the need for targeted preventive measures in at-risk populations.



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Keywords: urinary tract infection; women; *Klebsiella* spp.; uropathogen; risk factor; prevalence

1. Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections in clinical practice [1]. Key symptoms include dysuria, urinary urgency, hematuria, pyuria, increased urinary frequency and pain in the lumbar and/or suprapubic regions [2]. Globally, the burden of UTIs continues to grow; the total number of cases rose by 60.40% from

252.25 million in 1990 to 404.61 million in 2019, with approximately 236.786 deaths attributed to these infections [3]. Several studies have highlighted the high incidence of UTIs in developing countries. A global review reported that the highest incidence was observed in the African Region at 3.60%, compared with 0.40% in the Western Pacific Region, 1.10% in the Eastern Mediterranean Region and 1.90% in the Region of the Americas [4].

UTIs represent a major cause of morbidity, particularly among women; at least one in two women will experience a UTI during her lifetime, often with a high risk of recurrence [5]. This increased susceptibility is largely explained by anatomical, hormonal and behavioral factors [6]. The vagina plays a central role in the pathogenesis of these infections, serving as a potential reservoir for uropathogenic bacteria that ascend from the intestinal microbiota to the urinary tract and bladder [7]. For instance, a study conducted in Italy reported a UTI prevalence of 62.2% in women compared with 37.8% in men [8]. Similarly, in Jordan, women accounted for 92% of cases versus 8% in men [9].

Furthermore, numerous studies have investigated the factors predisposing individuals to recurrent urinary tract infections in both men and women. These studies highlight that key risk factors associated with UTIs in women include a history of previous infections, pre-existing diabetes, menopausal status, hygiene practices, frequent sexual activity, low socioeconomic status, and immunosuppression, among others [10,11].

Urinary tract infections are inflammatory conditions of the urinary tract primarily caused by a variety of microorganisms, including bacteria, fungi, and, less commonly, viruses. In most cases, they are caused by bacteria originating from the commensal gastrointestinal microbiota, among which Enterobacterales are the most frequently isolated and well-recognized uropathogens [2]. These infections are predominantly caused by *Escherichia coli* (*E. coli*), which accounts for 70% to 80% of UTIs worldwide, followed by *Klebsiella* spp. Within this genus, *Klebsiella pneumoniae* species complex (KpSC) has emerged as the second most common uropathogen globally. A study conducted in China identified *Klebsiella* spp. as the second leading uropathogen, with an isolation rate of 17% [12]. Similarly, in Iraq, *Klebsiella* spp. were isolated in 37.1% of UTI cases [13], while in Cameroon, the isolation rate was 14.7% [14]. Furthermore, these bacteria possess an extensive arsenal of virulence factors and a strong capacity to acquire and disseminate antibiotic resistance genes. This increasing resistance represents a major challenge for the effective clinical management of UTIs [15].

Although numerous studies have focused on UTIs in pregnant women, few have investigated the female population as a whole. Furthermore, in Gabon, as in many sub-Saharan African countries, epidemiological data on *Klebsiella* spp.-associated UTIs remain limited and fragmented. Additionally, few studies in the Gabonese population have examined the specific risk factors associated with UTIs in women. Therefore, the objective of the present study was to evaluate the prevalence and identify the risk factors associated with *Klebsiella* spp. UTIs among women in Libreville, Gabon.

2. Materials and Methods

2.1. Study Design and Setting

We conducted a cross-sectional analytical study to investigate urinary tract infections (UTIs) among women attending the medical analysis laboratory of the Omar Bongo Ondimba Army Instruction Hospital (HIAOBO) in Libreville, Gabon. The study was carried out from April to December 2024.

2.2. Study Participants

The study included women of all ages residing in Libreville and the surrounding areas, including both outpatients and inpatients referred for cytobacteriological examination of

urine. Participants were enrolled upon voluntary agreement and provision of written informed consent. All eligible participants were included to assess the prevalence of *Klebsiella* spp. in UTIs.

2.3. Data Collection Tools

Data were collected using a structured questionnaire. This tool captured sociodemographic characteristics, including age, district of residence, marital status, and educational level. It also assessed potential risk factors for UTIs, such as gravidity and parity, as well as clinical data, including symptoms and the presence of underlying comorbidities.

2.4. Bacteriological Examination of Urine

Urine bacteriological analysis was performed in accordance with the European urinalysis guidelines [16] and recommendations for urine culture and biochemical identification of bacterial uropathogens in low-resource settings [17]. Midstream urine samples were collected in sterile containers following aseptic procedures as recommended by the institution. All samples were transported immediately to the laboratory and processed within 4 h of collection.

2.5. Isolation and Quantification of Uropathogens

Bacteria were isolated using solid culture media, including MacConkey agar (for the isolation and differentiation of non-fastidious Gram-negative bacilli), cystine–lactose–electrolyte-deficient (CLED) agar (for the enumeration of urinary pathogens), and enriched media such as chocolate agar supplemented with Polyvitex and fresh blood agar (Columbia CNA) for the isolation of Gram-positive bacteria. All media were prepared according to the manufacturers' instructions.

A calibrated loop was used to inoculate 10 µL of urine onto the agar plates using the streak plate method. Petri dishes were incubated at 37 °C for 24 h. After incubation, colonies were assessed based on morphology, texture, and color. The bacterial load, expressed as the bacterial count, was determined.

Urine culture results were interpreted as follows:

- Negative: No microbial growth at 24 h; growth $< 10^5$ colony-forming units per milliliter (CFU/mL); growth of non-uropathogenic organisms (e.g., skin contaminants); or polymicrobial growth (> 2 organisms) without leukocyturia.
- Positive: Monomicrobial or polymicrobial growth (≤ 2 organisms) with a bacterial load $\geq 10^5$ CFU/mL.
- Repeat required: Polymicrobial growth involving more than two distinct uropathogens with a bacterial load $> 10^4$ CFU/mL associated with leukocyturia.

2.6. Identification of Uropathogens

Uropathogens were identified using preliminary tests based on colony morphology and Gram staining. For orientation, catalase, oxidase, and coagulase tests were performed (specifically for *Staphylococcus* spp.). Definitive identification was achieved through standard biochemical methods using Analytical Profile Index (API 20E) strips (bioMérieux SA, Marcy-l'Étoile, France) and the VITEK® 2 Compact automated system (bioMérieux, Marcy-l'Étoile, France), in accordance with the manufacturer's instructions.

2.7. Data Management and Statistical Analysis

Data from laboratory analyses and questionnaires were entered into Microsoft Excel. The dataset was cleaned and analyzed using R software (version 4.3.1). Descriptive statistics were used to summarize the data. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. To identify factors independently

associated with *Klebsiella* spp. infection within the study population, a multivariate binary logistic regression model was performed. In this model, the comparison group (*Klebsiella* spp. absent) included both UTI-negative participants and participants with UTIs caused by non-*Klebsiella* pathogens. Variables that demonstrated a p -value < 0.20 in the univariate analysis were entered into the final model to control for potential confounding factors. The results are reported as Adjusted Odds Ratios (aOR) with their corresponding 95% Confidence Intervals. Additionally, to explore the interrelationships between *Klebsiella* spp. and all study variables, a Multiple Correspondence Analysis was performed exclusively on the subset of UTI-positive patients, using the FactoMineR and factoextra packages. A p -value ≤ 0.05 was considered statistically significant.

3. Results

3.1. Prevalence of Urinary Tract Infection According to Sociodemographic Characteristics

A total of 791 women were enrolled in this study, with ages ranging from 1 to 94 years. The mean age was 36.3 ± 15.9 years, and the median age was 33 years. The sociodemographic characteristics of the participants and the prevalence of urinary tract infections (UTIs) stratified by these parameters are summarized in Table 1.

Table 1. Prevalence of UTIs according to sociodemographic characteristics.

Characteristics	Total N	UTI n (%) [95% CI]	No UTI n (%)	p-Value
Women	791	345 (43.6) [40.2–47.1]	446 (56.4)	
Age Groups	791			7.2×10^{-3}
<20	70	23 (32.9)	47 (67.1)	
20–39	467	196 (42.0)	271 (58.0)	
40–59	161	71 (44.1)	90 (55.9)	
≥ 60	93	55 (59.1)	38 (40.9)	
Marital Status (Adults)	758			9.5×10^{-4}
Single/Divorced	337	133 (39.5)	204 (60.5)	
Cohabiting	373	176 (47.2)	197 (52.8)	
Widow	48	31 (64.6)	17 (35.4)	
Education Level	791			3.4×10^{-1}
None	27	14 (51.8)	13 (48.1)	
Primary	83	35 (42.2)	48 (57.8)	
Secondary	461	211 (45.8)	250 (54.2)	
Higher Education	220	85 (38.6)	135 (61.4)	
Employment Status	743			1.5×10^{-1}
Unemployed	432	202 (46.8)	230 (53.2)	
Employed	311	127 (40.8)	184 (59.2)	
Neighborhood Type	631			4.9×10^{-2}
Mixed	243	99 (40.7)	144 (59.3)	
Modern	76	21 (27.6)	55 (72.4)	
Precarious	312	135 (43.3)	177 (56.7)	

Table 1. Cont.

Characteristics	Total N	UTI n (%) [95% CI]	No UTI n (%)	p-Value
Religion	791			6.2×10^{-1}
Christian	609	268 (44.0)	341 (56)	
Muslim	18	8 (44.4)	10 (55.6)	
Traditionalist	22	12 (54.5)	10 (45.4)	
None	142	57 (40.1)	85 (59.9)	
Ethnic group	791			6.3×10^{-1}
Bakota	29	13 (44.8)	16 (55.2)	
Non-Gabonese	16	5 (31.2)	11 (68.7)	
Fang	229	94 (41.0)	135 (58.9)	
Mbété-téké	74	31 (41.9)	43 (58.1)	
Membé	20	13 (65)	7 (35)	
Merié	247	111 (44.9)	136 (55.1)	
Ngwèmyènè	22	10 (45.4)	12 (54.5)	
Nzébi	135	61 (45.2)	74 (54.8)	
Others	19	7 (36.8)	12 (63.2)	
Number of sexual partners	524			1×10^{-1}
0	99	29 (29.3)	70 (70.7)	
1	406	171 (42.1)	235 (57.9)	
≥ 2	19	6 (31.6)	13 (68.4)	

As shown in Table 1, the most represented age group was 20–39 years ($n = 467$, 59.0%), followed by the 40–59 age bracket ($n = 161$, 20.4%). Regarding ethnic distribution, the Merié group was the most frequent ($n = 247$, 31.2%), followed by the Fang ($n = 229$, 29.0%) and Nzébi ($n = 135$, 17.1%) groups.

The overall prevalence of urinary tract infections (UTIs) in the total study population was 43.6% (95% CI: 40.2–47.1%). Analysis of prevalence according to sociodemographic criteria revealed several significant findings: (1) UTI prevalence was significantly associated with age ($p = 7.2 \times 10^{-3}$), with the highest rates observed among women aged ≥ 60 years (59.1%) compared to those under 20 years (32.9%). (2) Among the adult population ($N = 758$), marital status was a highly significant factor ($p = 9.5 \times 10^{-4}$); widowed women exhibited the highest prevalence (64.6%), while married or cohabiting women showed a prevalence of 47.2%, compared to 39.5% in the single/divorced group. (3) A significant association was also found regarding neighborhood type ($p = 4.9 \times 10^{-2}$), where women residing in precarious (43.3%) and mixed (40.7%) districts were more frequently infected than those in modern districts (27.6%). (4) In contrast, no statistically significant differences in UTI prevalence were observed based on education level ($p = 3.4 \times 10^{-1}$), employment status ($p = 1.5 \times 10^{-1}$), religion ($p = 6.2 \times 10^{-1}$), or ethnic group ($p = 6.3 \times 10^{-1}$). (5) Finally, the number of sexual partners did not significantly influence UTI frequency in this cohort ($p = 1.0 \times 10^{-1}$), although a higher prevalence was noted among women with one partner (42.1%) compared to those with no partners (29.3%).

3.2. Prevalence of UTI According to Gynecological and Medical Factors

The prevalence of UTIs based on gynecological and medical parameters is illustrated in Table 2.

Table 2. Prevalence of UTIs according to gynecological and medical factors.

Characteristics	Total N	UTI n (%)	No UTI n (%)	p-Value
Pregnancy Status	782			2.0×10^{-1}
Pregnant	104	52 (50)	52 (50)	
Non-pregnant	678	290 (42.8)	388.0 (57.2)	
Parity (Mother)	638			9×10^{-3}
No	174	60 (34.5)	114 (65.5)	
Yes	464	215 (46.3)	249 (53.7)	
Contraceptive use	558			2.3×10^{-1}
No	429	186 (43.4)	243 (56.6)	
Yes	74	26 (35.1)	48.0 (64.9)	
Patient Type	791			1.2×10^{-2}
Outpatient	715	301 (42.1)	414.0 (57.90%)	
Inpatient	76	44 (58)	32 (42.1)	
Menopause	573			2×10^{-3}
No	486	196 (40.3)	290.0 (59.7)	
Yes	87	51 (58.6)	36 (41.4)	
Known Pathology	551			3.50×10^{-3}
None	490	201 (41)	289 (59)	
At least one pathology	61	37 (60.7)	24 (39.3)	

Analysis of urinary tract infection (UTI) data according to gynecological and medical factors showed the following trends:

(1) Regarding reproductive history, menopausal women exhibited a significantly higher prevalence (58.6%) compared to pre-menopausal women (40.3%, $p = 2.0 \times 10^{-3}$). Similarly, parity was a significant factor, with parous women showing a higher infection rate (46.3%) than nulliparous women (34.5%, $p = 9.0 \times 10^{-3}$). (2) Although the UTI prevalence was higher among pregnant women (50.0%) than non-pregnant women (42.8%), this trend did not reach statistical significance ($p = 2.0 \times 10^{-1}$). Likewise, the use of contraceptives did not significantly influence UTI status ($p = 2.3 \times 10^{-1}$). (3) Hospitalization status was significantly associated with UTIs ($p = 1.2 \times 10^{-2}$), as inpatients presented a higher prevalence (57.9%) compared to outpatients (42.1%). (4) Finally, the presence of at least one underlying chronic pathology (hypertension, diabetes, or HIV) was strongly associated with an increased risk of UTI ($p = 3.5 \times 10^{-3}$). In this group, the prevalence reached 60.7% compared to 41.0% in participants with no known pathology. Notably, very high infection rates were observed among the small subgroups of HIV-positive participants (83.3%) and patients with diabetes (70.0%).

3.3. Temporal Evolution of UTI During the Study Period

The analysis of the monthly prevalence of UTI throughout the study period revealed significant fluctuations (Figure 1). The overall prevalence ranged from a minimum of 31.5% [95% CI: 23.3–39.6] in August to a maximum of 56.8% [95% CI: 40.8–72.7] in December. Other notable peaks were observed in November (45.6% [95% CI: 36.5–54.7]) and April (45.5% [95% CI: 16.1–74.8]). In July, the prevalence was recorded at 40.7% [95% CI: 32.6–48.8]. These monthly variations indicate a dynamic trend in UTI cases among women attending the hospital during the study period.

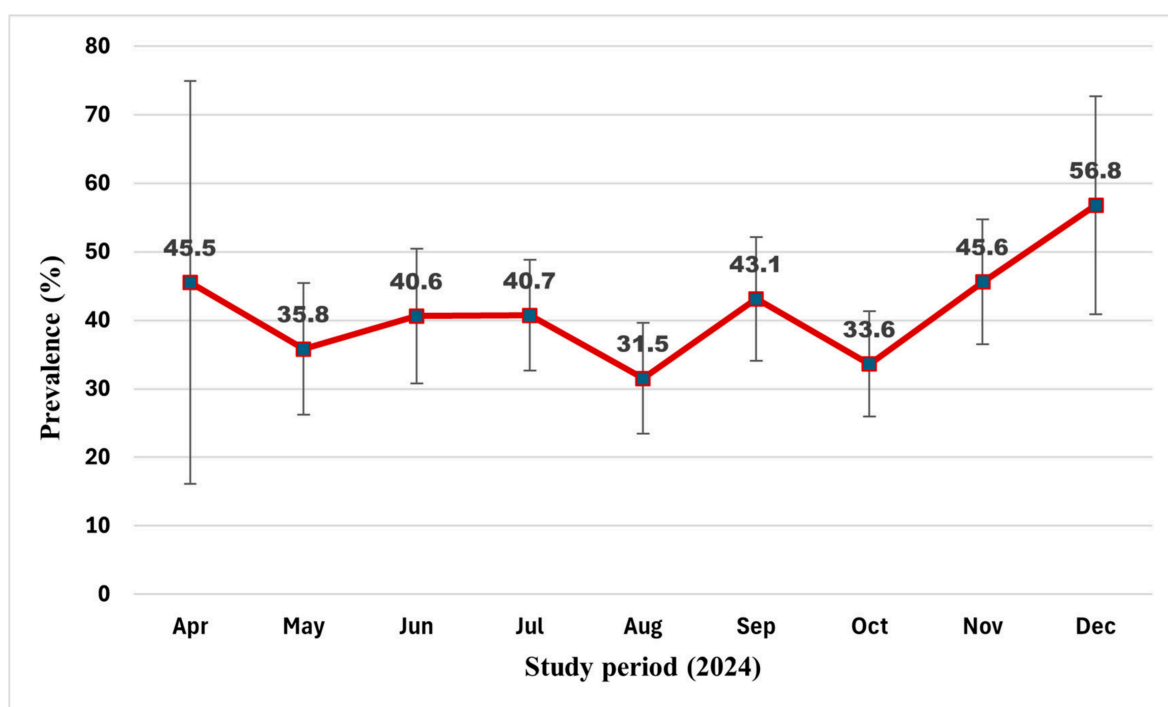


Figure 1. Evolution of the prevalence of urinary tract infections during the study period.

3.4. Identification of Bacteria Responsible for UTIs in Women

The prevalence of urinary tract infections caused by *Klebsiella* bacteria in this study was 14.4% (114/791). In addition, data on the identification of bacteria responsible for urinary tract infections in women are presented in Table 3.

Table 3. Isolation rate of uropathogens.

Uropathogens	<i>n</i>	%	95% CI
Enterobacterales	291	84.3	[80.5–88.2]
<i>E. coli</i>	122	35.4	[30.3–40.4]
<i>Klebsiella</i> spp.	114	33.0	[28.1–38.0]
<i>K. pneumoniae</i> species complex ^a	96	84.21	[77.5–91.0]
<i>K. aerogenes</i> ^a	11	9.6	[4.2–15.1]
<i>K. oxytoca</i> ^a	7	6.1	[1.7–10.5]
<i>Enterobacter</i> spp.	32	9.3	[6.2–12.3]
<i>Citrobacter</i> spp.	10	2.9	[1.1–4.7]
<i>Raoultella ornithinolytica</i>	7	2.0	[0.5–3.5]
<i>Proteus mirabilis</i>	6	1.74	[0.4–3.1]
Other Gram-negative bacteria	18	5.2	[2.9–7.6]
<i>Pseudomonas</i> spp.	9	2.6	[0.9–4.3]
<i>Acinetobacter</i> spp.	7	2.0	[0.5–3.5]
<i>Salmonella</i> spp.	2	0.6	[0.0–1.4]
Gram-positive bacteria	6	1.7	[0.4–3.1]
Yeasts	30	8.7	[5.7–11.7]

95% CI = 95% confidence interval. ^a: Percentages for *Klebsiella* species are calculated using the total number of *Klebsiella* isolates (*n* = 114) as the denominator.

Table 3 reveals that Enterobacterales were the overwhelmingly dominant group, accounting for 84.3% [95% CI: 80.5–88.2] of all isolates. (1) *E. coli* was the most frequently isolated species at 35.4% [95% CI: 30.3–40.4]. However, it was closely followed by *Klebsiella* spp., which represented 33.0% [95% CI: 28.1–38.0] of the total isolates. (2) Among the *Klebsiella* genus, the KpSC was the most predominant, representing 84.2% of the isolates within this group. This was followed by *Klebsiella aerogenes* (9.6%) and *Klebsiella oxytoca* (6.1%).

3.5. Comparison of *Klebsiella* spp. and *E. coli* Isolation Rates

This study also aimed to compare the evolution of isolation rates during the period of study for strains of *Klebsiella* spp. and *E. coli*, which is recognized worldwide as the leading uropathogen. The results are presented in Figure 2.

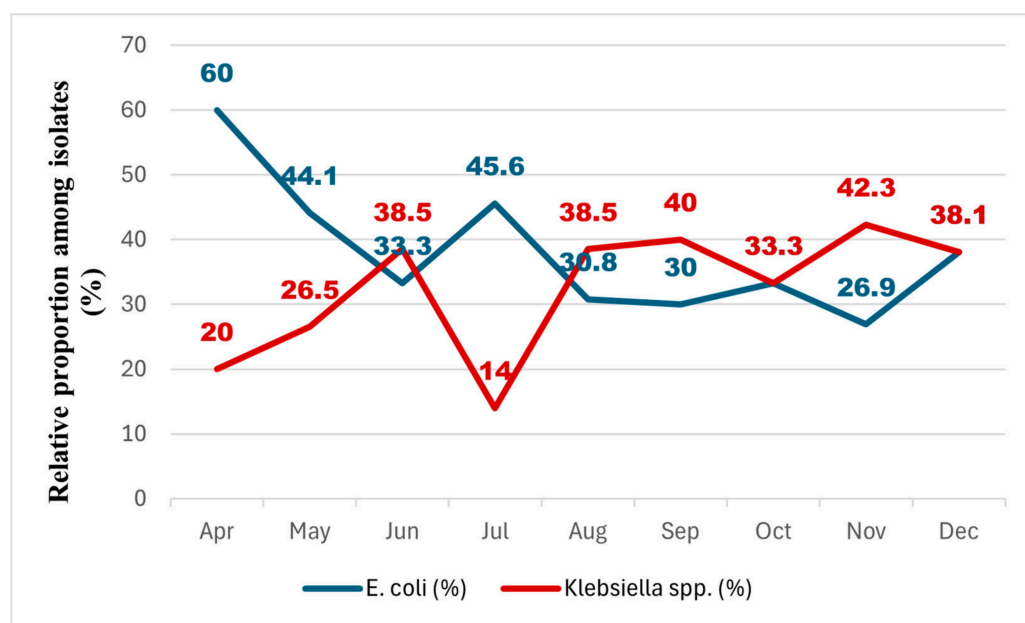


Figure 2. Evolution of isolation rates of *Klebsiella* spp. and *E. coli* over time.

The analysis of the monthly relative proportions of *Klebsiella* spp. and *E. coli* throughout the study period revealed significant variations between the two genera. The relative frequency of *Klebsiella* spp. was higher than that of *E. coli* during four specific months: June (38.5% vs. 33.3%), August (38.5% vs. 30.8%), September (40.0% vs. 30.0%), and November (42.3% vs. 26.9%). In contrast, *E. coli* remained the predominant isolate during three months (April, May, and July). Finally, during October and December, both pathogens exhibited identical relative proportions (33.3% and 38.1%, respectively). These fluctuations highlight a dynamic shift in the uropathogenic landscape, with *Klebsiella* spp. emerging as the leading isolate during the latter half of the year.

3.6. Risk Factors Associated with *Klebsiella* spp. UTIs

This study also aimed to identify risk factors associated with urinary tract infections caused by *Klebsiella* spp. in women. Odds ratios (ORs) were estimated as the primary measures of association between the presence of *Klebsiella* spp. and the different variables. These results are presented in Tables 4 and 5.

Table 4. Risk factors related to *Klebsiella* spp. in women.

Characteristics	N %	<i>Klebsiella</i> spp. Test Results		OR (IC 95%)	p-Value
		Absent N (%)	Present N (%)		
age groups	791				
<20	70 (8.8)	62 (9.2)	8 (7.0)	Ref	
20–39	467 (59.0)	404 (59.7)	63 (55.3)	1.2 (0.5–2.6)	6.3×10^{-1}
40–59	161 (20.4)	133 (19.6)	28 (24.6)	1.6 (0.7–3.8)	2.5×10^{-1}
≥60	93 (11.8)	78 (11.5)	15 (13.1)	1.5 (0.6–3.6)	3.8×10^{-1}
Marital Status	758				
Single/Divorced	337 (44.5)	300 (48.7)	37 (35.1)	Ref	
Married/Cohabiting	373 (49.2)	309 (47.7)	64 (55.7)	1.7 (1.1–2.6)	1.3×10^{-2}
Widow	48 (6.3)	38 (5.9)	10 (9.0)	2.1 (1.0–4.5)	4.0×10^{-2}
Employment Status	743				
Unemployed	432 (58.1)	372 (58.8)	60 (54.5)	Ref	
Employed	311 (41.9)	261 (41.2)	50 (45.4)	1.2 (0.8–1.8)	4.1×10^{-1}
Neighborhood type	649				
Mixed	609 (93.8)	517 (93.7)	92 (94.8)	Ref	
Modern	18 (2.8)	14 (2.5)	4 (4.1)	1.6 (0.4–4.8)	4.1×10^{-1}
Precarious	22 (3.4)	21 (3.8)	1 (1.0)	0.3 (0.0–1.5)	1.6×10^{-1}
Ethnic group	791				
Merié	247 (31.2)	212 (31.3)	35 (30.7)	Ref	
Fang	229 (29.0)	192 (28.4)	37 (32.5)	1.2 (0.7–1.9)	5.4×10^{-1}
Nzébi	135 (17.1)	122 (18.0)	13 (11.4)	0.6 (0.3–1.3)	2.0×10^{-1}
Mbété-téké	74 (9.4)	63 (9.3)	11 (9.6)	1.1 (0.5–2.2)	8.8×10^{-1}
Bakota	29 (3.7)	26 (3.8)	3 (2.6)	0.7 (0.2–2.4)	5.7×10^{-1}
Ngwèmyènè	22 (2.8)	18 (2.7)	4 (3.5)	1.3 (0.4–4.1)	6.0×10^{-1}
Membé	20 (2.5)	14 (2.1)	6 (5.3)	2.6 (0.9–7.3)	7.1×10^{-2}
Others	19 (2.4)	16 (2.4)	3 (2.6)	1.1 (0.3–4.0)	8.4×10^{-1}
Non-Gabonese	16 (2.0)	14 (2.1)	2 (1.8)	0.9 (0.2–3.9)	8.5×10^{-1}
Number of sexual partners	524				
1	406 (77.5)	353 (76.6)	53 (84.1)	Ref	
0	99 (18.9)	91 (19.7)	8 (12.7)	0.6 (0.3–1.3)	1.8×10^{-1}
≥2	19 (3.6)	17 (3.7)	2 (3.2)	0.8 (0.2–3.5)	7.4×10^{-1}

OR, odds ratio; IC, confidence interval; Ref, reference category.

The univariate analysis of sociodemographic factors associated with *Klebsiella* spp. isolation is presented in Table 4. (1) Marital status was the only sociodemographic variable significantly associated with the presence of *Klebsiella* spp. Compared to single or divorced women (reference), women in stable unions (married or cohabiting) exhibited a significantly higher risk (OR = 1.7; 95% CI: 1.1–2.6; $p = 1.3 \times 10^{-2}$). The risk was even more pronounced among widowed women, who were twice as likely to harbor *Klebsiella* spp. (OR = 2.1; 95% CI: 1.0–4.5; $p = 4.0 \times 10^{-2}$). (2) In contrast, age groups did not show a statistically significant association with *Klebsiella* spp. infection ($p > 0.05$), although a slight trend toward increased risk was observed in the 40–59 age bracket (OR = 1.6; 95% CI: 0.7–3.8). (3) Regarding ethnicity, although no single group reached statistical significance ($p = 6.3 \times 10^{-1}$), a notable trend was observed among women of the Membé group, who had higher levels of exposure to *Klebsiella* spp. isolation (OR = 2.6; 95% CI: 0.9–7.3; $p = 7.1 \times 10^{-2}$). Conversely, the Nzébi (OR = 0.6) and Bakota (OR = 0.7) groups showed lower odds of isolation compared to the Merié reference group. (4) Finally, no significant associations were found for employment status, neighborhood type or the number of sexual partners. These findings highlight that marital status and its associated lifestyle or biological factors are key indicators for *Klebsiella* spp. risk in this population.

Table 5. Risk factors associated with gynecological and medical parameters in *Klebsiella* spp. infections.

Characteristics	N %	<i>Klebsiella</i> spp. Test Results		OR (IC 95%)	p-Value
		Absent N (%)	Present N (%)		
Pregnancy Status	782				
Non-pregnant	678 (86.7)	584 (87.3)	94 (83.2)	Ref	
Pregnant	104 (13.3)	85 (12.7)	19 (16.8)	1.4 (0.8–2.4)	2.30×10^{-1}
Parity (Mother)	638				
No	174 (27.3)	153 (27.9)	21 (23.6)	Ref	
Yes	464 (72.7)	396 (72.1)	68 (76.4)	1.2 (0.7–2.1)	4×10^{-1}
Patient Type	791				
Outpatient	715 (90.4)	615 (90.8)	100 (87.7)	Ref	
Inpatient	76 (9.6)	62 (9.2)	14 (12.3)	1.4 (0.7–2.5)	2.9×10^{-1}
Menopause	573				
No	486 (84.8)	422 (85.8)	64 (79.0)	Ref	
Yes	87 (15.2)	70 (14.2)	17 (21)	1.6 (0.9–2.9)	1.2×10^{-1}
Known Pathology	551				
None	490 (89.4)	430 (89.4)	60 (85.7)	Ref	
At least one pathology	61 (10.6)	51 (10.6)	10 (14.3)	1.4 (0.7–2.8)	3.50×10^{-1}

OR, odds ratio; CI, confidence interval; Ref, reference category.

The associations between medical or gynecological factors and *Klebsiella* spp. isolation are summarized in Table 5. Overall, no variables reached the threshold for statistical significance in the univariate analysis (all $p > 0.05$). (1) Regarding reproductive status, pregnant women showed a higher frequency of *Klebsiella* spp. isolation compared to non-pregnant women (16.8% vs. 12.7%), although this trend was not statistically significant (OR = 1.4; 95% CI: 0.8–2.4; $p = 2.3 \times 10^{-1}$). Similarly, a higher isolation rate was observed among menopausal women (21.0%) compared to pre-menopausal women (14.2%, OR = 1.6; 95% CI: 0.9–2.9; $p = 1.2 \times 10^{-1}$). (2) Hospitalization status and parity also showed no significant correlation with *Klebsiella* spp. isolation, with odds ratios of 1.4 and 1.2, respectively ($p > 0.05$). (3) Finally, the presence of at least one underlying comorbidity (hypertension, diabetes, or HIV) was associated with a slight increase in the odds of *Klebsiella* spp. isolation (OR = 1.4; 95% CI: 0.7–2.8), but the association was not significant ($p = 3.5 \times 10^{-1}$).

3.7. Multivariate Analyses Associated with Urinary Tract Infections with *Klebsiella* spp. in Women

A multivariate descriptive analysis was employed to simultaneously evaluate all variables. Multiple Correspondence Analysis (MCA) was performed to characterize these qualitative variables, and the results are illustrated in Figures 3 and 4.

The Multiple Correspondence Analysis (MCA) presented in Figure 3 explores potential associations between the sociodemographic profiles of the patients and the presence of *Klebsiella* spp. The two main dimensions account for 17.4% of the total variance (Dim 1: 9.6% and Dim 2: 7.8%). Although these percentages reflect the high variability of the study population, the MCA suggests trends that characterize the epidemiological landscape of urinary tract infections in the study area. A closer examination shows that *Klebsiella* spp. (red point) is centrally located but leans toward the lower-left quadrant. It exhibits a strong proximity to women aged 20–39 years, those who are married or cohabiting, and those residing in “precarious” or “mixed” neighborhoods. Additionally, Specific ethnic groups, such as the Fang and Nzébi, are positioned near the *Klebsiella* spp. cluster, suggesting a potential association within these demographic segments.

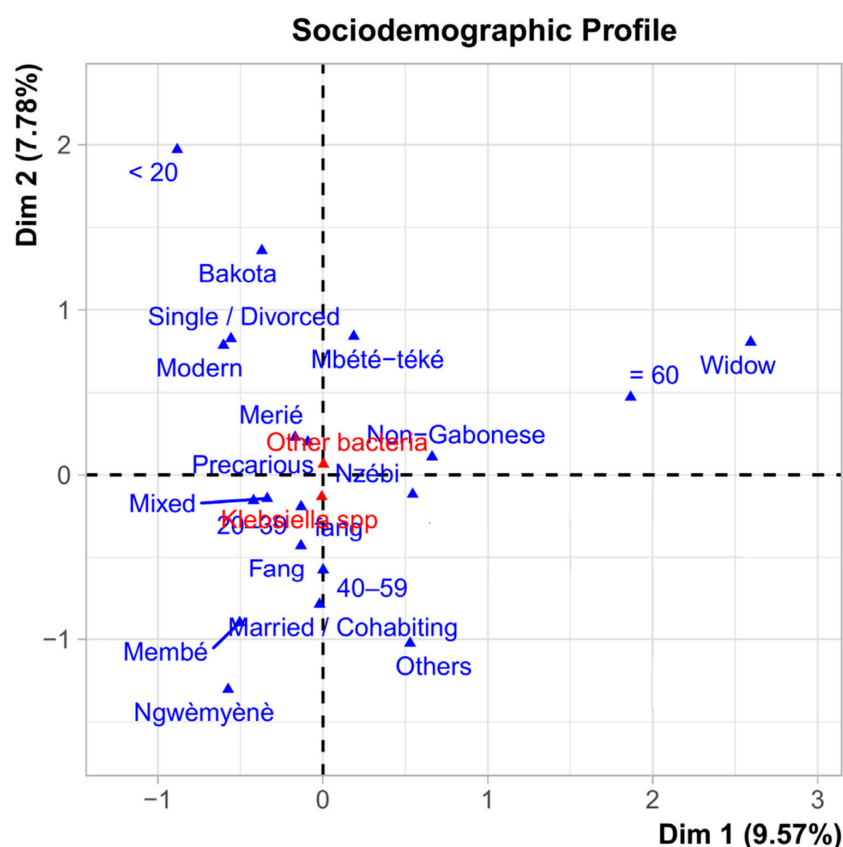


Figure 3. Plot of the two-dimensional analysis of sociodemographic parameters and urinary tract infection of *Klebsiella* spp. using MCA among patients with confirmed urinary tract infections.

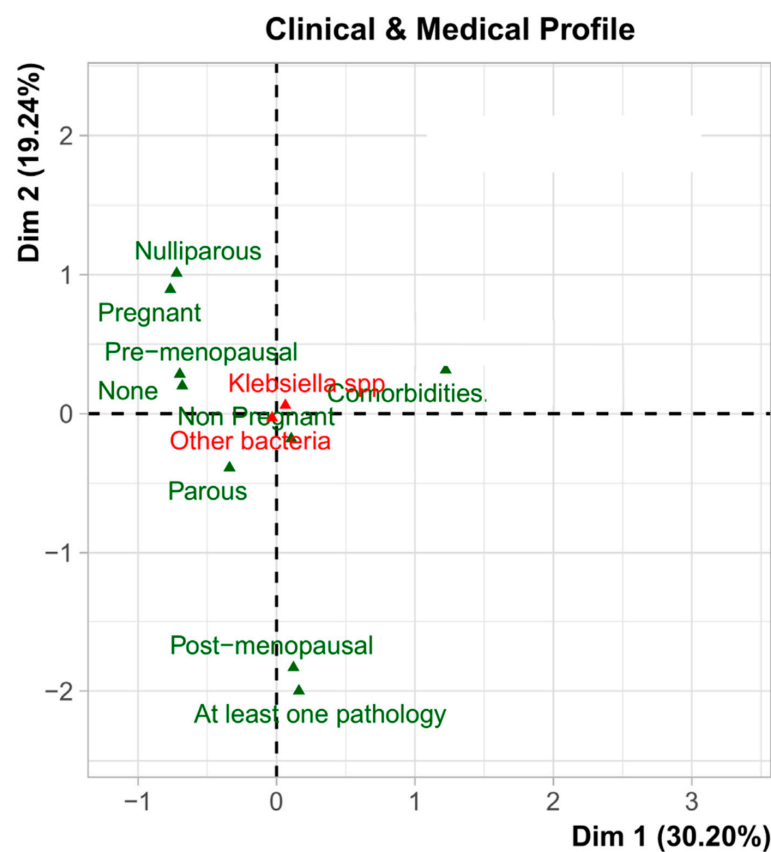


Figure 4. Plot of the two-dimensional analysis of gynecological and medical parameters and urinary tract infection with *Klebsiella* spp. using MCA among patients with confirmed urinary tract infections.

The Multiple Correspondence Analysis (MCA) for the clinical and medical profile (Figure 4) explains a substantial portion of the total variance (49.4%), with Dimension 1 and Dimension 2 accounting for 30.2% and 19.2%, respectively. The point representing *Klebsiella* spp. suggests a visual proximity with pre-menopausal status and pregnancy. The exploratory plot also illustrates proximity to nulliparous women and the absence of associated comorbidities (“None”). Conversely, postmenopausal patients and those with at least one pathology form a distinct cluster in the lower part of the graph, moving away from the *Klebsiella* spp. focal point. This visualization suggests that, in this sample, *Klebsiella* spp. infection primarily affects young, reproductively active women who generally lack significant underlying medical conditions.

4. Discussion

Numerous studies worldwide have highlighted the high prevalence of urinary tract infections (UTIs) among women, identifying female sex as a predominant risk factor [1,3,18]. To our knowledge, this is the first study in this region to focus specifically on the female population regarding UTIs within a tertiary hospital setting. Our results demonstrate that UTI prevalence among women varies according to age, marital status, and neighborhood type. We found an overall UTI prevalence of 43.6% [95% CI: 40.2–47.1%], which aligns with rates reported in other regions such as Ecuador (37.7%) and Cameroon (31%) [11,19].

Consistent with recent research, this study suggests that socioeconomic and environmental factors significantly influence prevalence. We observed that 59.1% of women aged ≥ 60 years, 64.6% of widows, and 43.3% of women living in precarious districts were infected. In older women, this high prevalence may be explained by age-related morpho-physiological changes, particularly the loss of bladder elasticity and reduced contractility leading to incomplete voiding and subsequent bacterial proliferation [6]. Regarding widows, social isolation or changes in health-seeking behavior might influence vulnerability. Furthermore, inadequate sanitary conditions in disadvantaged neighborhoods remain a major risk factor, facilitating increased exposure to uropathogens.

Moreover, this study highlights the potential influence of cultural factors on the prevalence of urinary tract infections. Indeed, the distribution of cases appears to vary across ethnic groups, with the Membé group exhibiting the highest prevalence (65.0%). Although this difference did not reach statistical significance, it deserves special attention, as this parameter could play an important role in the etiology of urinary tract infections in Gabon. The observed variations could hypothetically be influenced by specific cultural practices. For example, in some Gabonese ethnic groups, women resort to vaginal baths using medicinal plants for intimate maintenance and the treatment of gynecological disorders. An ethnobotanical study conducted in Gabon revealed that many women use traditional herbal remedies for vaginal cleansing and menstrual management [20]. However, as these practices were not directly assessed in our study, they remain speculative explanations. Further research incorporating specific behavioral variables is necessary to confirm whether such practices disrupt the vaginal microbiota and increase UTI susceptibility among these groups.

Gynecological and medical factors also play a significant role in the occurrence and proliferation of urinary tract infections in women. The results of this study indeed indicate that 46.3% of women who have already given birth, 57.9% of hospitalized women, 58.6% of postmenopausal women, and 83.3% of women living with HIV have a high prevalence of urinary tract infections. These high prevalences are justified by anatomical alterations probably due to multiple parities, which likely contribute to weakening the pelvic floor muscles, leading to incontinence, which promotes urinary stagnation and therefore urinary infections [21]. In addition, menopause causes a decrease in estrogen, which modifies the

vaginal flora and vaginal pH, factors that greatly increase the risk of contracting urinary tract infections in women [6]. Finally, the high prevalence of urinary tract infections among women living with HIV would be attributed to the decrease in immune defenses that results from the condition. This significantly reduces the body's ability to contain infections, associated with the high consumption of antibiotics that disrupt the protective flora and promote increased occurrence of urinary tract infections in these [22].

In contrast, monitoring the monthly distribution of UTIs revealed that prevalence peaked in December, exceeding 50%. In Gabon, this month coincides with the dry (cooler) season and major school holidays. It is plausible to hypothesize that these periods might be associated with an increased frequency of sexual activity, which is a well-documented risk factor for UTIs, as evidenced by Vincent et al., who observed higher frequencies of sexual intercourse in UTI cohorts compared to control groups [23]. However, as seasonal activities and behavioral changes were not directly measured in this study, these links remain speculative. Other factors, such as variations in health-seeking behavior during holiday periods, might also influence these trends and warrant further investigation using specific behavioral metrics.

Regarding etiology, *Klebsiella* species were responsible for 14.4% of all cases. This is higher than the values reported in Nigeria (7.4%) [24]. We hypothesize that this discrepancy could be influenced by several factors. While it is possible that Gabon's high environmental humidity and rainfall might favor bacterial survival and transmission [25], the selection of *Klebsiella* spp. is often favored in contexts of frequent antibiotic use and self-medication, both of which are common in Libreville. Furthermore, as a tertiary hospital, our cohort likely includes cases of recurrent or complicated UTIs, where *Klebsiella* is a well-known major pathogen.

While many studies rank *Klebsiella* spp. as the second most common uropathogenic group, our study found a notably high isolation rate of 33.04% among positive cases, with KpSC being the predominant species (84.21%). This represents a significant increase compared to previous Gabonese studies in 2012 (13.6%) and 2019 (18.9%) [26,27]. This trend underscores the emerging epidemiological threat posed by *Klebsiella* [28,29]. Variations compared to Turkey (9.9%), Morocco (17.9%) and Bangladesh (12%) likely result from differences in study populations and identification [30,31]. Furthermore, the monitoring and comparison of *E. coli* and *Klebsiella* spp. isolation rates across the study period appear, to our knowledge, to be a novel finding. The explanation for these trends may lie in the differing pathophysiology of these two uropathogens. Indeed, *Klebsiella* spp. and *E. coli* compete for binding sites on urothelial cells; consequently, environmental factors that vary across different time periods may favor the colonization of one species over the other [32]. Nevertheless, the specific environmental drivers in our context remain to be elucidated. In conclusion, our study highlights a significant shift in the uropathogenic landscape among women in Libreville, with *Klebsiella* spp. isolation rates approaching those of *E. coli*. This evolving trend disrupts established epidemiological hierarchies and emphasizes that *Klebsiella* spp. are no longer secondary pathogens in this region. These findings underscore the necessity of adapting local empirical antibiotic therapies to address this high prevalence and emphasize the importance of continuous microbiological monitoring in Gabonese tertiary hospitals.

Finally, risk factor analysis specifically for *Klebsiella* spp. identified marital status (Married/Cohabiting and Widow) as a significant variable. Multivariate analysis suggested the need for a risk profile consisting of specific ethnic groups (Membé).

However, the low total inertia in our Multiple Correspondence Analysis (MCA) model limits the generalization of these specific associations. This study presents some limitations: first, it was conducted in a single hospital (HIAOBO), and second, certain behavioral data, such as self-medication or recent antibiotic use, were not collected.

Regarding risk factors specifically for *Klebsiella* spp. UTIs, marital status (notably cohabitation) emerged as a relevant variable. While the multivariate analysis suggested a specific risk profile involving women in the 20–59 age range, particularly those belonging to the Fang, Nguèmyènè, or Membé ethnic groups, Multiple Correspondence Analysis further refines this by illustrating a trend of clustering with nulliparity and the absence of known comorbidities. Contrary to the conventional understanding of *Klebsiella* spp. as a pathogen primarily affecting immunocompromised patients, our study indicates that in this specific setting, the pathogen appears to be more frequent among young or middle-aged, reproductively active women without traditional chronic risk factors. Although this study provides pioneering data on *Klebsiella* spp. urinary tract infections in Gabon, several limitations must be acknowledged.

First, our findings are based on data collected from a single tertiary hospital (HIAOBO) in Libreville, representing a hospital-based population rather than a community-wide sample. Consequently, the high prevalence rate observed (43.6%) may reflect a selection bias, as individuals visiting the laboratory were often referred due to clinical suspicion of a UTI. Therefore, these results cannot be directly generalized to the entire female population of Libreville or Gabon. Nonetheless, this study provides critical baseline epidemiological data for hospital settings in the region. Second, the cross-sectional design precludes the establishment of direct causality between sociodemographic factors and UTI occurrence. Third, key behavioral variables, such as intimate hygiene practices and prior self-medication with antibiotics, were not documented, potentially confounding some associations. Additionally, the absence of a control group of healthy women and the lack of molecular characterization of the *Klebsiella* isolates (e.g., identification of virulence or resistance genes) limit the depth of our epidemiological analysis. Furthermore, we acknowledge the lack of antibiotic susceptibility data as a limitation; while this restricts the immediate therapeutic utility of the findings, the study provides a critical epidemiological baseline for the region. Finally, the low total inertia in the MCA model and the small sample size in specific medical subgroups suggest that these preliminary findings should be interpreted with caution.

5. Conclusions

This study aimed to evaluate the prevalence and describe the risk factors associated with *Klebsiella* spp. urinary tract infections (UTIs) among women in Gabon. To our knowledge, this is the first study to determine the prevalence of *Klebsiella* spp. in UTIs specifically within the female population of Libreville and to identify the risk factors associated with this uropathogen. Our findings reveal a substantial overall UTI prevalence among women, which varies significantly according to sociodemographic, hormonal, and medical characteristics. This study also highlights the significant involvement of *Klebsiella* spp. in these infections, with KpSC identified as the predominant species.

These results emphasize the critical need for continuous surveillance of this uropathogen's dissemination in both hospital and community settings. A deeper understanding of the risk factors for *Klebsiella* spp. UTIs could significantly improve the prevention, diagnosis and clinical management of these infections. Furthermore, identifying virulence factors and characterizing the genetic diversity of these uropathogens is essential to determine the epidemiological distribution of these strains in Gabon. While these data call for increased clinical attention toward both UTIs in women and the *Klebsiella* genus, several limitations must be acknowledged. Notably, this was a single-center study. Additionally, the absence of a control group may limit the full characterization of risk factors related to UTIs among women in Gabon.

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E.M.N.; Investigation, E.M.N., F.M.M., O.Z.M., A.C.D., L.F.O. and M.M.; Resources, F.S.L.B., J.F.Y. and A.C.D.; Data Curation, F.M. and E.M.N.; Writing—Original Draft Preparation, E.M.N.; Writing—Review and Editing, E.M.N., R.M.M., J.F.Y., O.Z.M. and L.F.O.; Visualization, L.F.O., F.M.M. and M.M.; Supervision, J.F.Y. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent was obtained from all participants; for minors, consent was obtained from their parents or legal guardians.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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