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Uro-pathogens: Prevalence of bacterial agents, and antimicrobial susceptibility profiles of urinary tract infections among pregnant women living with HIV in Kisumu County, Kenya

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Keywords: Bacterial prevalence; Antimicrobial susceptibility profiles; Uro-pathogens; UTI; Pregnancy; HIV.

Abstract

Background: During pregnancy, urinary Tract Infections (UTIs) are among the most common infections, particularly in women living with HIV worldwide, and can lead to poor perinatal and maternal outcomes. This study determined the prevalence of UTIs during pregnancy, associated risk factors, and antimicrobial susceptibility profiles of associated bacterial pathogens in pregnant women living with HIV attending a high-volume hospital in Kisumu County, Kenya.

Methodology: A cross-sectional study was conducted among 168 pregnant women attending the antenatal clinic at Jaramogi Oginga Odinga Teaching & Referral Hospital (JOOTRH) in Kisumu County, Kenya. The socio-demographic profiles of the study participants were obtained using a structured questionnaire. Cultures were taken from aseptically collected midstream urine, and antimicrobial susceptibility testing was determined using the disc diffusion test.

Result: A total of 168 HIV-positive pregnant women were included of which, 32.1% (54/168) showed UTI symptoms. In terms of the age of the pregnancy, 34.5% (58/168) were in trimester I, 47.6% (80/168) in trimester II, and lastly 17.9% (30/168) in trimester III. About 61.3% (103/168) of participants were urban dwellers. Bacteria were isolated from 29 (53.7%) clinically confirmed UTI patients and 9.7% (11) non-clinically confirmed patients. The most frequent bacterium was E. coli which accounted for 25% (10/40) of which 84.4% were resistant to Tetracycline among the Gram-negative group and 50% (4/8) Saureus whereas 75% of isolates were susceptible to Erythromycin for Gram-positive groups. Overall, 22.5% (9/40) bacterial isolates were resistant to at least one antimicrobial agent, and 62.5% (25/40) isolates were resistant to ≥2 antimicrobials.

Conclusion: The burden of urinary tract infections among HIV-positive pregnant women is significantly increased. Therefore, therapeu-tics selection based on microbiological culture is quite advisable for the management of urinary tract infections of HIV-positive pregnant women, hence pregnant women should be screened by urine culture, and treatment be guided by the antimicrobial susceptibility data.

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Introduction

Urinary Tract Infection (UTI) is an infection of the urinary tract, including the ureters, kidneys, urethra, bladder, and accessory structures that collect store, and release urine from the body happening when microorganisms, characteristically bacteria from the digestive tract, enter the urethral opening and begin to multiply [1-3]. Among the most common health problems in developing countries, Urinary tract infections are commonly observed affecting women in their reproductive ages. Due to a combination of hormonal and physiologic changes pregnant women are more prone to UTIs since they dispose of bacteriuria due to the combination hence increasing acute pyelonephritis incidence [4,5]. Factors such as a history of recurrent urinary tract infection, HIV-positive status, diabetes status, low socioeconomic status, increasing maternal age, multiparity, and anatomical abnormalities of the urinary tract have been seen to promote bacteriuria increase during pregnancy [5]. The global UTI burden ranges from 13% to 33%, with symptomatic bacteriuria occurring in 1% to 18% while asymptomatic cases are noted in 2%-10% of pregnant women [6,7]. Based on a study done in Tanzania in sub-Saharan Africa on epidemiological, urinary tract infections were estimated from 35-45% of cases [8] while in Ethiopia, a systematic review and meta-analysis indicated that the pooled prevalence of urinary tract infection was 15.97% [9]. Urinary tract infections in HIV patients were 12.8% [10]. Prevalence has remained constant from the most recent observational studies in developing countries [5], where Escherichia coli has been a common agent implicated in symptomatic and asymptomatic bacteriuria responsible for 70-80% of the infections, followed by other microorganism such as Staphylococcus spp., Klebsiella pneumoniae, Proteus spp., Pseudomonas aeruginosa, Enterococcus spp., and Acinetobacter [11,12]. In Kenya among pregnant mothers UTIs have been indicated to range from 10-19% from past studies [13] where most concentrate only on selected bacterial pathogens while a larger spectrum of bacterial etiologic agents remains unknown. The sociodemographic and lifestyle factors are additionally associated with UTIs among pregnant women which remain uninvestigated among those living with HIV in Kenya. Urine culture is not performed for antenatal mothers as a routine test among the recommended test for Antenatal Clinic (ANC) mothers in most hospitals in developing countries such as Kenya, hence most of them are treated empirically without culture and Antimicrobial Susceptibility Testing (AST) hence treatment is based on empiric guidelines that are rarely updated [14]. Currently, even in the known UTI signs situation dipstick analysis and direct wet microscopy of urine tests are the only tests used, but these tests have poor positive and negative predictive values to detect bacteriuria, particularly in asymptomatic persons [15]. The culture and susceptibility testing under use have partly led to the under-diagnosis of UTIs and this may be fueling the rising cases of treatment failure. In standard urine culture, a colony count of 105 CFU/ml is usually considered significant for infection [15], but there's missing data regarding the phenotypic characteristics of isolates whose counts fall below this threshold since such counts are regarded as contaminants. No data has described if such counts represent a receding infection or an infection that is established in UTI cases. In this study, we compared the results of antimicrobial resistance phenotypes from UTI cases among those living with HIV attending a clinic at Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) in Kisumu County within western Kenya. The results of this study provide critical data to caregivers and health planners regarding diagnosis, common etiological agents, and probable treatment options concerning antimicrobial resistance. This study also identified associated risk factors for UTI amongst pregnant women attending the antenatal clinic at JOOTRH.

Materials and methods

Study design: This study adopted a cross-sectional research design. Within a three-month timeframe from February to April 2024, urine samples were collected and tested from both patients displaying symptoms and asymptomatic. This investigation considered essential health metrics, including the prevalence of HIV, the utilization of antibiotics, nutritional status, and the presence of comorbidities such as diabetes, hypertension, as well as tumors.

Study area: This research was carried out at Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH), located in Kisumu County in the western region of Kenya. This particular area was selected due to its high prevalence of HIV [16] within the region JOOTRH serves as the primary healthcare facility in the Nyanza, catering to a wide range of medical cases, including complicated maternal health conditions, HIV-related cases, and Urinary Tract Infections (UTIs). Other health institutions in the vicinity refer patients with these specific health issues to this hospital to ensure they receive appropriate and specialized medical care.

Study population: The source of the population was all HIV-positive pregnant individuals attending the ANC clinic at JOOTRH. The HIV-positive patients who had symptomatic UTI and visited the Patient Support Center (PSC) at JOOTRH during the study period were the target populations. A total of 168 participants at the end of the sample collection period were considered.

Eligibility criteria of study participants: HIV-positive pregnant patients who were ≥18 years old with symptoms of UTI including; lower abdominal or flank pain, dysuria and hematuria, and frequency urinations were included in the study while patients who were mentally ill, patients who received antibiotics in the last 14 days before sample collection and unable to give samples were not included in the study.

Laboratory analysis

Data and specimen collection: A pretested structured questionnaire was used to collect information on socio-demographic data (age, and residence), and clinical history (existing antibiotic treatment, previous antibiotic therapy). About 10 mL of voided cleancatch mid-stream fresh urine was collected from each study participant using a leakproof and sterile widemouthed screw-capped container. These specimens were labeled and stored in a cold box (4˚C) and transported to the JOOTRH microbiology laboratory for analysis within 1 hour of collection [17].

Isolation and identification of bacteria: Bacterial isolation and phenotypic characterization were performed using the

recommended culture and biochemical tests [18]. A calibrated loop that delivers 0.001 mL of urine was used to inoculate each urine sample onto the Cysteine Lactose Electrolyte Deficient Agar (Oxoid Ltd, UK). The plates were incubated aerobically at 37˚C for 24 hours and colony count growth of ≥104-105 CFU/mL (colony-forming units per milliliter) was considered significant. Gram stain was performed from significant growth and subculture onto MacConkey agar (HiMediaTM) and 5% blood agar plates (HiMediaTM). However, bacteria that did not show growth after 24 hours of incubation were further incubated for 24 hours and discarded as negative when the colony count was not significant [19]. Colony characteristics, Gram reactions, and a series of biochemical reactions, including catalase, coagulase, oxidase, urease, indole, citrate utilization, lysine decarboxylase, glucose, lactose fermentation, gas and H2S production, and motility tests were used for the isolations of bacteria [20].

Antimicrobial susceptibility testing: An antimicrobial susceptibility test was performed using the Kirby–Bauer disk diffusion method based on the Clinical Laboratory Standards Institute (CLSI) recommendation [21]. About 3–5 pure colonies of isolated species from nutrient agar (HiMediaTM) were picked and transferred to a tube containing 5 mL of tryptonesoya broth and mixed well to make a homogenous suspension. The suspension was incubated at 37˚C until the turbidity of the suspension matched a 0.5 McFarland standard. Using a sterile swab, the suspension was inoculated over the entire surface of the Mueller Hinton agar plate. The selected antimicrobial disks were put on the inoculated plates and incubated at 37˚C for 16-18 hours. Antimicrobial agents were selected based on CLSI recommendations and local (Ethiopian) prescription habits for bacteria. The antimicrobials (Oxoid Ltd) that were used for bacterial susceptibility testing were Amoxicillin-Clavulanic Acid (AMC) 10 µg, Ampicillin (AMP) 10 µg, Amikacin (Amk) 30 µg, Cefotaxime (CTX) 30 µg, Ceftriaxone (CRO) 30 µg, Trimethoprim-Sulphamethoxazole (SXT) 25 µg, Ciprofloxacin (CIP) 5 µg, Gentamycin (Gen) 10 µg, Ceftazidime (CAZ) 30 µg, Nitrofurantoin (F) 300 µg, Tetracycline (TE) 30 µg and Penicillin (Pen) 10 µg [21]. Within 15 minutes after the application of the discs, the plates were incubated at 35˚C for 18 hours. Diameters of zones of inhibition were measured using a digital caliper. The antimicrobial susceptibility test results were interpreted as sensitive, intermediate, or resistant based on the standardized CLSI guidelines and the isolates were considered MDR, resistant to at least one antimicrobial in three or more antimicrobial categories [21].

Quality assurance: The questionnaire was pretested on 5% (for 18) of HIV-positive pregnant patients at the JOOTRH ANC department. The sterility of culture media was checked by incubating 5% of the prepared media overnight at 37˚C without specimen inoculation. The collected data was checked for completeness and adequate recording on the worksheet both during and after data collection. Standard Operating Procedures (SOPs) were strictly followed for each microbiological procedure. All clinical specimens were collected, transported, and processed correctly. The expiration dates of the media, reagents, and Muller Hilton agar antimicrobial discs were checked before use. The new batch culture medium and antimicrobial disks were checked for performance and quality using the American Type Culture Collection (ATCC) reference strains such as E. coli (ATCC1 25922), S. aureus (ATCC1 25923), Klebsiella pneumonia (ATCC 700603) and P. aeruginosa (ATCC1 27853).

Validity and reliability: To validate reproducibility, all experiments were done independently in triplicates.

Data management and statistical analysis: The data was entered into MS Excel version 4.6 and exported to Social Sciences Statistical Package (SPSS) version 25 for analysis. Descriptive statistics were computed and presented using graphs and tables. All values of diameter zones of inhibition are reported as mean ± standard error of 0.5.

Results

Socio-demographic characteristics: In the study, a total of 168 HIV-positive pregnant women were included of which 54 (32.1%) showed UTI symptoms. The age of the study participants ranged from 18 to 55 years with a mean (±SD) age of 39.44 (±10.87) years, and 78 (46.4%) of them were in the age range of 18-24 years, followed by 45 (26.8%) were of age bracket of 25-34 years, 30 (17.9%) were in the age range of 35-44 years and lastly 15 (8.9%) were in the age range of >44 years. About 53.6% (90/168) of the respondents were married. Regarding educational status, 52.4% (88/168) of the respondents were unable to read and write. Moreover, in terms of the age of the pregnancy, 47.6% (80/168) were in trimester II, followed by 34.5% (58/168) in trimester I, and lastly 17.9% (30/168) in trimester III (Table 1).

Prevalence of UTI pathogens isolated among the HIV-positive pregnant women: Among 168 HIV pregnant patients, 54 (32.1%) were clinically confirmed to have UTI and of these bacteria were isolated from 29 (53.7%) clinically confirmed UTI patients and 11 (9.7%) non-clinically confirmed patients. The most frequent bacterium was E. coli which accounted for 25% (10/40) followed by P. aeruginosa, K. pneumoniae, and P. mirabilis, accounting for 22.5% (9/40), 20% (8/40), and 12.5% (5/40), respectively among the Gram-negative pathogens. Gram-positive bacteria accounted for only 20% (8/40) of the bacterial isolates, of which 50% (4/8) of the isolates were S. aureus, followed by Staphylococcus saprophyticus and coagulase negative staphylococci (CoNS) both at 25% (2/8) (Table 2).

Antimicrobial susceptibility pattern of bacterial Uro-pathogens gram-negative bacteria: From the total isolated 80% (32/40) were Gram-negative Uro-pathogens. From the tested antimicrobial susceptibility patterns 71.9% (23/32) of the isolates were susceptible to ceftriaxone. Whereas, 84.4% were resistant to tetracycline, followed by 81.3% to Trimethoprim-Sulphamethoxazole, 65.6% resistance to both Ampicillin and Amoxicillin-Clavulanic Acid, 62.5% to Nitrofurantoin, 53.1% to both Ciprofloxacin and Ceftazidime, 46.9% to Cefotaxime, 43.8% to Gentamicin, 37.5% to Amikacin and lastly 28.1% to Ceftriaxone. High resistance to Tetracycline and Trimethoprim-Sulphamethoxazole was observed on E. coli and K. pneumoniae strains at 80% (8/10) and 87.5% (7/8), respectively (Table 3).

Gram-positive bacteria: Of the total isolated 20% (8/40) were Gram-positive Uro-pathogens in which 75% (6/8) of isolates were susceptible to Erythromycin. Whereas, 62.5% (5/8) were resistant to Chloramphenicol and Tetracycline followed by 50% (4/8) to both Penicillin, Cefotaxime, Ciprofloxacin, Trimethoprim-Sulfamethoxazole, and Cefoxitin, 37.5% (3/8) to Nitrofurantoin, 25% (2/8) to Erythromycin and lastly 12.5% (1/8) to Clindamycin. S. aureus was sensitive 100% to Clindamycin, while coagulase-negative staphylococci (CoNS) showed 100% sensitivity to Nitrofurantoin and lastly 100% of Staphylococcus saprophyticus showed sensitivity to both Penicillin, Nitrofurantoin, Clindamycin, and Trimethoprim-Sulfamethoxazole (Table 4).

Table 1: Socio-demographic characteristics of UTI among HIV-positive pregnant women attending ANC at JOOTRH.

Variable	Category	Urinary tract infection		Total participants (N=168)	
		Positive No (%)	Negative No (%)	Total No (%)	Percentage
Residence	Rural	24(36.9)	41(63.1)	65	38.7
	Urban	16(9.5)	87(84.5)	103	61.3
Age (in years)	18-24	10(12.8)	68(87.2)	78	46.4
	25-34	20(44.4)	25(55.6)	45	26.8
	35-44	6(20)	24(80)	30	17.9
	>44	4(26.7)	11(73.3)	15	8.9
Educational status	Unable to read and write	15(17)	73(83)	88	52.4
	Primary	12(34.3)	23(65.7)	35	20.8
	Secondary	8(40)	12(60)	20	11.9
	College/University	5(20)	20(80)	25	14.9
Marital status	Married	16(17.8)	74(82.2)	90	53.6
	Unmarried	14(28)	36(72)	50	29.7
	Divorced	4(40)	6(60)	10	6.0
	Widowed	6(33.3)	12(66.7)	18	10.7
Age of pregnancy	Trimester I	15(25.9)	43(74.1)	58	34.5
	Trimester II	20(25)	60(75)	80	47.6
	Trimester III	5(16.7)	25(83.3)	30	17.9
HIV stage	Stage I	25(23.8)	80(76.2)	105	62.5
	Stage II	15(23.8)	48(76.2)	63	37.5
UTI symptoms	YES	29(53.7)	25(46.3)	54	32.1
	NO	11(9.7)	103(90.3)	114	67.9
Self-medication	YES	12(25)	36(75)	48	28.6
	NO	28(23.3)	92(76.7)	120	71.4

Table 2: Prevalence of UTI pathogens among HIV-positive pregnant women with UTI attending ANC at JOOTRH.

Isolates	N (%)
S. aureus	4 (10%)
CoNS	2 (5%)
Staphylococcus saprophyticus	2 (5%)
E. coli	10 (25%)
K. pneumoniae	8 (20%)
P. mirabilis	5 (12.5%)
P. aeruginosa	9 (22.5%)

Multidrug resistance patterns of the bacterial isolates: Overall, 22.5% (9/40) bacterial isolates were resistant to at least one antimicrobial agent, and 62.5% (25/40) isolates were resistant to ≥2 antimicrobials. About 17.5% (7/40) isolates resistant five or more antimicrobials. The overall prevalence of MDR bacteria (a bacterium simultaneously resistant to three or more antimicrobial categories) was 75% (30/40). About 80% (8) of E. coli, 77.8% (7/40) of P. aeruginosa, and 62.5% (5/40) of K. pneumoniae were the most frequently exhibited MDR (Table 5).

Table 3: Antimicrobial susceptibility pattern of Gram-negative bacterial isolates from HIV-positive pregnant women with UTI attending ANC at JOOTRH.

Etiologic agents	Pattern	Antimicrobial agents N (%)										
		AMP	AMC	AK	CRO	CIP	GN	CAZ	TE	CTX	SXT	F
E. coli (10)	S	4(40)	3(30)	9(90)	9(90)	5(50)	6(60)	7(70)	2(20)	5(50)	2(20)	4(40)
	R	6(60)	7(70)	1(10)	1(10)	5(50)	4(40)	3(30)	8(80)	5(50)	8(80)	6(60)
K. pneumoniae (8)	S	3(37.5)	4(50)	3(37.5)	6(75)	2(25)	5(62.5)	2(25)	1(12.5)	5(62.5)	1(12.5)	3(37.5)
	R	5(62.5)	4(50)	5(62.5)	2(25)	6(75)	3(37.5)	6(75)	7(87.5)	3(37.5)	7(87.5)	5(62.5)
P. mirabilis (5)	S	1(20)	2(40)	3(60)	3(60)	3(60)	1(20)	2(40)	1(20)	3(60)	1(20)	2(40)
	R	4(80)	3(60)	2(40)	2(40)	2(40)	4(80)	3(60)	4(80)	2(40)	4(80)	3(60)
P. aeruginosa (9)	S	3(33.3)	2(22.2)	5(55.6)	5(55.6)	5(55.6)	6(66.7)	4(44.4)	1(11.1)	4(44.4)	2(22.2)	3(33.3)
	R	6(66.7)	7(87.8)	4(44.4)	4(44.4)	4(44.4)	3(33.3)	5(55.6)	8(88.9)	5(55.6)	7(87.8)	6(66.7)

Abbreviations: S: Sensitive; R: Resistant; AMP: Ampicillin; AMC: Amoxicillin-Clavulanic acid; CTX: Cefotaxime; CAZ: Ceftazidime; F: Nitrofu-rantoin; CRO: Ceftriaxone; CIP: Ciprofloxacin; GN: Gentamicin; AK: Amikacin; TE: Tetracycline; SXT: Trimethoprim-Sulphamethoxazole.

Table 4: Antimicrobial susceptibility pattern of Gram-negative bacterial isolates from HIV-positive pregnant women with UTI attending ANC at JOOTRH.

Bacterial isolates		Antimicrobial Agents N (%)									
		E	P	C	CTX	F	DA	CIP	SXT	FOX	TE
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
S. aureus (4)	S	3(75)	1(25)	2(50)	2(50)	1(25)	4(100)	3(75)	1(25)	2(50)	1(25)
	R	1(25)	3(75)	2(50)	2(50)	3(75)	0(0)	1(25)	3(75)	2(50)	3(75)
CoNS (2)	S	2(100)	1(50)	0(0)	1(50)	2(100)	1(50)	0(0)	1(50)	1(50)	1(50)
	R	0(0)	1(50)	2(100)	1(50)	0(0)	1(50)	2(100)	1(50)	1(50))	1(50)
Staphylococcus saprophyticus(2)	S	1(50)	2(100)	1(50)	1(50)	2(100)	2(100)	1(50)	2(100)	1(50)	1(50)
	R	1(50)	0(0)	1(50)	1(50)	0(0)	0(0)	1(50)	0(0)	1(50)	1(50)

Abbreviations: DA: Clindamycin; E: Erythromycin; C: Chloramphenicol; CIP: Ciprofloxacin; TE: Tetracycline; SXT: Trimethoprim-Sulfamethoxazole; CTX: Cefotaxime; FOX: Cefoxitin; F: Nitrofurantoin; P: Penicillin; R: Resistant; FOX: Cefoxitin; S: Sensitive; NT: Not Tested.

Table 5: Multi-drug resistance patterns of Uro-pathogenic bacterial isolates among UTI HIV-positive women attending ANC at JOOTRH.

Isolated organisms	Total	MDR to antimicrobials						
		R0 N (%)	R1 N (%)	R2 N (%)	R3 N (%)	R4 N (%)	≥R5 N (%)	MDR N (%)
E. coli	10	3(30)	5(50)	3(30)	2(20)	4(40)	2(20)	8(80)
K. pneumoniae	8	1(12.5)	1(12.5)	-	1(12.5)	2(25)	2(25)	5(62.5)
S. aureus	4	1(25)	-	-	2(50)	1(25)	-	3(75)
P. mirabilis	5	2(40)	1(20)	-	2(40)	1(20)	1(20)	4(80)
CoNs	2	1(50)	-	-	1(50)	1(50)	-	2(50)
P. aeruginosa	9	3(33.3)	1(11.1)	1(11.1)	3(33.3)	2(22.2)	2(22.2)	7(77.8)
Staphylococcus saprophyticus	2	1(50)	1(50)	-	-	1(50)	-	1(50)
Total	40	12(30)	9(22.5)	4(10)	12(30)	12(30)	7(17.5)	30(75)

Abbreviations: R0: No antibiotic resistance category; R1: Resistance to one antibiotic category; R2: Resistance to two antibiotics category; R3: Re-sistance to three antibiotics category; R4: Resistance to four antibiotics category; R5: Resistance to five antibiotics category; MDR: Multidrug Resistance.

Discussion

A Urinary Tract Infection (UTI) is defined as the invasion of the urinary tract by one or more uropathogenic bacteria species, which results in significant bacteriuria and the presence of suggestive UTI such as dysuria, pain, and burning during urinating, cloudy urine, and urine appears red, bright pink [22]. From our study, the urinary tract infection prevalence among the UTI HIV-positive women was 23.8% [94% CI: 20.5%-30.2%]. This result concurs with a recent study done in Hawassa and Uganda which showed a prevalence of 23.1% and 22.0%, respectively [23,24]. As per other studies done, our finding was relatively higher compared to others, for instance, in Jimma the prevalence was 13.7% [25], 20.6% in Gojjam Ethiopia [26], 4.9% in Hawassa [27], 18.6% in Addis Ababa, Ethiopia [28,29], and lastly 18% in Harare, Ethiopia [30]. Studies conducted in Nigeria, South Africa, Nepal, and India showed a higher prevalence than our findings at 32.5%, 48.7%, 54.76%, and 49.15% respectively [31-34]. This variation might be due to differences in sample size, the degree of the immune status of the study participants, geographical variation, ART status, and socio-economic conditions. From the Gram-negative bacterial isolate, E. coli was the most frequent bacterium at 25% followed by P. aeruginosa, K. pneumoniae, and P. mirabilis, accounting for 22.5%, 20%, and 12.5% respectively, while Gram-positive bacteria most frequent bacterium was S. aureus at 50%, followed by Staphylococcus saprophyticus and CoNS both at 25%. Studies done in different parts of Ethiopia and across different countries like, Bahirdar (38.1%) [30], Gondar, (56.1%) [35], and Jimma (54.3%) [25] from Ethiopia, tertiary care hospitals, India (41.7%) [28], Saudi Arabia [36] and Ethiopia [27] also shows E. coli predominant. From the study done in Ebony State, Nigeria [37] and India [38] the findings were inconsistent with our study findings, which reported that S. aureus was at 45.3% and P. aeruginosa at 41.9%, while in Turkey the most common causative agent was E. coli (66.6%) followed by K. pneumoniae (16.6%) and others such as Enterobacter spp. (7.7%) [39] were the commonest urinary tract pathogens. This discrepancy might be due to differences in the test facility, strain variety, geographical variation, and study group variations. The presence of a unique structure that aids bacteria attachment to uroepithelial cells, allowing for multiplication and tissue invasion, could explain the predominance of E. coli [40,41]. In the current study, out of the total isolated Gram-negative Uro-pathogens, about 71.9% of the isolates were susceptible to Ceftriaxone. Whereas, 84.4% were resistant to Tetracycline, followed by 81.3% to Trimethoprim-Sulphamethoxazole, 65.6% resistance to both Ampicillin and Amoxicillin-Clavulanic acid, 62.5% to Nitrofurantoin, 53.1% to both Ciprofloxacin and Ceftazidime, 46.9% to Cefotaxime, 43.8% to Gentamicin, 37.5% to Amikacin and lastly 28.1% to Ceftriaxone. The other study on urinary tract bacterial isolates supported these current findings with a percentage of Sulphamethoxazole, Nitrofurantoin, and Ceftazidime, and most of the urinary bacterial isolates being highly sensitive to Ceftazidime (95%), and Ciprofloxacin (88%) [42]. High resistance to Tetracycline and Trimethoprim-Sulphamethoxazole was observed on E.

coli and K. pneumoniae strains at 80% and 87.5%, respectively. Similar findings from studies conducted in Addis Ababa which indicated K. pneumoniae had the highest level of resistance against Trimethoprim-Sulphamethoxazole (86.4%), Cefotaxime (86.4%), Cefepime (85.4%), Ceftazidime (85.4%), Amoxicillin-Clavulanic acid (85.4%), Gentamicin (70.0%), and Ciprofloxacin (50.5% [43], in Iran: Trimethoprim-Tulphamethoxazole (91.4%), Ceftazidime (91.4%), and Gentamicin (82.8%) [44]; in Sierra Leone: Ciprofloxacin (73.4%) and Gentamicin (60%) [45], in Equatorial Guinea: Trimethoprim-Sulphamethoxazole (100%), Amoxicillin-Clavulanic acid (96.6%), Gentamicin (86.2%) and Ciprofloxacin (87.5%) [46]. The occurrence of high antibiotic resistance might be due to misuse and overuse of antibiotics, and poor infection control measures [47. This was comparable with the study done in Gondar, Ethiopia [35] and Harare, Ethiopia [30], P. aeruginosa was 88% resistant to tetracycline and P. mirabilis 87% resistant to Ampicillin, Gentamycin, Tetracycline, and Trimethoprim-Sulphamethoxazole. This is in agreement with a study done in Ethiopia [29]. Similarly, of Gram-positive isolates, about 75% of isolates were susceptible to Erythromycin. Whereas, 62.5% were resistant to both Chloram-phenicol and Tetracycline followed by 50% to both Penicillin, Cefotaxime, Ciprofloxacin, Trimethoprim-Sulfamethoxazole, Cefoxitin, 37.5% to Nitrofurantoin, 25% to Erythromycin and lastly 12.5% to Clindamycin. S. aureus was 100% sensitive to Clindamycin, while coagulase-negative staphylococci (CoNS) showed 100% sensitivity to Nitrofurantoin and lastly 100% of Staphylococcus saprophyticus showed sensitivity to both Penicillin, Nitrofurantoin, Clindamycin, and Trimethoprim-Sulfamethoxazole This is in line with a study done in Harare, Ethiopia, where 57.1% of S. aureus were resistant to Gentamicin, Tetracycline, and Cefoxitin 57.1% [30]. Multidrug resistance has serious implications for the health outcomes of HIV-infected pregnant patients [48]. It is alarming to note that almost 22.5% of bacterial isolates were resistant to at least one antimicrobial agent, and 62.5% were resistant to ≥2 antimicrobials. About 17.5% of isolates had resistance to five or more antimicrobials. The overall prevalence of MDR bacteria was 75% in which about 80% of E. coli, 77.8% of P. aeruginosa, and 62.5% of K. pneumoniae were the most frequently exhibited MDR. This was higher compared to previous findings reported in Harare, Ethiopia (46%) [30], Dessie (74.6%) [49], Gondar (68%) [50], Nepal (64.04%) [51] and India (28%) [52]. But it was lower than a report from Gondar, Ethiopia (95%) and 87.4%) [35], Addis Ababa (100%) [29], Bahirdar (93.1%) [53], and Nepal (96.84%) [51]. These differences might be due to the irrational drug utilization habit of the communities or to the distribution of those sensitive and resistant strains of bacteria. In this study, there was no statistically significant association between significant bacteriuria and patients' residence, marital status, and use of antibiotics [26,29,30].

Conclusion

This study demonstrated that UTI is prevalent among antenatal HIV-positive pregnant mothers in JOOTRH. A moderately high level of resistance against firstline drugs and a high level of resistance against 3rd generation Cephalosporins and Fluoroquinolones were observed. There is therefore a need to revise existing empiric treatment regimens to periodically reflect prevailing resistance phenotypes based on our data. Management of UTI among symptomatic HIV pregnant patients should be supported by laboratory results of urine culture. Regular monitoring of antimicrobial resistance patterns should be undertaken by healthcare providers. Individuals at risk for bacterial-associated UTIs should have good adherence to ART. Health information about UTIs should be given and the habit of drug use for HIV-positive patients be monitored.

Limitations of the study

The study was a single hospital-based study and might not represent all HIV-infected pregnant patients in Kisumu County. We did not attempt to identify other causative agents (anaerobic bacteria and fungus, etc) that would have made a significant contribution to a true prevalence of UTI in HIV-positive pregnant patients.

Declarations

Ethical consideration: Confidentiality and privacy were strictly adhered to and no names of individuals were recorded or made known in the collection or reporting of information, written informed consent was obtained from each participant prior to any protocol/-procedures being conducted. The study was granted ethical clearance by the School of Graduate Studies (SGS) of Maseno University Ref no. PHD/PH/00064/2020 and ethical approval to conduct the study was sought from the Institutional Research Ethics Committee (IREC) at JOOTRH Ref. No. ISERC/JOOTRH/779/23 and the National Commission of Science, Technology and Innovations (NACOSTI) Ref. No. 304908.

Clinical trial: Not Applicable.

Consent for publication: Not Applicable.

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Author contributions: Conceptualization, KK; methodology, KK, GB, CO and SA; resources, KK, GB, CO; writing-original draft preparation, KK, GB, CO and SA; writing-review and editing, SA, KK, GB, and CO; Final editing, All authors; visualization, KK, and SA; supervision, GB, CO, and SA; project administration, KK. All authors have read and agreed to the published version of the manuscript.

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