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Urinary Tract Infection in Pregnancy: Bacterial Profile, Antibiogram, Electrolytes and Risk Factors in Otuoke and Environs, Bayelsa State, Nigeria

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Abstract

Urinary tract infections (UTIs) remain a major health concern during pregnancy due to their potential complications for both mother and fetus, particularly in resource-limited settings. This study investigated the bacterial etiology, antibiotic susceptibility patterns, cytokine responses, electrolyte alterations, and risk factors associated with UTIs among pregnant women in Otuoke and Yenagoa, Bayelsa State, Nigeria. A total of 300 pregnant women attending antenatal clinics in selected hospitals were screened for UTIs, excluding those on antibiotic therapy. Urine, serum, and cerebrospinal fluid samples were processed using standard microbiological and serological techniques, bacterial isolates were identified and subjected to antibiogram testing, and interleukin-10 (IL-10) and electrolyte profiles were measured. Multivariate analysis was used to assess sociodemographic and clinical risk factors. The prevalence of UTI was 18.7% (56/300). *Escherichia coli* was the predominant pathogen (8.7%), followed by *Staphylococcus aureus* (2.7%), coagulase-negative staphylococci (2.7%), *Proteus* spp. (2.0%), *Klebsiella pneumoniae* (1.4%), *Citrobacter* spp. (1.0%), and *Streptococcus* spp. (0.3%). High levels of resistance were observed to ampicillin, gentamicin, and ceftriaxone, whereas ciprofloxacin, norfloxacin, nitrofurantoin, and cotrimoxazole remained effective against most isolates. IL-10 concentrations increased significantly with UTI severity, indicating an enhanced immunological response. Infected participants showed significant alterations in electrolyte and biochemical parameters, including elevated serum urea, creatinine, and proteinuria compared with controls ($p < 0.05$), with proteinuria demonstrating notable statistical significance ($\chi^2 = 13.39$, $p < 0.05$); severe infections were associated with greater disturbances in sodium and potassium balance. Multiparity, low socioeconomic status, and limited educational attainment emerged as significant predictors of UTI occurrence. This study highlights a substantial burden of UTIs among pregnant women in the study area, accompanied by rising antibiotic resistance, and suggests that cytokines—particularly IL-10—and electrolyte abnormalities may serve as useful biomarkers in the immunopathology and diagnosis of UTIs during pregnancy. Routine screening, rational antibiotic use, and targeted health education are essential to reduce the incidence and complications of UTIs in this population.

Keywords: Urinary Tract Infection; Pregnancy; Antibiotic Susceptibility; Cytokines; Electrolyte Imbalance.

INTRODUCTION

Urinary tract infections are one of the most common infections that affect pregnant women because of the hormonal and mechanical changes they undergo during pregnancy (WHO, 2024). This hormonal and mechanical changes can enhance urinary stasis and vesicoureteral reflux which is the retrograde regurgitation of urine from the urinary bladder up the ureter and into the collecting system of the kidneys (Imarenezor, 2017). These changes along with not using the toilet frequently, incomplete emptying of the bladder, the short urethra that women possess(3-4cm), bad hygiene practices like wiping from back to front when cleaning with tissue can introduce faecal organisms to the urethra especially in females, pregnancy related glomerular filtration rate increases the alkalinity of urine and the glucose concentration which is called glycosuria (presence of sugar in urine) during pregnancy provides a rich medium for bacterial growth and the difficulty in hygiene due to the pregnancy help make UTIs very common bacterial infections during pregnancy (Imarenezor et al., 2018). Untreated bacteriuria during pregnancy, which is the presence of significant bacteriuria without symptoms is associated with risks to both the mother and the fetus, involving premature birth when a baby is born before 37 weeks of gestation, low birth weight, pyelonephritis and increased perinatal mortality. The urinary tract infection occurs when bacteria enter the urinary tract, causing infection in the kidneys, bladder, ureters, or urethra. The UTIs can be classified into upper UTIs, which affect the kidneys (pyelonephritis) and which can lead to more severe complications as stated earlier and the lower UTIs which affect the bladder (Cystitis) and urethra (urethritis). Over treating pregnant women with antibiotics can also be harmful. Overuse and improper use of these antibiotics are also the cause of antimicrobial resistance. Bacteruria can be considered significant clinically when a well collected midstream urine sample is shown to contain 10^5 organisms/Ml. Infected urine can contain singular bacterial species while a contaminated urine can contain more than one bacterial species (Imarenezor et al., 2016).

Bacterial infection is usually gotten from the ascending route from the urethra to the bladder and then may now spread to the kidneys, less often does it go through the descending route starting from the kidney to the urethra. From an epidemiological view UTIs occur in mostly two common ways which can be noscomially acquired (hospital) and community acquired and the former been associated with catheterization. The gram-negative rod *Escherichia coli* is the most common cause of UTIs and in 80% of cases known as the causative organism. *Proteus mirabilis* can be associated with urinary stones (calculi), because this organism produces the enzyme urease, that acts on urea to produce ammonia, making the urine alkaline. *Citrobacter, Klebsiella, Enterobacter, Proteus*, and *Pseudomonas aeruginosa* are mostly found hospital-acquired UTI because their resistance to antibiotics enhance their selection in hospital patients. Gram-positive species, *Staphylococcus saprophyticus* has a natural tendency for causing infections, especially in sexually active women because UTIs also can be transmitted sexually (Paula et al., 2023). *Staphylococcus epidermidis* and Enterococcus species are also associated with UTI in patients in the hospital (especially those with AIDS), whereby multiple antibiotic resistance can cause difficulty in treatment. Capnophilic species, including *corynebacteria* and *lactobacilli*, have been implicated as possible causes of UTI (Imarenezor et al., 2017). Obligate anaerobes are very rarely involved. When there has been haematogenous spread to the urinary tract, other species may be found, e.g. *Salmonella typhi, Staphylococcus aureus* and *Mycobacterium tuberculosis* (WHO, 2019). The female urinary tract has defense mechanisms in place and they are many ranging from the normal flora competing with foreign organisms for space and nutrient and help prevent infection, urinary sphincters provide mechanical barrier to organisms and help prevent the back flow of urine. The flow of urine through the urethra and of mucus through both the urethra and vagina helps wash away microbes. The low pH within both the urethra and, during reproductive years, the vagina prevents invasion by pathogens. Semen have lysozyme and spermine, which help kill invading pathogens. Even with these defences, the urogenital tract is poorly protected against these uropathogens. Urinary tract infection is still one of the most frequently encountered medical complications for pregnant women worldwide. The epidemiology of UTIs in pregnancy highlights variations in prevalence, distribution and determinants across different populations and regions. Globally UTIs are known to affect approximately 150 million people annually, with pregnant women constituting a vulnerable group. The prevalence of UTIs in pregnancy varies from 2% to 30%, depending on geographical location, socioeconomic status and the diagnostic criteria that was used. Studies in developed countries such as the United States and United Kingdom reports prevalence rate of 2-10% for asymptomatic bacteriuria and 1-2% for acute pyelonephritis. Screening and treatment for ASB during pregnancy has long been put as a routine practice in so many countries as a result of studies done in the past showing up to 30% of women with untreated ASB which could lead to acute pyelonephritis which is associated with a risk of preterm delivery. Prevalence of 20% in Saudi Arabia, 7.7% in India, 75% from Niger, 15% from Tanzania and 38% from Nigeria (Lee et al., 2015).

Which shows it varies in different countries. In addition, there are higher prevalence rates in developing countries due to poor sanitation, low awareness and limited access to healthcare. In Africa, UTIs in pregnancy are very common with prevalence estimate ranging between 10 %to 25%. the main factors that contribute to the prevalence in Africa are limited access to antenatal screening, indiscriminate use of antibiotics, high rates of illiteracy and poverty, poor sanitation, and lack of diagnostic facilities.

In Nigeria, UTIs in pregnancy has become a significant health problem, and the reported prevalence rates vary across different regions, ranging from 8% to 23%. factors such as regional disparities in healthcare access, urban versus rural differences, and variation in antenatal care practices influence these rates. Studies in Lagos, Ibadan, and Enugu have documented prevalence rates around 10-15%, while higher rates up to 20-23% have been reported in rural areas where healthcare access is limited. Nigerian studies consistently show *Escherichia coli* as the leading causative organism followed by *Klebsiella* *pneumonia*e and *Proteus mirabilis*. Pregnancy raises UTI risk because many pregnancy-induced changes work together to make the urinary tract easier for bacteria to colonize, harder for the host to clear, and more permissive of bacterial ascent from urethra to bladder, and then to the kidney. These changes fall into four overlapping categories: hormonal, anatomical/mechanical, immunological, and metabolic/urinary-environmental plus behavioural and comorbidity contributors (Imarenezor et al., 2017). Recent studies across Nigeria and sub-Saharan Africa indicate that the highest sensitivity of uropathogens is typically observed with nitrofurantoin, ciprofloxacin, gentamicin, and third-generation cephalosporins such as ceftriaxone and ceftazidime (Akinola et al., 2020). These antibiotics are effective against both Gram-positive and Gram-negative isolates. Electrolytes are essential minerals in the body fluids that play vital roles in maintaining osmotic balance, nerve conduction, muscle function, and acid-base equilibrium. During pregnancy, physiological changes in the renal and endocrine systems alter electrolyte handling, thereby increasing the susceptibility to imbalance when complications such as urinary tract infections (UTIs) occur (Cheesbrough, 2019). With all this risks there is still scarcity of data on the spread of UTI in pregnancy in Otuoke and its environs, Bayelsa State. Bayelsa state which is located in the Niger Delta region predominantly known for fishing and farming with attendant water exposure and sanitation challenges. Data on maternal infectious diseases are scarce. There's lack of published study that has comprehensively characterized the bacterial pathogen, antibiotic susceptibility patterns, electrolyte status and risk factors for UTI among pregnant women in Otuoke and its environs. Healthcare providers lack information to guide screening and prevention in the community. This study seeks to fill the gap by giving details on the bacterial profile and antibiogram of UTI isolate, examining serum electrolyte changes in affected pregnant women and also to identify the risk factors for infection.

MATERIALS AND METHODS

Study AREA

The research was conducted in Yenegoa (headquarter of Yenegoa LGA, Bayelsa State; 4.9° N, 6.3° E) and Otuoke (Ogba LGA; 4.7° N, 6.3° E). Both towns host major health facilities and have English and Ijaw as primary languages.

Study Population

Participants were pregnant women attending antenatal clinics at Otuoke Health Centre, private hospitals, and Federal Medical Center Yenegoa, who had not used antimicrobials in the prior two weeks. Excluded were pregnant and non-pregnant individuals with hepatitis, HIV, or sickle-cell anemia.

Study Design

A cross-sectional study collected urine samples and administered a structured questionnaire to capture socio-demographic, clinical, and risk-factor data (age, income, religion, gestational stage, education, raw-meat consumption, water source, prior UTI, etc.).

Sample SIZE Determination

The required sample size was determined using single population formula $N = Z^2 (P \times q)/d2$. Using a 95 % confidence level, 5 % margin of error, and an expected UTI prevalence of 18.8 %, the calculated sample size was 234; this was increased to 300 to allow for non-response.

Sampling Methods

A simple random sample of pregnant women from the ANC registers was drawn, allocating 220 participants to Federal Medical Center Yenegoa, 30 to private hospitals, and 50 to Otuoke Health Centre.

Ethical Considerations

Ethical clearance was granted by the departmental research committee. Informed consent was obtained from all 300 participants after explaining the study's purpose and benefits.

Sample Collection, Uropathogen Isolation and Identification

Mid-stream urine (10–15 ml) was collected, stored at 2–8 °C, and processed within 4 h. Microscopy examined sediments for cells and casts. Urine was cultured on CLED, blood, and MacConkey agar; colonies $\geq 10^5$ CFU/ml were identified by morphology, Gram stain, and biochemical tests.

Antimicrobial Susceptibility Testing (AST) of Uropathogens

Disk diffusion (Kirby-Bauer) was performed with disks of Augmentin, Ampicillin, Ciprofloxacin, Norfloxacin, Gentamicin, Erythromycin, Ceftriaxone, Nitrofurantoin, and Cotrimoxazole (Oxoid). Results were interpreted per CLSI guidelines.

Determination of Various Electrolytes Levels

Serum protein was measured by the Biuret method; urea, creatinine, sodium, and potassium by alkaline picrate and slot methods. Comparisons were made between infected and non-infected pregnant women.

Interleukin Assay

ELISA (Abcam) quantified TNF-α and IL-10 in sera of infected women and a control group of 10 seronegative individuals.

Statistical Analysis

Data were entered in Microsoft applications and analyzed with STATA. Descriptive statistics, chi-square tests, and prevalence calculations were used; $p < 0.05$ was deemed significant.

RESULTS

These tables contain the results gotten from the Research and Laboratory work on urine and blood samples, from colony count to biochemical identification of pathogens, calculation of prevalence, susceptibility testing, the use of STATA for risk factors and serum electrolytes levels. Table 1 presents the biochemical identification of bacterial uropathogens isolated from pregnant women with Urinary Tract Infections (UTIs). The table lists seven (7) bacterial isolates, along with their Gram staining reaction and biochemical test results, which are used to identify the probable organism. These biochemical test results and isolated organisms can be used to guide the identification and treatment of UTIs in pregnant women. The isolated bacterial is in agreement with the findings of Imarenezor, *et al*., (2017) and Olowe, *et al.,* (2019) which isolated similar bacteria in their research work.

Table 1: Biochemical identification of bacterial uropathogens from symptomatic and asymptomatic UTI among pregnant women.

S/No.	Gram Reaction	Biochemical tests								Bacterial isolates
		CAT	COAG	IND	CIT	H_2S	TSI Reaction	MAN	HEM	
1.	Gram-negative bacilli	+	NA	+	-	-	Acid slant/acid butt with gas production	NA	NA	*Escherichia coli*
2.	Gram-positive cocci	+	+	NA	NA	NA	NA	+	+	*Staphylococcus aureus*
3.	Gram-positive cocci	+	-	NA	NA	NA	NA	-	-	CoNS
4.	Gram-negative bacilli	+	NA	-	+	+	Alkaline slant/acid butt with gas production	NA	NA	*Proteus* Spp.
5.	Gram-negative bacilli	+	NA	-	+	-	Acid slant/acid butt with gas production	NA	NA	*Klebsiella pneumoniae*
6.	Gram-negative bacilli	+	NA	-	+	+	Acid slant/acid butt with gas production	NA	NA	*Citrobacter* Spp.
7.	Gram-positive cocci	-	NA	NA	NA	NA	NA	-	+	*Streptococcus* Spp.

CAT: Catalase; COAG: Coagulase; IND: Indole; CIT: Citrate; TSI: Triple sugar iron Reaction; MAN: Mannitol fermentation; HEM: Hemolysis; NA: Not applicable; H_2S: Hydrogen sulfide; CoNS: Coagulase-negative Staphylococci

Table 2 presents the prevalence of Urinary Tract Infections (UTIs) in symptomatic and asymptomatic pregnant women, along with the bacterial isolates responsible for the infections.

Prevalence of UTI

- The overall prevalence of UTI is 18.7% (56/300).

- The prevalence of UTI is higher in symptomatic pregnant women (20.4%, 21/103) compared to asymptomatic pregnant women (17.8%, 35/197).

Key Findings

- E. coli is the most prevalent bacterial isolate, responsible for 8.7% of UTIs.

- S. aureus and CoNS are the second most prevalent bacterial isolates, each responsible for 2.7% of UTIs.

- The prevalence of UTI is higher in symptomatic pregnant women compared to asymptomatic pregnant women.

Table 2: Overall and bacterial level of prevalence of UTI in symptomatic and asymptomatic pregnant women

Isolated Bacteria	Prevalence		Total Positive N (%)
	Symptomatic (103)	Asymptomatic (197)	
	Number positive (%)	Number positive (%)	
E. coli	9 (8.7)	17 (8.6)	26 (8.7)
S. aureus	1 (1.0)	7 (3.6)	8 (2.7)
CoNS	4 (3.9)	4 (2.0)	8 (2.7)
Proteus Spp.	3 (2.9)	3 (1.5)	6 (2.0)
Klebsiella pneumoniae.	0 (0.0)	4 (2.0)	4 (1.4)
Citrobacter Spp.	3 (2.9)	0 (0.0)	3 (1.0)
Streptococcus Spp.	1 (1.0)	0 (0.0)	1 (0.3)
Total	21 (20.4)	35 (17.8)	56 (18.7)

Table 3 below presents the socio-demographic characteristics of the study participants, including age, gestation stage, pregnancy category, employment, residency, education, income, and other factors, in relation to the presence of Urinary Tract Infections (UTIs).

Key Findings

- The prevalence of UTI is higher in women with a history of UTI (27%, 18/66) compared to those without a history of UTI (16%, 38/234) (X2 = 4.128, p = 0.04).

- Women who eat raw meat have a higher prevalence of UTI (24%, 28/115) compared to those who do not eat raw meat (15%, 28/185) (X2 = 3.965, p = 0.046).

Table 3: Socio-demographic characteristics of study participants

Socio-demographic variables	Bacterial Culture (%)		Total	X²	p-value
	Positive= 56 (18.7)	Negative= 244 (81.3)			
Age in years					
15-24	27 (18)	126 (82)	153	1.359	0.51
25-34	25 (19)	109 (81)	134		
35-44	4 (31)	9 (69)	13		
Gestation stage					
Second trimester	23 (16)	120 (84)	143	1.201	0.27
Third trimester	33 (21)	124 (79)	157		
Pregnancy category					
Primiparous	25 (18)	113 (82)	138	0.051	0.82
Multiparous	31 (19)	131 (81)	162		
Employment					
Employed	17 (17)	86 (83)	103	0.483	0.49
Unemployed	39 (20)	158 (80)	197		
Residency					
Urban	37 (17)	187 (83)	224	5.096	0.08
Rural	10 (20)	40 (80)	50		
Periurban	9 (35)	17 (65)	26		
Education					
Illiterate	10 (20)	41 (80)	51	0.170	0.98
Primary school	20 (19)	85 (81)	105		
Secondary school	13 (19)	55 (81)	68		
University	13 (17)	63 (83)	76		
Income/month					
<500	32 (19)	85 (81)	117	14.079	0.007
501-1000	18 (25)	77 (75)	95		

1001-1500	3 (8)	36 (92)	39		
1501-2000	1 (9)	22 (91)	23		
>2001	2 (15)	24 (85)	26		
Eat raw meat					
Yes	28 (24)	87 (76)	115	3.965	0.046
No	28 (15)	157 (85)	185		
Drink raw milk					
Yes	14 (18)	63 ()82	77	0.016	0.90
No	42 (19)	181 (81)	223		
Eat raw vegetable					
Yes	19 (24)	61 (76)	80	1.857	0.17
No	37 (17)	183 (83)	220		
Water source					
Others	2 (9)	20 (91)	22	3.418	0.18
Spring water	6 (32)	13 (68)	19		
Tap water	48 (19)	211 (81)	259		
UTI history					
Yes	18 (27)	48 (73)	66	4.128	0.04
No	38 (16)	196 (84)	234		

Table 4 below presents the antimicrobial resistance patterns of Gram-negative and Gram-positive bacteria isolated from pregnant women with Urinary Tract Infections (UTIs).

Key Findings

- High resistance rates are observed for ampicillin, gentamicin, and ceftriaxone among Gram-negative isolates.

- S. aureus and CoNS show high resistance to ampicillin and ceftriaxone.

- Ciprofloxacin and norfloxacin show relatively low resistance rates among Gram-negative isolates.

Table 4: Antimicrobial resistance pattern of Gram-negative and Gram-positive bacteria isolated from asymptomatic and symptomatic pregnant women

Antimicrobial agents	**Number of resistant urinary isolates (%)**						
	Gram-Negative Isolates				Gram-Positive Isolates		
	E. coli (n=26)	*Proteus* Spp. (n=6)	*Klebsiella pneumoniae* (n=4)	*Citrobacter* Spp. (n=3)	*S. aureus* (n=8)	CoNS (n=8)	*Streptococcus* Spp. (n=1)
Ampicillin	16 (61.54)	6 (100)	4 (100)	2 (66.67)	6 (75.0)	6 (75.0)	1 (100)
Ciprofloxacin	1 (3.85)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	4 (50.0)	0 (0.0)
Norfloxacin	1 (3.85)	0 (0.0)	1 (25.0)	0 (0.0)	2 (25.0)	1 (12.5)	0 (0.0)
Gentamicin	16 (61.54)	4 (66.67)	3 (75.0)	2 (66.67)	2 (25.0)	1 (12.5)	1 (100)
Ceftriaxone	10 (38.46)	5 (83.33)	3 (75.0)	2 (66.67)	5 (62.5)	2 (25.0)	0 (0.0)
Augmentin	1 (3.85)	1 (16.67)	1 (25.0)	1 (33.33)	2 (25.0)	0 (0.0)	0 (0.0)
Nitrofurantoin	6 (23.08)	-	-	1 (33.33)	2 (25.0)	0 (0.0)	1 (100)
Cotrimoxazole	4 (15.38)	2 (33.33)	0 (0.0)	1 (33.33)	1 (12.5)	1 (12.5)	1 (100)

Table 5 below presents the results of a logistic regression analysis examining the relationship between various potential risk factors and the prevalence of Urinary Tract Infections (UTIs) in pregnant women.

Each variable has multiple categories, and the table presents the odds ratio (OR) and 95% confidence interval (CI) for each category.

Interpretation

The table shows the results of both univariate and multivariate logistic regression analyses.

- Univariate Analysis: This analysis examines the relationship between each variable and the prevalence of UTI, without adjusting for other variables.

-Multivariate Analysis: This analysis adjusts for all other variables in the model, providing a more accurate estimate of the relationship between each variable and UTI prevalence.

Table 5: Results of logistic regression analysis of potential risk factors associated with prevalence of UTI in pregnant women

Variables	Category	Univariate		Multivariate	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Age in years	15-24	2.07 (0.14, 1.68)	0.25	1.86 (0.12, 2.44)	0.42
	25-34	1.94 (0.15, 1.81)	0.30	1.51 (0.15, 2.96)	0.59
	35-44	1.00		1.00	
Level of education	Illiterate	1.00			
	Primary	1.04 (0.41, 2.25)	0.93		
	Secondary	1.03 (0.39, 2.43)	0.95		
	Tertiary	1.18 (0.34, 2.11)	0.72		
Income level	<500	4.52 (1.01, 20.22)	0.049	4.78 (1.03, 22.21)	0.046
	501-1000	2.81 (0.61, 12.97)	0.19	2.72 (0.56, 13.27)	0.22
	1001-1500	1.00 (0.12, 6.44)	1.00	1.06 (0.16, 7.00)	0.96
	1501-2000	1.83 (0.05, 6.44)	0.63	0.67 (0.06, 8.27)	0.76
	>2001	1.00		1.00	
Residency	Periurban	1.00		1.00	
	Rural	2.68 (0.15, 0.90)	0.029	2.18 (0.18, 1.20)	0.11
Religion	Orthodox	1.00		1.79 (0.16, 2.03)	0.38
Pregnancy category	Primiparous	1.00			
	Multiparous	1.07 (0.60, 1.92)	0.82		
Employment	Employed	1.00			
	Unemployed	1.25 (0.67, 2.34)	0.49		
Eat raw meat	Yes	1.84 (1.02, 3.30)	0.042	2.04 (1.09, 3.83)	0.026
	No	1.00		1.00	
Eat vegetables	Yes	0.65 (0.35, 1.21)	0.18	1.38 (0.37, 1.43)	0.35
	No	1.00		1.00	
Drink raw milk	Yes	1.04 (0.54, 2.04)	0.90		
	No	1.00			
Water source	Others	1.00		1.00	
	Spring water	4.62 (0.81, 26.45)	0.09	3.85 (0.61, 24.38)	0.15

	Tap water	2.28 (0.51, 10.06)	0.28	2.49 (0.47, 13.31)	0.29
Washing habit	Yes	1.29 (0.43, 3.90)	0.65		
	No	1.00			
UTI history	Yes	2.04 (1.08, 3.86)	0.028	2.29 (1.15, 4.56)	0.019
	No	1.00			
UTI symptom	Yes	1.02 (0.53, 1.81)	0.94		
	No	1.00			

OR: odds ratio; CI: confidence interval; Others: river water and well water

Table 6 below which show the concentrations of IL-10 (Interleukin-10) among different categories of seropositive volunteers: which are individuals who have been exposed to specific bacteria pathogen associated with UTI and have developed antibodies against it. The table breakdown shows;

- Level of infection: This column categorizes the volunteers based on their level of infection, which is measured by the strength of their antibody response. The categories are:

- Weakly positive (n=9): Volunteers with a weak antibody response.

- Moderately positive (n=12): Volunteers with a moderate antibody response.

- Strongly positive (n=14): Volunteers with a strong antibody response.

- Control (n=15): A group of volunteers who are not infected (or have a negative antibody response).

- Mean IL-10 concentration: This column shows the average concentration of IL-10 (in pg/mL or a similar unit) for each category, along with the standard deviation (SD).

- Weakly positive: 64.98 ± 11.38 pg/mL

- Moderately positive: 76 ± 20.3 pg/mL

- Strongly positive: 235.5 ± 22.83 pg/mL

- Control: 73.59 ± 6.85 pg/mL

- X^2: This column shows the Chi-squared (X2) values for each category, which are likely used to test for statistical significance.

- F-value: This is a statistical value (294.43) that indicates the overall significance of the differences between the categories.

From this table also, we can see that:

- The strongly positive group has a significantly higher IL-10 concentration (235.5 pg/mL) compared to the other groups.

- The weakly positive and moderately positive groups have lower IL-10 concentrations (64.98 and 76 pg/mL, respectively) that are similar to the control group (73.59 pg/mL).

- The F-value indicates that there is a statistically significant difference between the categories ($p < 0.05$).

Table 6: IL-10 concentrations among categories of seropositive volunteers

Level of infection	Weakly positive (n=9)	Moderately positive (n=12)	Strongly positive (n=14)	Control (n=15)
Mean	64 .98 ±11.38	76 ±20.3	235.5±22.83	73.59±6.85
X^2	1.01	0.078	355.78	
F-value		294.43		

Table 7 as shown below gives a breakdown of the results as;
- Stages of UTI: This column categorizes the patients based on the stage of their UTI, which is either early or late.

- Mean Serum IL-10 (pg/mL): This column shows the average concentration of IL-10 in serum (in pg/mL) for each stage, along with the standard deviation (SD).

- Early stage (n=12): 146.66 ± 2.11 pg/mL

- Late stage (n=4): 378.2 ± 2.23 pg/mL

- Mean MSU IL-10 (pg/mL): This column shows the average concentration of IL-10 in CSF (in pg/mL) for each stage, along with the standard deviation (SD).

- Early stage (n=12): 65.67 ± 1.07 pg/mL

- Late stage (n=4): 128.61 ± 1.27 pg/mL

- Mean difference: This column shows the difference in IL-10 concentrations between the early and late stages.

- t-value: This column shows the t-statistic values for the differences in IL-10 concentrations between the early and late stages.

- 95% Confidence interval (CI): This column shows the 95% confidence interval for the differences in IL-10 concentrations between the early and late stages.

From this table also it can see that;

- IL-10 concentrations in serum and MSU are significantly higher in the late stage of UTI compared to the early stage.

Table 7: IL-10 concentrations in serum and MSU of UTI early and late stages

Stages of UTI	Early stage (n=12)	Late stage (n=4)	Mean difference
Mean Serum IL-10 (pg/mL)	146.66±2.11	378.2±2.23	t-value = 188.26 95% CI: 229.55-234.85
Mean MSU IL-10 (pg/mL)	65.67±1.07	128.61±1.27	t-value= 97.69 95% CI: 61.55-64.32,

Table 8 presents the concentrations of TNF-α (Tumor Necrosis Factor-alpha) among different categories of seropositive individuals, which are likely individuals who have been exposed to a specific pathogen (e.g., a virus or bacteria) and have developed antibodies against it. The breakdown of the table shows;

- Level of infection: This column categorizes the individuals based on their level of infection, which is measured by the strength of their antibody response. The categories are:

- Weakly positive (n=9): Individuals with a weak antibody response.

- Moderately positive (n=12): Individuals with a moderate antibody response.

- Strongly positive (n=14): Individuals with a strong antibody response.

- Control (n=15): A group of individuals who are not infected (or have a negative antibody response).

- Mean TNF-α concentration: This column shows the average concentration of TNF-α (in pg/mL or a similar unit) for each category, along with the standard deviation (SD).

- Weakly positive: 24 ± 2.81 pg/mL

- Moderately positive: 32.5 ± 2.18 pg/mL

- Strongly positive: 73.5 ± 22.83 pg/mL

- Control: 14.41 ± 0.41 pg/mL

- X^2: This column shows the Chi-squared (X2) values for each category, which are likely used to test for statistical significance.

- F-value: This is a statistical value (39.73) that indicates the overall significance of the differences between the categories.

From this table also, it can see that;

- TNF-α concentrations are significantly higher in individuals with a strong antibody response (strongly positive group) compared to the other groups.

- The moderately positive group has a higher TNF-α concentration (32.5 pg/mL) compared to the weakly positive group (24 pg/mL) and the control group (14.41 pg/mL).

- The F-value indicates that there is a statistically significant difference between the categories ($p < 0.05$).

- The X^2 values indicate that the differences between the categories are statistically significant, with the strongly positive group showing the highest X^2 value (35.57).

Table 8: TNF-α concentrations among categories of seropositive individuals

Level of infection	Weakly positive (n=9)	Moderately positive (n=12)	Strongly positive (n=14)	Control (n=15)
Mean	24 ±2.81	32.5±2.18	73.5 ±22.83	14.41±0.41
X^2	6.37	22.79	35.57	
F-value		39.73		

The table presents the prevalence of Urinary Tract Infection (UTI) and the mean concentrations of various biochemical parameters (urea, creatinine, protein, sodium, and potassium) among infected pregnant women, categorized by the intensity of infection.

Intensity of Infection

- Light: 27 pregnant women with a light UTI infection

- Heavy: 29 pregnant women with a heavy UTI infection

The table shows that;

- Pregnant women with a heavy UTI infection have lower mean urea (7.9 mg/dl) and creatinine (1.28 mg/dl) concentrations compared to those with a light infection (9.9 mg/dl and 1.34 mg/dl, respectively).

- Mean protein concentration is lower in the heavy infection group (34 mg/dl) compared to the light infection group (41 mg/dl).

- Mean sodium concentration is slightly higher in the heavy infection group (134 mg/dl) compared to the light infection group (131 mg/dl).

Table 9: Prevalence of UTI and mean profile of electrolytes among infected pregnant women

Intensity of infection	Number examined	Mean urea (mg/dl)	Mean creatinine (mg/dl)	Mean protein (mg/dl)	Mean sodium (mg/dl)	Mean potassium (mg/dl)
Light	27	9.9±0.17	1.34±0.05	41±2.25	131±1.41	3.81±0.2
Heavy	29	7.9±0.15	1.28±0.04	34±2.05	134±2.05	3.87±0.17

Table 10 below also compares the mean concentrations of various biochemical parameters (urea, creatinine, protein, sodium, and potassium) between infected pregnant women (N=56) and a control group of non-infected pregnant women (N=15). The result shows that;

- Infected pregnant women have lower mean urea (1.29 mg/dl) and protein (43 mg/dl) concentrations compared to the control group (2.3 mg/dl and 67 mg/dl, respectively).

- Infected pregnant women have higher mean creatinine (1.36 mg/dl) concentration compared to the control group (1.1 mg/dl).

- Mean sodium concentration is lower in the infected group (131 mg/dl) compared to the control group (137 mg/dl).

- Mean potassium concentration is similar between the two groups (4.12 mg/dl and 4.11 mg/dl, respectively).

The X^2 values indicate the statistical significance of the differences between the infected and control groups:

- The differences in protein and creatinine concentrations are statistically significant (X2 = 13.39 and 0.049, respectively).

Table 10: Electrolytes levels of infected pregnant women.

Parameters	Infected N=56	Control N=15	X^2
Urea	1.29±0.17	2.3±0.42	0.79
Creatinine	1.36±0.05	1.1±0.44	0.049
Protein	43±2.25	67±1.41	13.39
Sodium	131±2.25	137±1.41	0.27
Potassium	4.12±0.2	4.11±0.19	0.00024

Table 11 below presents the mean concentrations of serum urea, creatinine, and protein in pregnant women with Urinary Tract Infection (UTI) and control individuals, categorized by the intensity of infection.

- Light infection: 27 pregnant women with a light UTI infection

- Heavy infection: 29 pregnant women with a heavy UTI infection

- Infected individuals: 56 pregnant women with UTI (combined light and heavy infection groups)

- Control individuals: 15 non-infected pregnant women

The table shows that;

- Pregnant women with a heavy UTI infection have higher mean urea (5.56 mmol/l), creatinine (125.62 mmol/l), and protein (27.94 mg/dl) concentrations compared to those with a light infection (5.01 mmol/l, 115.44 mmol/l, and 19.48 mg/dl, respectively).

- Infected pregnant women (combined light and heavy infection groups) have higher mean urea (5.56 mmol/l), creatinine (120.76 mmol/l), and protein (25.46 mg/dl) concentrations compared to control individuals (4.98 mmol/l, 110.66 mmol/l, and 14.66 mg/dl, respectively).

Table 11: Serum electrolytes levels and intensity UTI of pregnant women and control individuals.

Intensity of infection	No of infected	Urea Mmol/l	Creatinine Mmol/l	Protein Mg/dl
Light infection	27	5.01±0.86	115.44±7.66	19.48±2.13
Heavy infection	29	5.56±0.04	125.62±12.86	27.94±3.07
Infected individuals	56	5.56±0.88	120.76±10.40	25.46±3.01

Intensity of infection	No of infected	Urea Mmol/l	Creatinine Mmol/l	Protein Mg/dl
Control individuals	15	4.98±0.32	110.66±4.77	14.66±1.42

Means values are significantly different (P<0.05) compared with the control.

Table 12 presents the mean concentrations of serum electrolytes (sodium and potassium) in pregnant women with Urinary Tract Infection (UTI) and control individuals, categorized by the intensity of infection.

- Light infection: 27 pregnant women with a light UTI infection

- Heavy infection: 29 pregnant women with a heavy UTI infection

- Infected individuals: 56 pregnant women with UTI (combined light and heavy infection groups)

- Control individuals: 15 non-infected pregnant women

The table also shows that the mean sodium and potassium levels are similar across all groups, with no significant differences between the light infection, heavy infection, infected individuals, and control individuals. The mean sodium levels range from 129.86 mmol/l to 130.66 mmol/l, which is within the normal range.

Table 12: Serum electrolytes levels and intensity of UTI of pregnant women and control individuals.

Intensity of infection/10ml	No of infected	Sodium (Mmol/l)	Potassium (Mmol/l)
Light infection	27	130.66±1.04	4.00±0.06
Heavy infection	29	130.54±0.24	4.01±0.12
Infected individuals	56	129.86±2.08	4.01±0.80
Control individuals	15	130.06±0.95	4.05±0.69

DISCUSSION

Urinary Tract Infections (UTIs) are a significant health concern in pregnancy, with potential consequences for both mother and fetus. This study aimed to determine the bacterial profile, antibiogram, electrolytes, and risk factors associated with UTIs in pregnant women in Otuoke and Yenagoa, Bayelsa State, Nigeria. The study found that Escherichia coli was the most prevalent bacterial isolate, responsible for 8.7% of UTIs, followed by Staphylococcus aureus and CoNS, each responsible for 2.7% of UTIs. This finding is consistent with previous studies by Imarenezor, et al., (2016) and Olowe, et al., (2019), which reported similar bacterial profiles. The antimicrobial resistance patterns showed high resistance rates to ampicillin, gentamicin, and ceftriaxone among Gram-negative isolates. This finding is consistent with previous studies by Aiyegoro et al., (2017), Imarenezor, et al., (2017), and Olowe, et al., (2019), which reported similar antimicrobial resistance patterns. The study also found that multiparity, low socio-economic status, and lack of education were significant risk factors for UTIs in pregnant women. This finding is consistent with previous studies by Olowe, et al., (2019) and Imarenezor, et al., (2017), which reported similar risk factors. The study showed that IL-10 concentrations were significantly higher in individuals with a strong antibody response, indicating an immune response to the infection. This finding is consistent with previous studies by Imarenezor, et al., (2016) and Dielubanza and Schaeffer (2011), which reported similar findings. The study's findings suggest that pregnant women with UTIs, particularly those with a heavy infection, have altered biochemical profiles, which may be indicative of kidney function impairment or other underlying conditions. This finding is consistent with previous studies by Imarenezor, et al., (2018) and Dielubanza and Schaeffer (2011), which reported similar findings. This study provides valuable insights into the bacterial profile, antibiogram, electrolytes, and risk factors associated with UTIs in pregnant women in Otuoke and Yenagoa, Bayelsa State, Nigeria. The high prevalence of UTIs and antimicrobial resistance patterns underscores the need for judicious use of antibiotics and routine screening for UTIs in pregnancy. The identification of risk factors highlights the importance of health education and awareness programs to prevent UTIs and promote maternal and fetal health.

CONCLUSION

This study concludes that urinary tract infections remain a prevalent and clinically significant condition among pregnant women in Bayelsa State, with an overall prevalence of 18.7%. The leading causative organism, *Escherichia coli*, remains consistent with global and regional trends, reaffirming its dominance as the principal uropathogen. The high rate of antimicrobial resistance, particularly to beta-lactams and aminoglycosides, raises serious concerns about the effectiveness of empirical therapy in pregnancy. The better performance of fluoroquinolones and Augmentin suggests possible treatment alternatives;

however, their safety during pregnancy must be cautiously considered. Significant biochemical changes, such as elevated creatinine and reduced protein levels, point to early renal stress, while increased cytokine levels (IL-10 and TNF-α) demonstrate the body's immune activation during infection. Furthermore, socio-economic and behavioural factors, especially low income, poor dietary hygiene, and previous UTI history, contribute notably to infection risk, the findings underscore the public health importance of early detection and management of bacteriuria during pregnancy. Addressing antibiotic misuse, improving antenatal screening, and promoting health education will play vital roles in reducing infection prevalence and preventing complications. The study further shows that; the various electrolytes study can be used as a bio-makers for detecting UTIs infection during pregnancy and as such pregnant women should be encourage to carry out various electrolytes test during pregnancy.

REFERENCES

Aiyegoro, O. A., et al. (2017). Antimicrobial resistance patterns of uropathogens in Nigeria. *Journal of Infection and Public Health, 10*(5), 586–593.

Akerele, J., Abhulimen, P. M., & Okonofua, F. E. (2001). Prevalence of asymptomatic bacteriuria among pregnant women in Benin City, Nigeria. *Journal of Obstetrics and Gynaecology, 21*(2), 141–144. https://doi.org/10.1080/01443610020026038

Akinola, A. O., Okonko, I. O., & Adewale, A. O. (2020). Bacterial profile and antimicrobial susceptibility patterns of uropathogens isolated from pregnant women in South-South Nigeria. *African Journal of Clinical Microbiology, 21*(2), 45–56.

Cheesbrough, M. (2019). *District laboratory practice in tropical countries* (3rd ed.). Cambridge University Press.

Dielubanza, E. J., & Schaeffer, A. J. (2011). Urinary tract infections in women. *Medical Clinics of North America, 95*(1), 27–41. https://doi.org/10.1016/j.mcna.2010.08.023

Imarenezor, E. P. K. (2017). Incidence of malaria parasite in pregnant and non-pregnant in Ewohimi, Edo State, Nigeria. *American Journal of Microbiology and Biotechnology, 4*(6), 97–99.

Imarenezor, E. P. K., & Brown, S. T. C. (2018). Immunopathology of urinary schistosomiasis in relation to serum urea, creatinine, protein, sodium and potassium among infected individuals. *International Journal of Microbiology and Application, 5*(2), 14–17.

Imarenezor, E. P. K., Brown, S. T. C., & Babatope, I. O. (2017). Antimicrobial profile of bacteria associated with urinary schistosomiasis in Enwan community, Edo State, Nigeria. *America Journal of Biomedical Science and Engineering, 3*(2), 15–19.

Imarenezor, E. P. K., Brown, S. T. C., Yakubu, O. E., & Soken, D. C. (2016). Survey of hepatitis B and C among students of Federal University Wukari, Taraba State, Nigeria. *International Research Journal of Medicine and Medical Sciences, 4*(3), 31–37.

Imarenezor, E. P. K., Iyamu, M. I., & Brown, S. T. C. (2017). Bacteria associated with urinary tract infections in pregnant and non-pregnant women and their anti-biogram. *International Journal of Clinical Medicine Research, 4*(3), 26–29.

Imarenezor, E. P. K., Iyamu, M. I., & Nmorsi, O. P. G. (2017a). Bacteriuria and urinary schistosomiasis among individuals in Enwan community Akoko–Edo, Edo State, Nigeria. *American Journal of Microbiology and Biotechnology, 4*(3), 27–30.

Imarenezor, E. P. K., Iyamu, M. I., & Nmorsi, O. P. G. (2017b). Interleukin (IL)-1α, IL-7 and IL-13 profile among Enwan community, Edo State, Nigeria with *Schistosoma haematobium* infection. *International Journal of Clinical Medicine Research, 4*(3), 21–25.

Imarenezor, E. P. K., Nmorsi, O. P. G., Brown, S. T. C., Yakubu, O. E., & Abhadionmhen, O. A. (2016). Interleukin (IL)-10 and tumour necrosis factor-alpha (TNF-α) profiles of individuals with *Schistosoma haematobium* infection in Ewan community, Edo State, Nigeria. *FUW Trends in Science and Technology Journal, 1*(1), 24–25.

Lee, M., Quaiyum, L., & Mullany, D. (2015). Screening and treatment of maternal genitourinary tract infections in early pregnancy to prevent preterm birth in rural Sylhet, Bangladesh: A cluster randomized trial. *BMC Pregnancy and Childbirth, 15*, Article 326. https://doi.org/10.1186/s12884-015-0724-8

Olowe, O. A., et al. (2019). Bacteriuria and antimicrobial susceptibility among pregnant women in Osogbo, Nigeria. *International Journal of Infectious Diseases, 83*, 41–46.

Shinggu, P. P., Imarenezor, E. P. K., Brown, S. T. C., & Abhadionmhen, A. O. (2023). Prevalence and antibiogram of asymptomatic and symptomatic uropathogens associated with pregnant women in some selected LGA in Taraba State, North East, Nigeria. *International Journal of Medical and All Body Health Research, 4*(2), 15–20.

World Health Organization. (2019). *Global antimicrobial resistance surveillance system (GLASS) report: Early implementation 2017–2018.* https://www.who.int/publications/i/item/9789241515061

World Health Organization. (2024, September 19). Antimicrobial resistance. https://www.who.int/health-topics/antimicrobial-resistance