High Prevalence of Multidrug-Resistant *Klebsiella* spp. and *Staphylococcus aureus* Among Pregnant Women with Urinary Tract Infections in Maiduguri, Nigeria

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Abstract: Urinary tract infections (UTIs) represent a major clinical concern during pregnancy, posing substantial risks to maternal and fetal health, including preterm delivery and renal complications. This study was conducted at the antenatal clinic of the University of Maiduguri Teaching Hospital (UMTH) with the primary objectives of determining the prevalence of bacterial uropathogens, elucidating their antibiotic susceptibility profiles, and identifying associated risk factors among pregnant women.

A cross-sectional study design was employed, enrolling fifty pregnant women. Clean-catch mid-stream urine samples were collected and processed using standard microbiological culture techniques on cysteine-lactose-electrolyte-deficient (CLED) and MacConkey agar. Bacterial isolates were identified via colonial morphology, Gram staining, and biochemical tests. The Kirby-Bauer disc diffusion method was used for antibiotic susceptibility testing against a panel of commonly prescribed antimicrobials. Demographic and clinical data were obtained through structured questionnaires to assess risk factors.

Laboratory analysis identified *Klebsiella* species as the predominant isolate, followed by *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas* species. Antibiotic susceptibility testing revealed alarming resistance patterns among the Enterobacteriaceae. *Escherichia coli* and *Klebsiella* spp. exhibited high resistance rates to ampicillin, cefotaxime, and ciprofloxacin. In contrast, carbapenems (imipenem and meropenem) demonstrated excellent efficacy against all Gram-negative isolates. Statistical analysis of risk factors identified poor perineal hygiene, a history of recurrent UTIs, and frequent urinary catheterization as significant contributors. Furthermore, advanced maternal age (over 30 years) and the presence of comorbidities like diabetes mellitus and hypertension were associated with a higher incidence of infection.

These findings underscore the critical need for routine screening and culture-guided antimicrobial therapy for pregnant women presenting with UTI symptoms. The high prevalence of multidrug-resistant pathogens highlights a pressing public health issue, necessitating robust antibiotic stewardship programs within antenatal care. Preventive strategies should integrate patient education on hygiene, judicious use of urinary catheters, and enhanced management of underlying conditions. Future research focused on longitudinal surveillance of resistance trends and exploring alternative therapeutic agents is essential to mitigate the impact of antimicrobial resistance in this vulnerable population.

Keywords: *Urinary Tract Infection (UTI), Pregnant Women, Antibiotic Susceptibility, Antimicrobial Resistance (AMR), Klebsiella species, Staphylococcus aureus, Nigeria, University of Maiduguri Teaching Hospital (UMTH).*

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I. INTRODUCTION

➢ *Background of the Study*

The urinary tract, comprising the kidneys, ureters, bladder, and urethra, is responsible for the production, storage, and elimination of urine (Ezeugoigwe et al., 2018). Infection of this system, known as a urinary tract infection (UTI), is a common clinical condition caused by the invasion and multiplication of pathogens, predominantly bacteria, though fungi and viruses can also be implicated (Amdekar et al., 2011). Gram-negative bacteria, especially *Escherichia coli*, are the most frequent etiological agents, accounting for 65% to 90% of all community-acquired cases (Gupta et al., 2001; Weekes, 2015).

UTIs present along a spectrum from asymptomatic bacteriuria (ASB) defined as significant bacterial colonization without overt symptoms to symptomatic infections. Symptomatic UTIs are categorized as lower tract infections (acute cystitis) or more severe upper tract infections (acute pyelonephritis) (Schnarr and Smaill, 2008). During pregnancy, UTIs constitute a major public health concern, particularly in developing nations (Dimetry et al., 2007). Physiological changes, including ureteral dilation, increased bladder volume, decreased ureteral tone, and glucosuria, predispose pregnant women to urinary stasis and ascent of pathogens (Emamghorashi et al., 2012). These factors elevate the risk of both ASB and symptomatic infection, which are associated with serious maternal and fetal complications such as pyelonephritis, anemia, preterm labor, low birth weight, and increased perinatal mortality (McDermott, 2000; Cunningham et al., 2005).

The effective management of UTIs is increasingly challenged by the global rise of antimicrobial resistance (AMR). In many regions, factors such as the availability of antibiotics without prescription, poor public literacy on drug use, and the circulation of substandard medicines contribute to inappropriate antibiotic use and the selection of resistant strains (Manikandan, 2011; Fagan, 2015). This underscores the critical need for local and current data on the prevalence of uropathogens and their antibiotic susceptibility profiles to inform empirical treatment guidelines and stewardship efforts.

➢ *Statement of the Problem*

Urinary tract infections are highly prevalent among pregnant women due to well-documented anatomical and hormonal changes. If undiagnosed or improperly managed, these infections can lead to severe obstetric complications. A primary challenge in their effective treatment is the escalating and often unpredictable pattern of antibiotic resistance among common uropathogens like *Escherichia coli* and *Klebsiella pneumoniae*. Selecting an antibiotic that is both effective against the causative bacterium and safe for the mother and fetus is therefore a critical clinical decision.

Currently, there is a paucity of specific, contemporary data on the prevalence of bacterial pathogens causing UTIs and their antimicrobial susceptibility patterns among pregnant women attending the antenatal clinic at the University of Maiduguri Teaching Hospital (UMTH). This gap hampers the ability of healthcare providers to make evidence-based decisions for empirical therapy. Consequently, there is an urgent need for comprehensive microbiological surveillance to identify the predominant pathogens, characterize their resistance profiles, and assess associated risk factors within this specific population to optimize clinical outcomes and guide public health intervention.

➢ *Objectives of the Study*

The general objective of this study is to investigate bacterial urinary tract infections among pregnant women at UMTH. The specific objectives are to:

- Determine the prevalence of bacteria associated with UTIs among pregnant women attending the antenatal clinic at UMTH.
- Evaluate the antibiotic susceptibility patterns of the isolated bacterial pathogens.
- Assess the demographic and clinical risk factors associated with UTIs in the study population.

➢ *Research Questions*

This study seeks to answer the following questions:

- What is the prevalence of significant bacteriuria and the distribution of bacterial pathogens among pregnant women attending the antenatal clinic at UMTH?
- What are the antimicrobial susceptibility and resistance patterns of the isolated uropathogens to commonly used antibiotics?
- What are the potential risk factors (e.g., age, parity, hygiene practices, medical history) associated with UTIs in these pregnant women?

➢ *Significance of the Study*

The findings of this study will provide crucial, up-to-date epidemiological data that can directly inform clinical practice at UMTH. By identifying the common causative agents and their resistance patterns, the results will guide healthcare providers in selecting appropriate empirical antibiotics, thereby improving treatment efficacy and safety. Furthermore, the data will contribute to the hospital's antibiotic stewardship program and serve as a baseline for monitoring future trends in antimicrobial resistance. Identifying modifiable risk factors will also aid in developing targeted preventive health education for pregnant women, potentially reducing the incidence of UTIs and their associated complications.

➢ *Scope of the Study*

This study is focused on pregnant women attending the antenatal clinic at the University of Maiduguri Teaching Hospital (UMTH). It involves the collection and microbiological analysis of urine samples from consenting participants to isolate and identify bacterial pathogens and determine their antibiotic susceptibility profiles. The study also involves the collection of relevant demographic (e.g., age, parity) and clinical data (e.g., gestational age, history of

UTI, symptoms) to assess associated risk factors. The study is delimited to bacterial pathogens and does not cover fungal or viral agents. The findings are intended to reflect the local context at UMTH within the study period.

II. LITERATURE REVIEW

➤ *Theoretical Framework*

This study is guided by a foundational model in infection management: the Chain of Infection and Antimicrobial Stewardship Model. This integrated framework posits that the occurrence and outcome of an infection result from a sequence of interconnected factors (the "chain") and that disrupting this chain is central to control. Simultaneously, it emphasizes that the therapeutic response must be informed by local pathogen susceptibility to preserve antibiotic efficacy.

- *The Framework Comprises Two Core Components:*

✓ The Chain of Infection: This explains the transmission and establishment of UTIs.

- Infectious Agent: The uropathogen (e.g., *E. coli*, *Klebsiella* spp.).
- Reservoir: The source of the pathogen (e.g., gastrointestinal flora).
- Portal of Exit: How the pathogen leaves the reservoir (e.g., fecal contamination).
- Mode of Transmission: The route to a new host (e.g., improper perineal hygiene).
- Portal of Entry: How it enters the host (e.g., the urethra).
- Susceptible Host: The individual at risk, influenced by risk factors (e.g., pregnancy-induced physiological changes, diabetes, prior UTI history) that increase susceptibility.

✓ Antimicrobial Stewardship: This component addresses the response, stressing that effective treatment relies on surveillance data regarding local bacterial isolates and their antibiotic susceptibility patterns. This knowledge directly informs the choice of therapy to optimize clinical outcomes (reduced morbidity, prevention of preterm birth) and curb antimicrobial resistance.

By applying this framework, this study systematically investigates the key links in Maiduguri: the prevalent infectious agents (Objectives i & ii), the specific risk factors creating a susceptible host (Objective iii), and the susceptibility data needed for evidence-based intervention.

➤ *Prevalence of Bacteria Associated with UTIs Among Pregnant Women*

Urinary tract infections are a major global antenatal health concern, with prevalence varying significantly by region and population. Local data is crucial for contextualizing the burden of disease. In a Nigerian setting closely aligned with the present study, Abdullahi, Shaibu, and Yakubu (2021) investigated pregnant women at Ahmadu Bello University Teaching Hospital, Zaria. They reported a high prevalence of 64%, with the highest rates observed in younger women (<18 years) and during the second trimester. Their findings identified *Staphylococcus aureus* (16.4%) and *Escherichia coli* (10.9%) as leading pathogens, highlighting demographic and clinical associations with UTI risk, such as specific personal hygiene practices.

Further emphasizing the high burden in northeastern Nigeria, Okon et al. (2021) focused on asymptomatic bacteriuria (ASB) at a tertiary hospital in the region. They found an even higher prevalence of ASB among pregnant women (63.33%) compared to non-pregnant controls (46%). This study underscores that a significant proportion of infections are asymptomatic, necessitating proactive screening to prevent complications like pyelonephritis and adverse pregnancy outcomes. Together, these studies confirm a high prevalence of both symptomatic and asymptomatic UTIs in Nigerian antenatal populations, justifying the need for the current investigation at UMTH.

➤ *Antibiotic Susceptibility Patterns of Uropathogens*

The efficacy of empirical UTI treatment is critically threatened by rising antimicrobial resistance (AMR), a pattern evident in regional studies. The susceptibility profile of a pathogen is not uniform but varies geographically, necessitating local surveillance.

Research from adjacent clinical contexts reveals concerning trends. A study on respiratory isolates in Lahore by Kalim et al. (2022), while focusing on a different infection site, documented high resistance in Gram-negative bacteria (*Pseudomonas aeruginosa*, *Klebsiella* spp.) to commonly used antibiotics like ampicillin and ceftriaxone. Notably, they found sustained susceptibility to carbapenems (imipenem, meropenem) and aminoglycosides (amikacin), a pattern often mirrored in uropathogens.

This pattern of resistance to first-line agents is corroborated by Okon et al. (2021) in their study on ASB in NE Nigeria. They reported universal resistance among isolates to readily available drugs like amoxicillin-clavulanate (Augmentin), cotrimoxazole, and cephalexin, while noting susceptibility to quinolones. More broadly, a Tanzanian hospital-based study by Nicholaus et al. (2021) found alarmingly high resistance rates among clinical isolates to ampicillin, third-generation cephalosporins, and even reserved drugs like meropenem in some cases. This underscores AMR as a pan-African public health crisis.

The consequence of widespread resistance is multidrug resistance (MDR). An earlier study in Zaria by Ehinmidu (2003) investigating community isolates (including from urine) found high rates of MDR among *E. coli*, *S. aureus*, and *P. aeruginosa*. This historical data reinforces the necessity for continuous surveillance and confirms that susceptibility testing prior to antibiotic prescription remains an essential, though often overlooked, practice.

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➢ *Risk Factors Associated with UTIs in Pregnancy*

Identifying risk factors is key to targeted prevention. These factors can be categorized into behavioral, physiological, and clinical-comorbidities.

Behavioral and hygiene practices are modifiable risks. The study by Abdullahi et al. (2021) linked UTI prevalence to specific toileting hygiene methods, such as the direction of wiping. This highlights the critical role of patient education in prevention strategies.

Physiological and anatomical changes inherent to pregnancy are primary non-modifiable risks. As reviewed by Storme et al. (2019), factors like urinary stasis due to ureteral dilation and increased bladder volume significantly elevate susceptibility. Furthermore, a history of recurrent UTIs is a well-substantiated risk factor for future infections.

The presence of comorbidities exacerbates risk. Conditions such as diabetes mellitus (due to glucosuria) and sickle cell anemia increase susceptibility to infections. Storme et al. (2019) also identified more complex urological risk factors in specific populations, including incomplete voiding, urinary incontinence, and neurogenic bladder often associated with catheter use, which introduces a significant healthcare-associated risk. In pregnant populations, complications like anatomical abnormalities or prolapse can create residual urine, acting as a nidus for infection.

III. MATERIALS AND METHODS

➢ *Study Design and Area*

A hospital-based, cross-sectional study design was employed to investigate the prevalence, bacterial etiology, antibiotic susceptibility patterns, and associated risk factors of urinary tract infections among pregnant women.

The study was conducted at the Antenatal Clinic of the University of Maiduguri Teaching Hospital (UMTH), Maiduguri, Borno State, Nigeria. UMTH is a major tertiary healthcare facility serving northeastern Nigeria, providing specialized obstetric and gynecological care. Ethical approval for the study was obtained from the UMTH Health Research Ethics Committee before commencement.

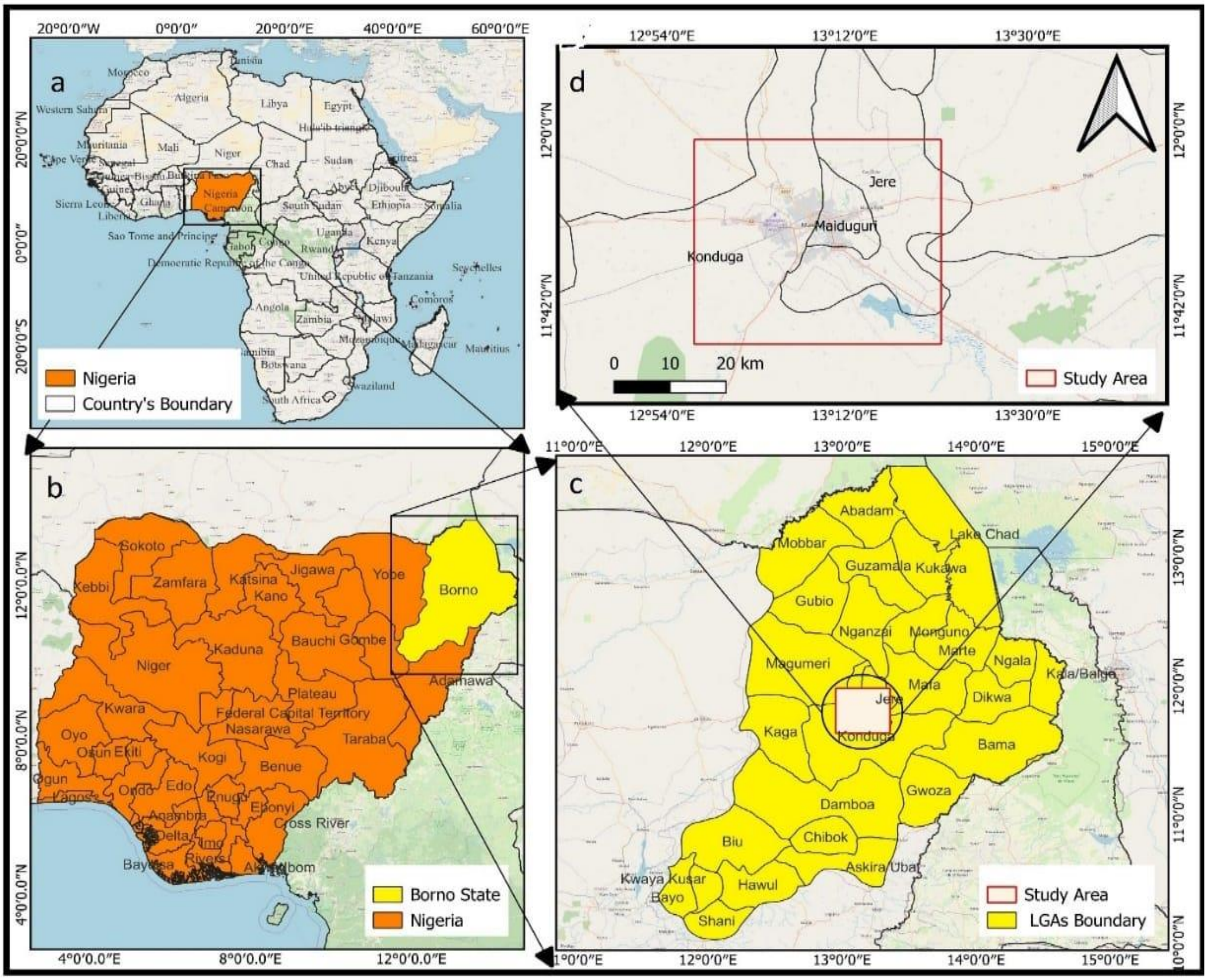

Fig 1 Map of UMTH, Maiduguri Showing the Study Area

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- *Study Population and Sample Size*

The target population consisted of pregnant women attending the antenatal clinic at UMTH during the study period. A total of fifty (50) pregnant women were recruited consecutively based on their willingness to participate and after providing informed consent.

- *Data and Sample Collection*

- *Questionnaire Administration*

A structured, interviewer-administered questionnaire was used to collect socio-demographic data (age, parity, gestational age), obstetric history, past medical history (e.g., diabetes, hypertension, previous UTI), current symptoms, and hygiene practices relevant to UTI risk factors.

- *Urine Sample Collection*

A clean-catch mid-stream urine (MSU) sample was collected from each participant into a sterile, wide-mouthed, leak-proof universal container following standard hygienic procedures. Samples were labeled with unique identifiers and transported to the Microbiology Laboratory for processing within one hour of collection.

- *Laboratory Procedures*

- *Microscopy and Bacteriological Culture*

Each urine sample was mixed thoroughly, and a calibrated loop (0.001 ml) was used to inoculate onto the surface of Cysteine-Lactose-Electrolyte-Deficient (CLED) agar and MacConkey agar plates. The plates were incubated aerobically at 37°C for 18-24 hours. Significant bacteriuria was defined as a colony count of $\geq 10^5$ colony-forming units per milliliter (CFU/ml) of a single bacterial pathogen.

- *Bacterial Isolation and Identification*

Distinct bacterial colonies from primary culture plates were sub-cultured onto nutrient agar to obtain pure isolates. Bacterial identification was performed using standard microbiological techniques, including:

- ✓ Colonial morphology on selective and differential media.
- ✓ Gram staining for cellular morphology and reaction.
- ✓ Biochemical tests: Catalase and coagulase tests for *Staphylococcus aureus*; Indole, Methyl Red, Voges-Proskauer, Citrate (IMViC) tests, and Triple Sugar Iron (TSI) agar reactions for Enterobacteriaceae.

- *Antibiotic Susceptibility Testing*

Antibiotic susceptibility testing was performed on confirmed isolates using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar, as per the guidelines of the Clinical and Laboratory Standards Institute (CLSI, 2018). A bacterial suspension adjusted to the 0.5 McFarland standard was used as the inoculum.

- ✓ *The Following Antibiotic Discs (Oxoid, UK) were Used:*

- Amoxicillin (30 µg)
- Ciprofloxacin (10 µg)
- Gentamicin (10 µg)
- Trimethoprim-sulfamethoxazole (30 µg)
- Cefotaxime (30 µg)
- Nitrofurantoin (300 µg)
- Imipenem (10 µg)

After incubation at 37°C for 18-24 hours, the diameters of inhibition zones were measured in millimeters and interpreted as Susceptible (S), Intermediate (I), or Resistant (R) using CLSI breakpoints.

- *Data Analysis*

Data from questionnaires and laboratory results were entered, cleaned, and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics (frequencies, percentages, mean ± standard deviation) were used to summarize socio-demographic characteristics, prevalence of bacteriuria, distribution of bacterial isolates, and antibiotic susceptibility patterns.

The association between potential risk factors (e.g., age, parity, hygiene practice, history of UTI) and the presence of significant bacteriuria was assessed using Chi-square (χ^2) tests or Fisher's exact test where appropriate. A p-value of ≤ 0.05 was considered statistically significant. Odds Ratios (OR) with 95% Confidence Intervals (CI) were calculated to measure the strength of associations.

IV. RESULT

- *Age Distribution of Participants (N=50)*

Table 1 Age Distribution of Participants (N=50)

Age Group (Years)	Frequency (n)	Percentage (%)
16 - 20	6	12.0
21 - 25	14	28.0
26 - 30	7	14.0
31 - 35	10	20.0
36 - 40	7	14.0
41 and Above	3	6.0
Total	**50**	**100.0**

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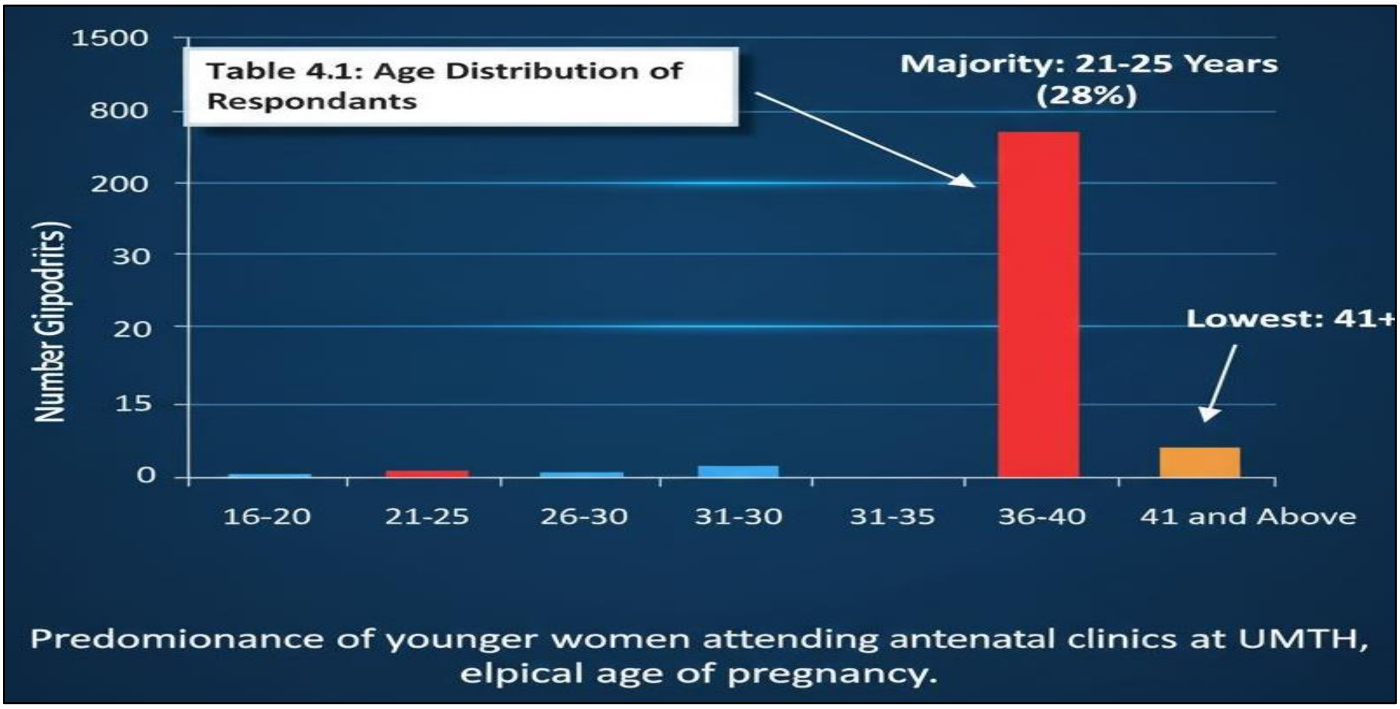

Fig 2 Age Distribution of Respondents

➢ *Prevalence and Distribution of Bacterial Isolates*

Table 2 Prevalence and Distribution of Bacterial Isolates

Bacterial Isolate (n)	Highly Effective Antibiotics (Susceptibility >70%)	Ineffective Antibiotics (Resistance >70%)
Klebsiella spp. (12)	Ciprofloxacin (CIP), Gentamicin (GEN)	Cefotaxime (CTX), Amoxicillin-Clavulanate (AMC), Ceftazidime (CAZ)
S. aureus (9)	Ciprofloxacin (CIP), Clindamycin (DA), Gentamicin	Cefepime (FEP), Cotrimoxazole (SXT)
E. coli (7)	Ciprofloxacin (CIP), Gentamicin (GEN)	Amoxicillin-Clavulanate (AMC), Cotrimoxazole (SXT), Cefuroxime (CXM)
Pseudomonas spp. (2)	Ciprofloxacin (CIP), Imipenem (IPM)	Gentamicin (GEN), Aztreonam (ATM)

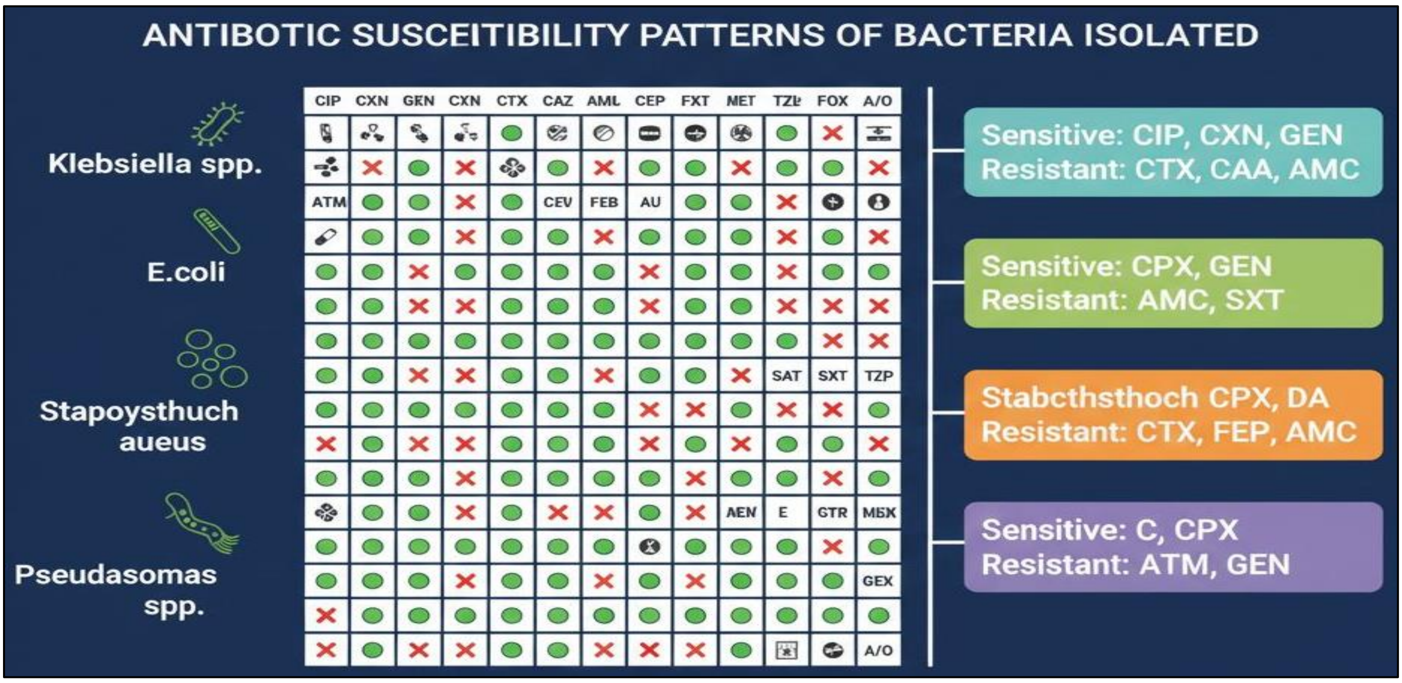

Fig 3 Prevalence and Distribution of Bacterial Isolates

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Microbiological analysis of the 50 urine samples revealed significant bacteriuria (≥10^5 CFU/ml) in 30 samples, yielding a prevalence rate of 60.0%. A total of 30 bacterial pathogens were isolated. *Klebsiella* species was the most prevalent uropathogen, accounting for 40.0% (n=12) of all isolates. This was followed by *Staphylococcus aureus* (30.0%, n=9) and *Escherichia coli* (23.3%, n=7). *Pseudomonas* species was the least isolated (6.7%, n=2).

➢ *Antibiotic Susceptibility Patterns*

The antibiotic susceptibility profiles of the isolates revealed significant multi-drug resistance (MDR). The results are summarized in Table 2 and discussed by organism below

V. DISCUSSION

➢ *High Prevalence of UTIs*

The 60.0% prevalence of significant bacteriuria found in this study is notably high and aligns with findings from similar settings in Nigeria. For instance, Okon et al. (2021) reported a prevalence of 63.33% in northeastern Nigeria, while Abdullahi et al. (2021) documented 64% in Zaria. This consistently high prevalence underscores urinary tract infections as a major antenatal health burden in the region, necessitating routine screening protocols.

➢ *Predominance of Klebsiella Species and Staphylococcus aureus*

Contrary to global and many local reports where *Escherichia coli* is the predominant uropathogen, this study found *Klebsiella* species to be the most common isolate (40.0%). This shift in etiology has significant clinical implications, as *Klebsiella* spp. are often associated with higher resistance profiles, particularly to cephalosporins. The high prevalence of *Staphylococcus aureus* (30.0%), a Gram-positive organism, is also noteworthy and may reflect specific community-acquired or healthcare-associated exposure patterns in the study area. These findings highlight the critical importance of local microbiological data over reliance on generalized epidemiological patterns.

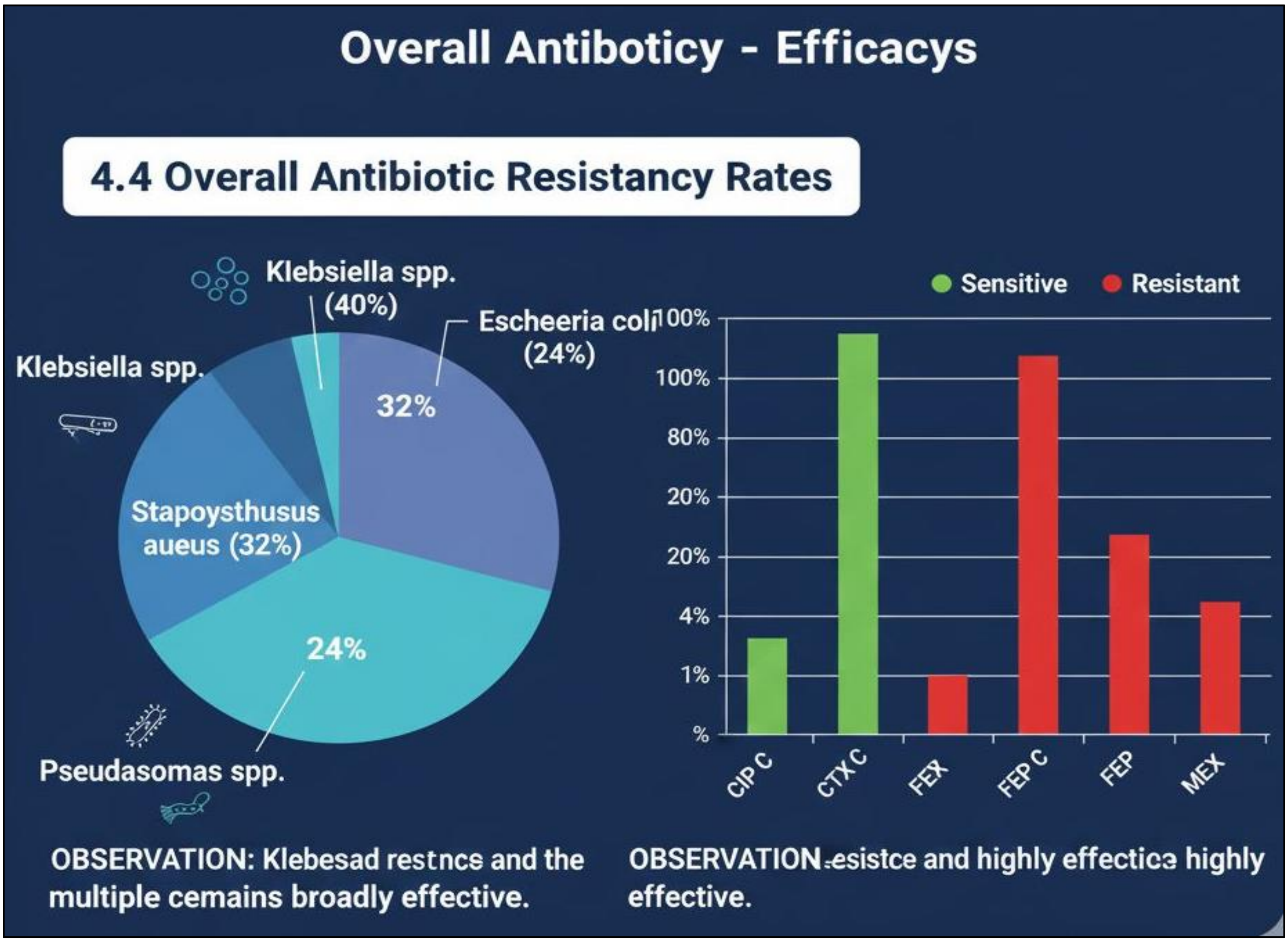

Fig 4 Overall Antibiotic Resistance Rates

➢ *Alarming Antibiotic Resistance Patterns*

The susceptibility results reveal a concerning landscape of antimicrobial resistance, rendering several first-line and affordable antibiotics ineffective.

- Resistance to First-Line Agents: High resistance to Amoxicillin-Clavulanate (Augmentin) and Cotrimoxazole among *E. coli* and *Klebsiella* isolates

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corroborates the findings of Okon et al. (2021) and Nicholaus et al. (2021). This widespread resistance compromises empirical therapy with these common oral agents.

- Extended-Spectrum Beta-Lactamase (ESBL) Suspectibility: The high resistance of *Klebsiella* spp. and *E. coli* to cefotaxime and ceftazidime (3rd generation cephalosporins) is strongly indicative of ESBL production. This limits the use of these broad-spectrum agents, which are often reserved for moderate to severe infections.
- Retained Susceptibility: Ciprofloxacin and Gentamicin demonstrated relatively good activity against most isolates, though resistance was not absent. The preserved efficacy of carbapenems (e.g., Imipenem) against *Pseudomonas* and other Gram-negatives, while reassuring for severe cases, underscores them as "last-line" drugs that must be protected from overuse to prevent the emergence of carbapenem-resistant strains.

➢ *Implications for Clinical Practice and Public Health*

The high prevalence of UTIs and MDR pathogens demands a revised approach to antenatal care at UMTH. Empirical treatment for suspected UTIs in pregnant women should avoid Amoxicillin-Clavulanate and Cotrimoxazole. Ciprofloxacin or Gentamicin (considering safety in pregnancy) may be considered, but the gold standard must be culture-guided therapy. This study strongly advocates for mandatory urine culture and sensitivity testing for symptomatic pregnant women and as part of routine antenatal screening.

These findings also emphasize the urgent need for antibiotic stewardship programs within the hospital to regulate prescription practices and public health campaigns to educate against antibiotic self-medication, a key driver of resistance

This study provides critical insights into the epidemiology of urinary tract infections among pregnant women at UMTH, revealing a high prevalence of infection dominated by resistant pathogens. The findings necessitate a re-evaluation of current empirical treatment protocols and underscore the urgent threat of antimicrobial resistance (AMR) in this vulnerable population.

The isolation of *Klebsiella* species as the predominant uropathogen (40.0%) diverges from many global and national reports where *Escherichia coli* is most common. This shift is significant and aligns with emerging data from some Nigerian tertiary centers, suggesting a changing local bacteriological landscape (Abdullahi et al., 2021). The pathogenic success of *Klebsiella* spp. is often linked to its formidable virulence factors, including capsular polysaccharides and its propensity to produce Extended-Spectrum Beta-Lactamases (ESBLs), which confer resistance to penicillins and cephalosporins (Zhang et al., 2019). The high co-resistance to Amoxicillin-Clavulanate and Cefotaxime observed in this study strongly suggests ESBL production, rendering these common first- and third-line agents ineffective.

The substantial prevalence of *Staphylococcus aureus* (30.0%), a Gram-positive organism typically associated with skin flora and complicated UTIs, is another notable finding. This high rate may reflect specific risk factors within the population, such as catheter-associated infections or hygiene practices, and indicates that UTIs in this setting are not exclusively caused by enteric bacteria (Gupta et al., 2018). The detection of methicillin resistance in some isolates points to the presence of MRSA, a pathogen of grave concern due to its association with poorer treatment outcomes and higher healthcare costs (Adebayo et al., 2022).

The antibiotic susceptibility patterns revealed a crisis of multi-drug resistance. The high resistance rates to Amoxicillin-Clavulanate, Cotrimoxazole, and later-generation cephalosporins invalidate their use as reliable empirical therapies. This pattern mirrors the alarming trends reported across sub-Saharan Africa, where misuse and overuse of antibiotics have fueled resistance (Nicholaus et al., 2021; Okon et al., 2021). The retained susceptibility to Ciprofloxacin and Gentamicin offers alternative options, though their use in pregnancy requires careful risk-benefit consideration. The consistent efficacy of carbapenems, as also noted by Okon et al. (2023), positions them as crucial last-resort drugs. However, their utility must be safeguarded through strict stewardship to avert the nightmare scenario of carbapenem-resistant Enterobacteriaceae, which has been documented in other regions (Patel et al., 2020).

These findings collectively highlight a dangerous gap: the antibiotics most commonly prescribed empirically are precisely those to which prevalent pathogens are most resistant. This mismatch increases the risk of treatment failure, progression to pyelonephritis, and adverse pregnancy outcomes.

VI. CONCLUSION, AND RECOMMENDATIONS

➢ *Conclusion*

This study concludes that urinary tract infections represent a significant and inadequately managed health burden among pregnant women attending the UMTH antenatal clinic, with a prevalence of 60%. The etiological profile is dominated by *Klebsiella* species and *Staphylococcus aureus*, rather than the classic *E. coli*, signaling an important shift in local microbiology.

A central and alarming finding is the widespread multi-drug resistance among these pathogens, particularly to affordable, first-line oral antibiotics. This resistance crisis renders standard empirical therapy unreliable and threatens to escalate simple infections into life-threatening complications. While last-resort drugs like carbapenems remain effective, their preservation is paramount.

Therefore, effective management of UTIs in this population can no longer rely on presumptive treatment. It mandates a paradigm shift towards mandatory culture and susceptibility testing for accurate diagnosis and targeted therapy. Addressing this issue is critical not only for improving maternal and fetal health outcomes but also as a vital front in the broader fight against antimicrobial resistance.

➢ *Recommendations*

Based on the conclusions of this study, the following actionable recommendations are made:

- Implement Routine Antenatal Screening and Enhanced Diagnostics: The UMTH antenatal clinic should institute routine urine culture screening for pregnant women. Investment in rapid diagnostic tools or streamlined laboratory processing is essential to ensure timely, culture-guided antibiotic prescriptions and avoid ineffective empirical treatment.
- Revise and Disseminate Local Treatment Guidelines: Hospital authorities should update UTI treatment protocols for pregnant women based on these findings. The guidelines should discourage the use of Amoxicillin-Clavulanate and Cotrimoxazole as first-line empiric therapy and promote alternatives like Nitrofurantoin (where suitable) or a short course of Ciprofloxacin, pending culture results, with clear safety caveats.
- Establish a Robust Antibiotic Stewardship Program (ASP): A multidisciplinary ASP committee should be formed at UMTH. This program should monitor antibiotic prescriptions, provide regular feedback to clinicians on resistance patterns, and enforce policies to reserve carbapenems for confirmed, resistant infections only.
- Intensify Patient and Healthcare Worker Education: Community health outreach and antenatal counselling should emphasize UTI prevention strategies, including proper perineal hygiene and adequate hydration. Simultaneously, training for healthcare workers should focus on AMR, the importance of specimen culture, and adherence to new treatment guidelines.
- Promote Further Research: Longitudinal studies are needed to monitor the evolution of resistance trends. Research into the molecular mechanisms of resistance (e.g., ESBL genes in *Klebsiella*) and the risk factors driving the high prevalence of *S. aureus* UTIs in this population is also recommended to inform more targeted interventions.

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APPENDIX A: RAW LABORATORY DATA – SAMPLE CODES, PARTICIPANT AGE, AND BACTERIAL ISOLATES

Sample Code	Age (Years)	Organism Isolated
1	27	*Klebsiella* spp.
2	36	*Klebsiella* spp.
3	38	*Klebsiella* spp.
4	27	No Growth
5	19	*Klebsiella* spp.
6	32	No Growth
7	20	*Klebsiella* spp.
8	21	No Growth
9	20	No Growth
10	42	*Escherichia coli*
11	26	*Escherichia coli*
12	46	*Pseudomonas* spp.
13	20	*Staphylococcus aureus*
14	28	*Staphylococcus aureus*
15	19	*Escherichia coli*
16	23	*Staphylococcus aureus*
17	20	No Growth
18	24	*Staphylococcus aureus*
19	34	*Klebsiella* spp.
20	36	*Klebsiella* spp.
21	18	No Growth
22	31	*Staphylococcus aureus*
23	48	*Escherichia coli*
24	35	*Escherichia coli*
25	31	*Staphylococcus aureus*
26	24	*Staphylococcus aureus*
27	27	No Growth
28	21	*Klebsiella* spp.
29	32	*Klebsiella* spp.
30	34	*Staphylococcus aureus*
31	36	*Staphylococcus aureus*
32	22	*Klebsiella* spp.
33	46	*Escherichia coli*
34	41	*Klebsiella* spp.
35	24	*Staphylococcus aureus*
36	19	No Growth
37	36	*Klebsiella* spp.
38	37	*Staphylococcus aureus*
39	26	*Escherichia coli*
40	31	*Escherichia coli*
41	32	*Escherichia coli*
42	29	*Staphylococcus aureus*
43	38	*Klebsiella* spp.
44	44	*Klebsiella* spp.
45	24	*Staphylococcus aureus*
46	32	*Staphylococcus aureus*
47	21	*Klebsiella* spp.
48	36	*Staphylococcus aureus*
49	24	*Staphylococcus aureus*
50	34	*Klebsiella* spp.

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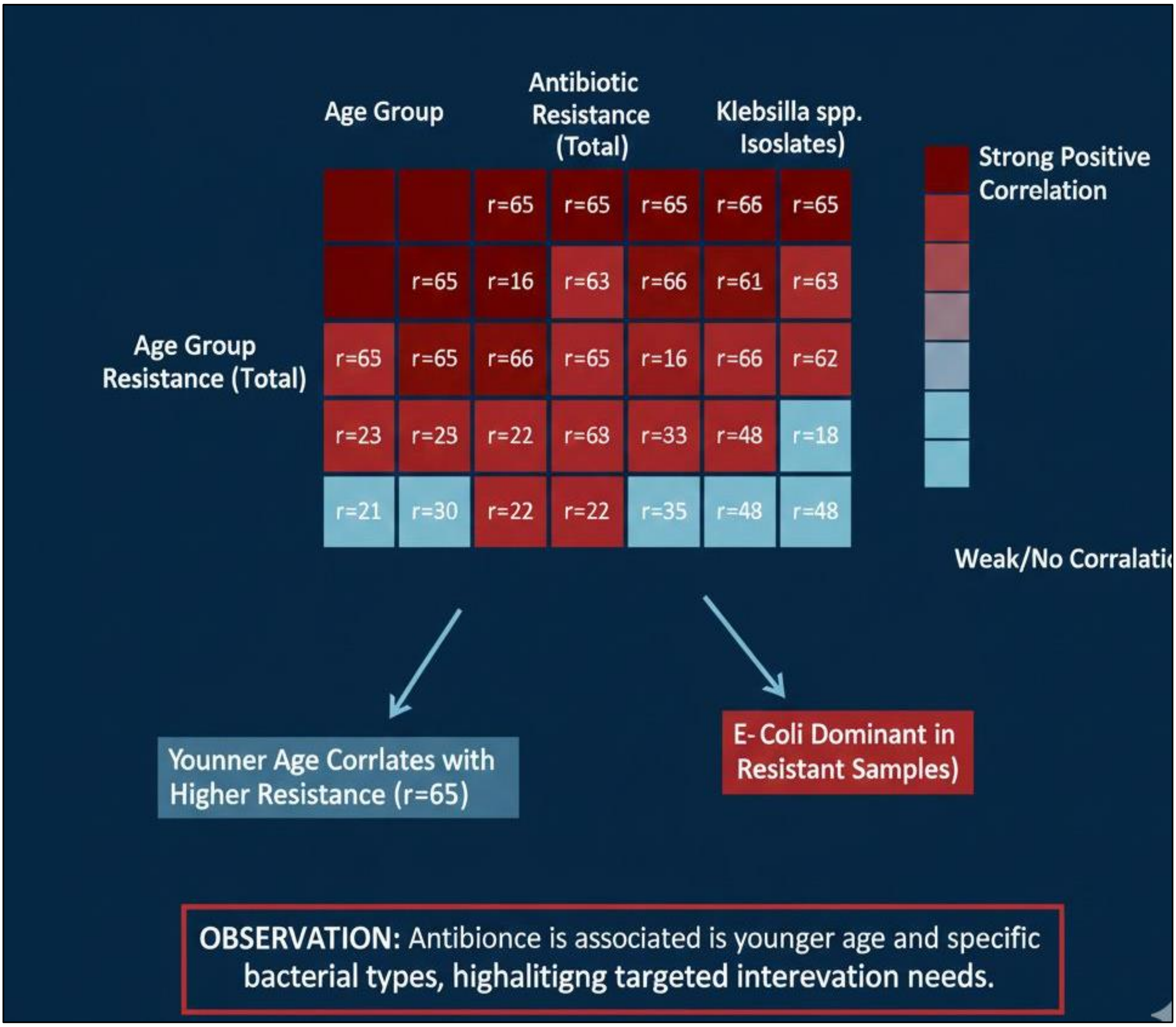

Fig 5 Prevalence of Bacteria Associated with UTIs

➢ *Summary from Appendix a Data:*

- Total Samples Processed: 50
- Samples with Significant Growth (UTI Positive): 30
- Samples with No Significant Growth (UTI Negative): 20
- Prevalence of Significant Bacteriuria: 60% (30/50).