African Urology 2026;6:126-132
https://doi.org/10.36303/AUJ.0337

AFRICAN UROLOGY
ISSN 2710-2750 EISSN 2710-2750

ORIGINAL RESEARCH

Diagnostic performance of urine leukocytes in predicting urinary tract infections among adult patients in Kisumu County, Kenya

BO Oyugi, G Ayodo, D Onguru

School of Health Sciences, Jaramogi Oginga Odinga University of Science and Technology, Kenya

Corresponding author, email: benoyugi89@gmail.com

Background: Urinary tract infections (UTI) remain a major global health burden. Diagnosis in resource-limited settings often relies on biochemical markers, like leukocytes. However, the predictive value of leukocyturia in culture-confirmed UTI is under-described in Kisumu, Kenya.

Objectives: This study determined the association between urine leukocyturia, uropathogen distribution, and antimicrobial resistance (AMR) among adult patients attending Synergy Clinics.

Methods: A retrospective record review was conducted using routine urine, microscopy, culture, and sensitivity testing records. Based on the Cochran formula, a minimum sample size of 255 patient records was calculated, and a total of 348 samples were analysed. Descriptive statistics were used to summarise demographic characteristics. Associations between leukocyturia and culture positivity were assessed using chi-square tests. Logistic regression analysis identified predictors of culture-confirmed bacteriuria.

Results: Most participants were male (79.6%). The largest age group was 46–64 years (39.6%). Of the samples, 22.7% were positive for leukocytes. Urine culture positivity was 57.6%, with *Escherichia coli* (*E. coli*) as the most frequently isolated pathogen (13.3%). Leukocyturia was significantly associated with culture positivity ($p = 0.001$). Multivariate analysis identified leukocyturia (odds ratio [OR] 3.36; $p = 0.008$) and sex ($p < 0.001$) as significant predictors of culture growth, while age and estimated glomerular filtration rate (eGFR) were not significant. Particularly high AMR was observed against trimethoprim/sulfamethoxazole (SXT) and ampicillin/cloxacillin (AMPCLX). Nitrofurantoin (NIT), aminoglycosides, and carbapenems demonstrated preserved effectiveness.

Conclusion: Urine leukocytes were strongly associated with culture-confirmed UTI, supporting their role in diagnostic triage in resource-strained settings. The predominance of *E. coli* and high resistance burden underscores the need for routine culture and susceptibility-guided therapy.

Keywords: leukocyturia, bacteriuria, urine cultures, antimicrobial resistance

Introduction

UTIs remain a major global public health concern, contributing significantly to morbidity, healthcare expenditure, and mortality.[1] UTIs are primarily caused by uropathogens, like *E. coli*, *Klebsiella pneumoniae*, and *Proteus mirabilis*, and may cause either cystitis or pyelonephritis.[2,3] The growing burden of AMR has further heightened the need for accurate and timely diagnosis.[4,5] Urinalysis is commonly used in routine clinical practice, with leukocytes serving as an indicator of urinary tract inflammation and a preliminary infection marker.[6] Although urine culture remains the diagnostic gold standard, access to culture and sensitivity testing is limited in many resource-constrained settings.[7]

In Kenya, only 31% of laboratory facilities provide comprehensive diagnostic services, and just 4% are equipped to perform culture and sensitivity testing.[8] Consequently, clinicians frequently rely on urinalysis alone, a practice that may contribute to inappropriate antibiotic use and worsening AMR trends.[9] While emerging evidence suggests that leukocyturia may correlate with culture positivity, its specificity remains uncertain, particularly in urology settings and in this region.[10] Against this backdrop, strengthening diagnostic stewardship through context-specific evidence is essential.[11,12] Emphasising the positive predictive value (PPV) of urinalysis over its negative predictive value (NPV) may also help reduce unnecessary diagnostic procedures by limiting further investigations to patients with a high likelihood of true infection.[5] Proper training and education for clinicians on the limitations and appropriate applications of urinalysis are critical to improve diagnostic accuracy and reduce the misuse of healthcare resources.[13]

Our study was conducted among adult patients attending Synergy Clinics in Kisumu County, western Kenya. The study aimed to identify bacterial UTI among adult patients, determine the presence of leukocyturia in patients diagnosed with UTI, and evaluate the association among urine leukocytes, bacterial species isolated, and AMR patterns in UTI. By addressing these objectives, the study seeks to clarify the diagnostic value of leukocyturia and to inform antimicrobial stewardship efforts in low-resource settings, where increasing resistance to first-line antibiotics underscores the need for accurate and timely diagnostic strategies.[14]

Materials and methods

Study design and setting

The study adopted a hospital-based, retrospective cross-sectional design to explore factors influencing UTI, as this design provides a foundation for identifying potential causal relationships.[15] The study's target group was adult patients visiting Synergy Clinics, from January to November 2025, for urine biochemistry, microscopy, culture, and sensitivity with creatinine (derived eGFR) testing.

Sample size

The sample size calculation was based on Cochran's formula (Cochran, 1977):

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

- *n* is the required sample size.
- Z is the Z-score corresponding to the desired confidence level (1.96 for 95% confidence).
- *p* is the estimated prevalence, approximated at 21% (or 0.21).[16]
- E is the margin of error, set at 5% (or 0.05).

Therefore:

$$n = \frac{1.96^2 \times 0.21 \times (1-0.21)}{0.05^2} = 254.9 \text{ (or ~ 255)}$$

Participant selection

Figure 1 illustrates participant selection using inclusion and exclusion criteria. A total of 881 patient records were screened for completeness and eligibility. After screening, 533 records were excluded: 88 with ages < 18 years, 181 with inconsistent study variables, and 264 duplicate or repeat visits. The result was 348 eligible participants. Since all eligible records were accessible, the study included all 348 records to maximise statistical power and minimise selection bias. Each patient was assigned a unique identifier and imported into IBM SPSS Statistics for final analysis.

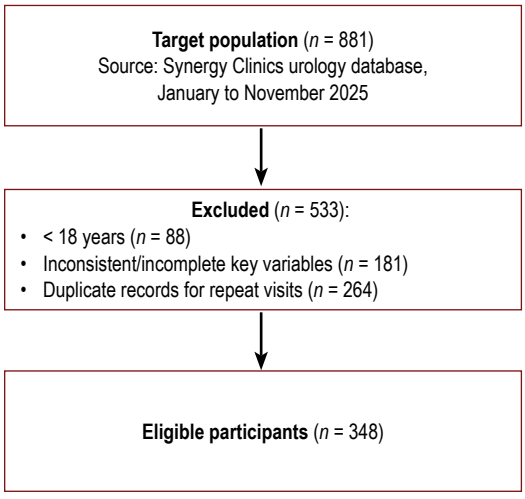


Figure 1: STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) flow diagram showing participant selection

Data collection, analysis, and laboratory quality

A structured data collection form was systematically developed. It was used to capture demographic and laboratory variables (urine biochemistry, microscopy, culture, antimicrobial profiles, creatinine, and derived eGFR reports) for the 348 eligible participants, all of whom were identified anonymously. Cross-verification of source documents before entry ensured data accuracy. Information was entered via Microsoft Forms into a secure OneDrive Excel database, ensuring integrity and backup.

Consistent with retrospective studies, descriptive statistics summarised key variables, including patient demographics, urinalysis findings, and culture and AMR profiles. Associations between leukocytes were assessed using the chi-square test. Binary logistic regression evaluated the effects of leukocytes on the odds of bacterial growth, while logistic regression identified significant predictors of UTI, adjusting for age, sex, and eGFR. The findings were presented in tables and figures.

All testing phases involved laboratory quality assurance procedures. In the pre-analytical phase, adherence to standardised patient identification, specimen collection, and transport procedures was verified. Internal quality control, reagent verification, equipment service, and participation in external quality assessments ensured quality in the analytical phase. In post-analytical result verification, the implementation of data quality assurance addressed inconsistencies and missing values.

Ethical approval was obtained from the university, as well as independent review board approval from the University of East Africa, Baraton, Institutional Scientific Ethics Review Committee (UEAB/ISERC/29/07/2025), the National Commission for Science, Technology and Innovation (NACOSTI/P/25/4177979), and the hospital's management.

Results

The study population was predominantly male (80.7%), with females representing 19.3% of participants. Age groups were categorised into four groups to reflect clinically relevant stages in urological disease progression. The adult (46–64 years) category accounted for 38.2%, the elderly (65–84 years) for 36.2%, the young adults (18–45 years) for 20.1%, and the oldest age group (> 85 years) for 5.5%.

Among the 348 adult patients, 64.4% (224/348) had negative leukocyte dipstick results, while 12.6% (44/348) had trace leukocytes. The remaining patients had positive leukocyte results distributed as follows: 0.9% (3/348) at 1+, 9.5% (33/348) at 2+, and 12.6% (44/348) at 3+. For primary binary analysis, leukocyte results reported as trace or higher were classified as positive, giving an overall positivity rate of 35.6% (124/348). In secondary analysis, a stricter threshold was applied, with only results ≥ 1+ considered positive. Following this, the positivity rate decreased to 23% (80/348).

A summary of the diagnostic statistics is shown in Table I. No leukocytes were detected in 268 (LE = 0, 77. 0%), while 80 had

Table I: Summary of diagnostic statistics

Metric	Contaminants excluded	Contaminants as negatives
Sample size	280	348
Sensitivity (%)	36.6	36.8
Specificity (%)	**89.7**	85.6
Positive predictive value (%)	**76.6**	61.3
Negative predictive value (%)	60.6	**68.7**
Likelihood ratio (+)	**3.56**	2.56
Likelihood ratio (-)	0.71	0.74

leukocytes (LE = 1, 23.0%). When cross-tabulated with culture results, 133 samples (38.2%) demonstrated bacterial growth, whereas 215 (61.8%) showed no growth. Among samples with no leukocytes (LE = 0), 85.6% (184/215) had no bacterial growth, while 63.2% (84/133) with growth still had no leukocytes detected. Conversely, in samples with leukocytes present (LE = 1), 61.3% (49/80) showed bacterial growth, compared with 38.8% (31/80) without growth. The sensitivity of leukocyte detection for culture-confirmed infection was 36.8% (49/133), specificity was 85.6% (184/215), PPV was 61.3% (49/80), and NPV was 68.7%% (184/268). The positive likelihood ratio was 2.56, and the negative likelihood ratio was 0.74.

After excluding contaminated cultures, 280 interpretable urine samples remained. Leukocytes were absent in 216 samples (77.1%) and present in 64 (22.9%). Urine culture demonstrated bacterial growth in 134 samples (47.9%) and no growth in 146 (52.1%). Among samples without leukocytes (LE = 0), 60.6% (131/216) had no bacterial growth, whereas 39.4% (85/216) showed growth. Conversely, among samples with leukocytes present (LE = 1), 76.6% (49/64) demonstrated bacterial growth compared with 23.4% (15/64) without growth. The sensitivity of leukocyte detection for culture-confirmed infection was 36.6% (49/134), specificity 89.7% (131/146), PPV 76.6% (49/64), and NPV 60.6% (131/216). The positive likelihood ratio was 3.56, and the negative likelihood ratio was 0.71.

Table II shows the Pearson chi-square, indicating a statistically significant association (χ^2 = 27.395, df = 1; p < 0.001). This was supported by the continuity correction (χ^2 = 25.924, df = 1; p < 0.001) and the likelihood ratio test (χ^2 = 28.383, df = 1; p < 0.001). Fisher's exact test also showed statistical significance for both two-sided and one-sided tests (p < 0.001). The linear-by-linear association was significant (χ^2 = 27.297, df = 1; p < 0.001).

Bacterial growth in culture occurred in 147 (57.6%), and 108 (42.4%) had no growth. Among the organism categories, *E. coli* was isolated from 34 samples (13.3% of the total), of which 33 (97.1%) showed culture growth. Other uropathogens accounted for 17 samples (6.7%), all of which were culture-positive. Contaminants were identified in 48 samples (18.8%), all of which were culture-positive. The "others" category comprised 51 samples (20.0%), of which 47 (92.2%) demonstrated culture growth. Samples with no growth comprised 105 of the total (41.2%), with 103 (98.1%) showing no growth, and two (1.9%) showing growth. The category labelled "others" comprised a heterogeneous group of less frequently isolated organisms: *Acinetobacter baumannii*, *Acinetobacter junii*, *Candida albicans*, other *Candida* spp., *Citrobacter freundii*, *Citrobacter* spp., coagulase-negative *Staphylococcus*, *Enterobacter cloacae*, *Enterococcus faecium*, *Klebsiella oxytoca*, *Leclercia adecarboxylata*, *Morganella morganii*, *Proteus mirabilis*, *Proteus penneri*, *Providencia rettgeri*, *Serratia fonticola*, and *Serratia marcescens*.

Multivariate regression analysis was conducted to examine the predictive power of the leukocyte dipstick in urine with a positive culture report. The R^2-values are presented in Table III. The logistic regression model given in Table IV evaluated the ability of leukocyte esterase (LEUKO) to predict bacterial growth in urine culture, demonstrating modest explanatory power. The model had a -2 log-likelihood of 359.850, indicating an acceptable fit relative to the null model. The Cox & Snell R^2 (0.096) and Nagelkerke R^2 (0.129) suggest that the predictors collectively explained approximately 9.6–12.9% of the variance in urine culture outcomes, indicating a limited but measurable predictive contribution of the included variables.

Table II: Chi-square analysis of urine leukocytes and bacterial culture results

	Value	df	Asymptotic significance (two-sided)	Exact sig. (two-sided)	Exact sig. (one-sided)
Pearson chi-square	27.395*	1	.000		
Continuity correction**	25.924	1	.000		
Likelihood ratio	28.383	1	.000		
Fisher's exact test				< 0.000	< 0.000
Linear-by-linear association	27.297	1	.000		
Number of valid cases	280				

* 0 cells (0.0%) have expected count < 5; the minimum expected count is 30.63.
** Computed only for a 2 × 2 table.

Table III: Model summary for leukocytes and white blood cell counts on bacterial growth

Step	-2 log-likelihood	Cox & Snell R^2	Nagelkerke R^2
1	359.265*	0.096	0.129

* Estimation terminated at iteration number 4 because parameter estimates changed by less than 0.001.

Table IV: Logistic regression predicting bacterial growth from LEUKO

Variable	B	SE	Wald χ^2	df	*p*-value	OR (Exp[B])	95% CI (lower to upper)
LEUKO	1.616	0.326	24.537	1	< 0.001	5.04	2.66 to 9.54
Constant	-0.433	0.139	9.645	1	0.002	0.65	—

CI – confidence interval, LEUKO – leukocyte esterase, OR – odds ratio

Table V: Logistic regression model fit and key predictors of urine culture outcome

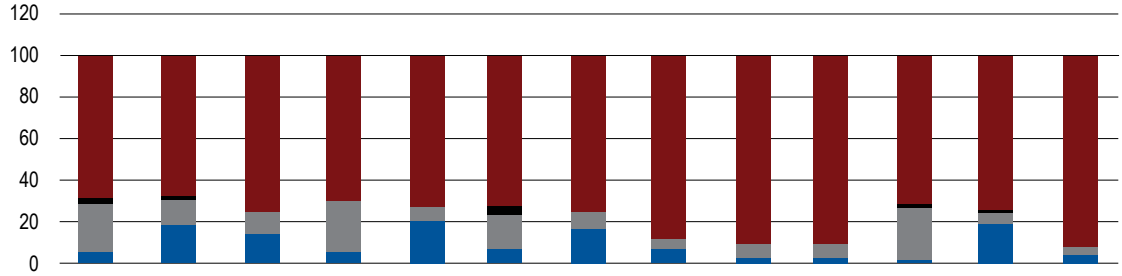
Component	Statistic	Value	*p*-value
Overall model fit	-2 log-likelihood (final model)	359.265	—
	Omnibus test (χ^2, df = 1)	28.383	< 0.001
Pseudo R^2	Cox & Snell R^2	0.096	—
	Nagelkerke R^2	0.129	—
Key predictors (likelihood ratio test)	LEUKO	χ^2 = 21.699	< 0.001
	Sex	χ^2 = 10.286	0.001
	Age group	χ^2 = 1.850	0.174
	eGFR category	χ^2 = 0.004	0.950

eGFR – estimated glomerular filtration rate, LEUKO – leukocyte esterase

In Table V, the multivariable logistic regression model assessing predictors of urine culture outcome showed a statistically significant improvement (likelihood ratio χ^2 = 44.418, df = 11; p < 0.001). The final model had a -2 log-likelihood of 139.132. Pseudo R^2-values indicated moderate explanatory power: Cox & Snell R^2 = 0.160, Nagelkerke R^2 = 0.215, and McFadden R^2 = 0.128. Likelihood ratio tests indicated that LEUKO (χ^2 = 7.165, df = 1; p = 0.007) and sex (χ^2 = 17.365, df = 1; p < 0.001) significantly contributed to the model.

In the adjusted model using culture growth as the reference category, LEUKO absence was associated with lower odds of culture growth (OR 0.274, 95% confidence interval [CI] 0.104 to 0.725; p = 0.009). Sex was significantly associated with culture outcome, with one sex category showing reduced odds of culture growth relative to the reference group (OR 0.210, 95% CI 0.096 to 0.462; p < 0.001). Age group and eGFR categories were not statistically significant predictors. The highest eGFR category showed a borderline association with culture outcome (OR 4.252, 95% CI 0.937 to 19.305; p = 0.061).

Figure 2 illustrates antimicrobial susceptibility patterns based on isolates tested per antibiotic. Resistance varied across agents, with the highest rates observed for SXT at 78.6% (22/28), AMPCLX at 76.9% (20/26), cefuroxime (CXM) at 65.4% (17/26), and cefepime (FEP) at 61.5% (8/13). Ciprofloxacin (CIP) and ceftriaxone (CRO) also demonstrated substantial resistance at 54.5% (18/33) and 57.7% (15/26), respectively. Lower resistance rates were observed for amikacin (AMK) at 10.3% (3/29), NIT at 19.4% (6/31), and gentamicin (GEN) at 23.3% (7/30), indicating retained effectiveness. Sensitivity was highest for AMK (86.2%, 25/29), GEN (76.7%, 23/30), and NIT (71.0%, 22/31). Carbapenems (imipenem and meropenem) demonstrated moderate susceptibility (60.0%, 6/10, each), while piperacillin/tazobactam (TZP) showed equal proportions of resistance and sensitivity (50.0%, 4/8, each), although based on fewer isolates. Intermediate susceptibility was generally low across all agents (< 10%), with a slightly higher proportion observed for amoxicillin/clavulanate (AMC) at 14.3% (4/28). Among the antimicrobial profiles of the bacterial isolates, AMK showed the highest susceptibility, particularly in *E. coli*. NIT and GEN also demonstrated high susceptibility among *E. coli*



	NIT	CIP	CRO	GEN	SXT	AMC	CXM	FEP	IPM	MEM	AMK	AMPCLX	TZP
Not applicable	69	67	75	70	73	73	75	88	90	90	71	74	91.8
Intermediate	3	2	0	0	0	4	0	0	0	0	2	1	0
Sensitive	22	13	11	23	6	16	8	5	6	6	25	6	3.9
Resistant	6	18	15	7	22	8	17	8	4	4	3	20	4.3

Figure 2: Antimicrobial susceptibility patterns based on isolates tested per antibiotic
AMC – amoxicillin/clavulanate, AMPCLX – ampicillin/cloxacillin, CIP – ciprofloxacin, CRO – ceftriaxone, CXM – cefuroxime, FEP – cefepime, GEN – gentamicin, IPM – imipenem, MEM – meropenem, NIT – nitrofurantoin, SXT – trimethoprim/sulfamethoxazole, TZP – piperacillin/tazobactam

(28 and 26 susceptible isolates, respectively). In contrast, *E. coli* exhibited high resistance to AMPCLX (93.3%), CIP (66.7%), and CRO (65.6%), while resistance to NIT (6.7%) and AMK (3.2%) remained low.

Discussion

The population's male predominance (80.7%) aligns with the patient profile typically observed in specialist urology clinics.[17] The male predominance reflects the higher frequency of male-specific urological disorders that prompt referral to urology services, underscoring the influence of care pathway and service setting on UTI epidemiology.[17] In contrast, community-based UTI prevalence studies usually report a higher female burden due to their anatomical predisposition, suggesting that the gender pattern in this study is more representative of a clinic-based case mix than a general population UTI epidemiology.[3]

Age was clustered to support comparisons of age-related trends in UTIs and urological conditions, as immune response, comorbidity burden, and anatomical changes vary significantly across these life stages.[18] The largest age group was 46–64 years (38.2%), followed by 65–84 years (36.2%), indicating a predominantly older cohort. This is consistent with urology clinic populations, where age-related urological conditions such as benign prostatic hyperplasia, urinary tract obstruction, and recurrent infections are common.[19] Age-related immunosenescence and comorbidities, such as diabetes and chronic kidney disease, increase susceptibility to UTIs and may contribute to higher culture positivity rates in older patients, suggesting a high-risk urology population.[20,21]

Leukocyte trace results or higher were classified as positive in the primary analysis, yielding a 35.6% positivity rate, while a secondary, stricter threshold (≥ 1+) reduced the positivity rate to 23%. This dual-threshold approach was used to capture traces reflecting low-grade pyuria, thereby improving sensitivity in detecting early recurrent or partially treated infections, especially in urology populations. Reports with ≥ 1+ enhance specificity and better correlate with bacteriuria, thereby strengthening diagnostic precision. Recent evidence supports this framework, demonstrating that trace-inclusive thresholds achieve higher sensitivity (> 80%) but lower specificity, while ≥ 1+ thresholds improve specificity (> 75%) and PPV.[22,23]

Additional data indicate that urology-specific factors, such as instrumentation and prior antibiotic exposure, may cause low-level leukocyturia detectable as a trace.[24] Collectively, this sensitivity analysis approach balances case detection and diagnostic accuracy, aligning with contemporary recommendations for dipstick-based UTI evaluation. After excluding contaminants (19.8%), the urine culture positivity rate was 39.7%, higher than broad mixed-practice cohorts (14.8%) but lower than enriched hospital or specialist cohorts (49.8–54.1%), though closely aligned to a recent urology-oriented study (41.0%).[7,25]

Culture positivity rates of 52–60% were reported among urology patients in Kenya, with an approximate rate of 55% documented in a tertiary-care urology cohort.[6,7] These similarities represent the selective testing of symptomatic patients and the prevalence of complicated or recurrent infections in these settings. This high positivity rate reinforces the characterisation of the study population as a high-risk clinical cohort. Moreover, it supports the internal validity of the findings, as observed outcomes are consistent with disease prevalence and diagnostic yield expected in specialist urology clinics.

The common uropathogens isolated (*E. coli*, *Klebsiella pneumoniae*, and *Enterococcus faecalis*) align with global and regional urology-specific reports. *E. coli* was also the primary pathogen in adult UTI patients (~ 30–40%), with *Klebsiella* and *Enterococcus* spp. as commonly occurring secondary pathogens.[26] Similarly, the prevalence of *E. coli* in both uncomplicated and complicated UTIs was lower in referral and urology clinic settings, reflecting pathogen diversity.[27] The comparatively low rate of *E. coli* (13.3%) in the current study is therefore not anomalous but indicative of a more complex, high-risk urology cohort.

Dipstick leukocyte positivity (23.0%) is consistent with the known variability of urine dipstick tests, which are influenced by factors such as urine concentration and contamination.[17] The higher rate of negative dipstick results in this cohort may reflect non-infectious urological inflammation, asymptomatic bacteriuria, or prior antibiotic use before specimen collection, which are common among urology patients. The diagnostic performance of leukocytes varied meaningfully depending on contaminant inclusion or exclusion. Consistently, it demonstrated low sensitivity (36.6–36.8%) and relatively high specificity (85.6–89.7%). This imbalance indicates that leukocytes have limited utility as screening (rule-out) tests, as reflected by the modest NPV (60.6% vs. 68.7%) and relatively weak negative likelihood ratios (LRs -0.71 and -0.74), both of which are insufficient to confidently exclude UTI.

Conversely, leukocytes demonstrate moderate rule-in capacity, particularly when contaminants are excluded. This is evidenced by higher specificity (89.7%), improved PPV (76.6%), and a stronger positive likelihood ratio (LR +3.56). However, even at its best performance, the positive likelihood ratio remains below the conventional threshold of ≥ 10 required for strong confirmatory testing.[28] Thus, leukocytes alone provide only moderate diagnostic evidence for confirming infection.[28] These findings align with other studies reporting similar low sensitivity (~ 30%) and high specificity (~ 90%) in urology settings, supporting the fact that leukocyte testing is not sufficient to rule out UTI and that complementary culture in high-risk patients is necessary.[9,29,30] The significant association between leukocyte positivity and culture growth suggests that dipstick testing retains diagnostic value in urology settings. However, sensitivity is limited by the presence of culture-positive samples devoid of leukocyturia. This also aligns with meta-analyses and large reviews reporting leukocyte sensitivity at 70–90%, with inconsistent specificity, making it a rule-in test rather than a conclusive diagnostic method.[29]

The logistic regression model indicated that leukocytes are a significant predictor of culture-confirmed UTI. In the univariate model, leukocytes were strongly associated with culture positivity

(Wald χ^2 = 24.537; p < 0.001), increasing the odds of bacterial growth by almost fivefold (OR 5.04, 95% CI 2.66 to 9.54). This indicates that leukocyte presence substantially increases the likelihood of infection and supports its role as a meaningful point-of-care predictor. These findings are consistent with Keenan et al.[9] (OR ~ 3.0; p < 0.01) and Wanja et al.[30] (OR ~ 2.8; p = 0.02). The stronger OR observed in our study underscores the value of leukocytes as a rapid, point-of-care predictor of culture positivity in complicated UTI settings.

In the multivariate likelihood ratio analysis, leukocytes remain the most influential predictor (χ^2 = 21.699; p < 0.001). Sex also contributed significantly to the model fit (χ^2 = 10.286; p = 0.001). In contrast, age group (χ^2 = 1.850; p = 0.174) and eGFR (χ^2 = 0.004; p = 0.950) do not significantly improve the model fit, indicating the discriminatory value of these variables in this cohort. This pattern mirrors findings from other studies, in which biological markers (leukocytes) and demographic factors (sex) outperform clinical stratifiers (age and renal function) in predicting bacteriuria in urology settings. The consistent importance of leukocytes and sex in high-risk groups indicates that rapid dipstick tests and demographic variables are important predictors of bacteriuria.[9,30]

AMK showed the greatest susceptibility across the bacterial isolates, with greater susceptibility in *E. coli* and the "others" category, and minimal observed resistance. NIT and GEN were also active in *E. coli*, and the susceptible number of the isolates was 28 and 26, respectively. Conversely, *E. coli* showed very high resistance to AMPCLX, CIP, and CRO, and low resistance to NIT and AMK, which aligns with the broader trend of recently reported increasing resistance to standard UTI antibiotics.[2,31] The overall resistance profile in this cohort was highest for SXT, AMPCLX, CXM, FEP, CIP, and CRO. While previous studies reported lower resistance rates (e.g. ~ 15–22% CIP resistance and 20–25% SXT resistance), the substantially higher resistance observed in this study likely reflects differences in the patient population, particularly in a higher-risk cohort in a clinically enriched set-up.[9,30]

Carbapenems and TZP showed very low resistance, consistent with their reserved use in multidrug-resistant infections. Nevertheless, stewardship is necessary to maintain such agents, and, in particular, resistance is more frequently reported in certain environments.[2] The high activity of NIT and AMK justifies their further use by empirical means where fluoroquinolones and SXT resistance are high. However, aminoglycosides must be closely monitored since nephrotoxicity can occur, especially in this group with a high prevalence of impaired renal function. Importantly, susceptibility proportions varied across antibiotics due to differences in denominators (n = 8–33), reflecting selective antimicrobial testing in accordance with Clinical & Laboratory Standards Institute M100 guidelines, which specify that antimicrobial panels are organism-specific and guided by intrinsic resistance patterns and clinical relevance. As such, not all isolates are tested against all agents.

The null hypothesis posited that no relationship exists among urine leukocytes, isolated bacterial species, and AMR patterns in UTI. Logistic regression demonstrated that leukocytes were an independent predictor of culture positivity (OR 3.361; p = 0.008) and may also reflect infection severity, often linked to resistant pathogens in urology clinic populations, thereby leading to partial rejection of the null hypothesis.

Study limitations

This study should be interpreted within the context of its design and data structure. The retrospective data review approach limits the ability to establish temporal relationships between leukocyturia and culture-confirmed UTI. However, this design is appropriate for evaluating diagnostic association and performance, which was the primary objective.

The use of routinely collected laboratory data reflects routine clinical practice, enhancing the external validity of the findings. Although some clinical variables, such as prior antibiotic exposure and presenting symptoms, were inconsistently documented and therefore not included, the consistency of observed associations, including the significant ORs and likelihood-based contributions, supports the robustness and utility of this study's findings.

Conclusion

This study evaluated the diagnostic performance of urine leukocyte indicators against culture-confirmed bacteriuria among adult patients attending a urology clinic. The study found that culture positivity for *E. coli* was the most common. In addition, the study revealed that leukocytes and sex had significant predictive value for culture growth, but age and kidney function (eGFR) were not independent predictors. Antimicrobial susceptibility patterns revealed high resistance to commonly used antibiotics, while NIT, aminoglycosides, and carbapenems showed better activity.

Acknowledgements

The authors acknowledge the supervisors, Synergy Clinics' urology clinic, headed by Dr Dedan Opondo, and the laboratory team for allowing data collection. The authors also thank the data team and statistician for their valuable contributions.

Conflict of interest

The authors declare no conflict of interest.

Funding source

The authors received no external funding.

Ethical approval

Ethical approval was obtained from the university, as well as independent review board approval from the University of East Africa, Baraton, Institutional Scientific Ethics Review Committee (UEAB/ISERC/29/07/2025), the National Commission for Science, Technology and Innovation (NACOSTI/P/25/4177979), and the hospital's management.

ORCID

BO Oyugi https://orcid.org/0009-0003-6149-3734
G Ayodo https://orcid.org/0000-0002-5565-2415
D Onguru https://orcid.org/0000-0002-2276-2853

References

1. Alateeq NM, Mohammed MB, Alsubaie AT, et al. Beyond urinalysis: evaluation of various clinical and laboratory reflex criteria to warrant urine culture collection

in the emergency department. Int J Emerg Med. 2024;17(77). https://doi.org/10.1186/s12245-024-00656-8.
2. Founou LL, Founou RC, Essack SY. Antimicrobial resistance in the farm-to-plate continuum: more than a food safety issue. Future Sci OA. 2021;7(5):FSO692. https://doi.org/10.2144/fsoa-2020-0189.
3. Foxman B. Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. Infect Dis Clin North Am. 2014;28(1):1-13. https://doi.org/10.1016/j.idc.2013.09.003.
4. Fetene G, Marami D, Ayele F, Abate D. Bacterial profiles, antibiotic susceptibility patterns, and associated factors of symptomatic urinary tract infections among symptomatic university students at Haramaya University, Eastern Ethiopia: cross-sectional study. Medicine (Baltimore). 2024;103(27):e38726. https://doi.org/10.1097/MD.0000000000038726.
5. Oh P, Lewis KC, Shoskes DA, et al. Urinalysis is predictive for absence of urinary tract infection in men with and without catheters. Neurourol Urodyn. 2024;43(8):1850-8. https://doi.org/10.1002/nau.25549.
6. Mohamed S, Hsu CY, Charlebois ED, et al. Dipstick leukocyturia as a kidney damage biomarker in rural Uganda and Kenya. Kidney Med. 2024;6(10):100895. https://doi.org/10.1016/j.xkme.2024.100895.
7. Maina J, Mwaniki J, Mwiti F, et al. Evaluation of the diagnostic performance of the urine dipstick test for the detection of urinary tract infections in patients treated in Kenyan hospitals. Access Microbiol. 2023;5(6):acmi000483.v3. https://doi.org/10.1099/acmi.0.000483.v3.
8. health.go.ke [Internet]. Kenya health facility census report. Nairobi: Ministry of Health; 2023[S1.1][BO1.2].
9. Keenan K, Papathomas M, Mshana SE, et al. Intersecting social and environmental determinants of multidrug-resistant urinary tract infections in East Africa beyond antibiotic use. Nat Commun. 2024;15(9418). https://doi.org/10.1038/s41467-024-53253-x.
10. Onyango HA, Sloan DJ, Keenan K, et al. The diagnostic accuracy of the point-of-care urine dipstick test in detecting urinary tract infection among symptomatic patients in Nairobi County, Kenya. medRxiv [Preprint]. 2024 medRxiv 24307793[S2.1][BO2.2]. https://doi.org/10.1101/2024.05.23.24307793.
11. Claeys KC, Trautner BW, Leekha S, et al. Optimal urine culture diagnostic stewardship practice-results from an expert modified-Delphi procedure. Clin Infect Dis. 2022;75(3):382-9. https://doi.org/10.1093/cid/ciab987.
12. Coffey KC, Claeys K, Morgan DJ. Diagnostic stewardship for urine cultures. Infect Dis Clin North Am. 2024;38(2):255-66. https://doi.org/10.1016/j.idc.2024.03.004.
13. Advani SD, North R, Turner NA, et al. Performance of urinalysis parameters in predicting urinary tract infection: does one size fit all? Clin Infect Dis. 2024:79(3):600-3. https://doi.org/10.1093/cid/ciae230. https://doi.org/10.1093/cid/ciae230
14. Kisuba K, Guyah B, Awuor SO, Ouma C. Uro-pathogens: prevalence of bacterial agents, and antimicrobial susceptibility profiles of urinary tract infections among pregnant women living with HIV in Kisumu County, Kenya. J Clin Images Med Case Rep. 2025;6. https://doi.org/10.52768/2766-7820/3421.
15. Capili B. Cross-sectional studies. Am J Nurs. 2021;121(10):59-62. https://doi.org/10.1097/01.NAJ.0000794280.73744.fe.
16. Mokaya CG, Emmanuel E, Sankarapandian V, et al. Prevalence of E. coli isolates from urinary tract infected patients attending selected hospitals in Kisii County, Kenya. IDOSR-JBCP[S3.1][BO3.2]. 2023;8(3):1-7. https://doi.org/10.59298/IDOSR/JBCP/23/11.1111.
17. Boehm U, Nelson G, Brown CM, et al. QUAREP-LiMi: a community endeavor to advance quality assessment and reproducibility in light microscopy. Nat Methods. 2021;18(12):1423-6. https://doi.org/10.1038/s41592-021-01162-y.
18. Cardone S, Petruzziello C, Migneco A, et al. Age-related trends in adults with urinary tract infections presenting to the emergency department: a 5-year experience. Rev Recent Clin Trials. 2019;14(2):147-56. https://doi.org/10.2174/1574887114666181226161338.
19. Santucci P, Greenwood DJ, Fearns A, et al. Intracellular localisation of Mycobacterium tuberculosis affects efficacy of the antibiotic pyrazinamide. Nat Commun. 2021;12(3816). https://doi.org/10.1038/s41467-021-24127-3.
20. Kumar NR, Balraj TA, Kempegowda SN, Prashant A. Multidrug-resistant sepsis: a critical healthcare challenge. Antibiotics (Basel). 2024;13(1):46. https://doi.org/10.3390/antibiotics13010046.
21. Magliano E, Grazioli V, Deflorio L, et al. Gender and age-dependent etiology of community-acquired urinary tract infections. Scientific World Journal. 2012;2012:349597. https://doi.org/10.1100/2012/349597
22. Rubilotta E, Balzarro M, Gubbiotti M, Antonelli A. Role of bladder emptying on outcomes of transurethral resection of the prostate. Urology. 2023;175:25-8. https://doi.org/10.1016/j.urology.2023.02.012.
23. Becknell B, Watson JR. Reexamining the role of pyuria in UTI diagnosis. Pediatrics. 2024;154(6):e2024068242. https://doi.org/10.1542/peds.2024-068242.
24. Sameer SK, Taha MJ, Alrubasy WA, et al. A systematic review of the accuracy and reliability of pyuria in diagnosing pediatric urinary tract infections. Cureus. 2025;17(2):e79135. https://doi.org/10.7759/cureus.79135.
25. Choi MH, Kim D, Bae HG, et al. Predictive performance of urinalysis for urine culture results according to causative microorganisms: an integrated analysis with artificial intelligence. J Clin Microbiol. 2024;62(10):e0117524. https://doi.org/10.1128/jcm.01175-24.
26. Yu SH, Jung SI, Lee S-J, et al. Antimicrobial resistance of Escherichia coli for uncomplicated cystitis: Korean antimicrobial resistance monitoring system. Antibiotics (Basel). 2024;13(11):1075. https://doi.org/10.3390/antibiotics13111075.
27. Sado K, Keenan K, Manataki A, et al. Treatment seeking behaviours, antibiotic use and relationships to multi-drug resistance: a study of urinary tract infection patients in Kenya, Tanzania and Uganda. medRxiv [Preprint]. 2023 medRxiv 23286801. https://doi.org/10.1101/2023.03.04.23286801.
28. Stengel D, Bauwens K, Sehouli J, Ekkernkamp A, Porzsolt F. A likelihood ratio approach to meta-analysis of diagnostic studies. J Med Screen. 2003;10(1):47-51. https://doi.org/10.1258/096914103321610806.
29. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015;13(5):269-84. https://doi.org/10.1038/nrmicro3432.
30. Wanja F, Caroline N, Omwenga EO, Maina J, Kiiru J. Urinary tract infection among adults seeking medicare at Kiambu Level 5 Hospital, Kenya: prevalence, diversity, antimicrobial susceptibility profiles and possible risk factors. Adv Microbiol. 2021;11(8):360-83. https://doi.org/10.4236/aim.2021.118028.
31. Saeed S, Chand P, Sulaiman A, et al. Process evaluation of paediatric fellowship training programs at a University Hospital in Pakistan. BMC Med Educ. 2023;23(1):612. https://doi.org/10.1186/s12909-023-04501-z.