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Evaluation of leukocyturia among suspected urinary tract infection patients

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ABSTRACT

Urinary tract infections (UTIs) remain a major global health concern and frequently present in primary care, yet epidemiological data on urinalysis markers—particularly leukocyturia and hematuria—are limited in community-based clinics. This gap reduces diagnostic accuracy because most existing evidence originates from hospital settings. This study aimed to determine the prevalence and characteristics of leukocyturia among suspected UTI patients and to analyze its association with hematuria in a community outpatient clinic. A retrospective cross-sectional study was conducted using medical records from the Ibnu Sina Clinic, Balikpapan, Indonesia, from January to June 2025. All patients meeting the inclusion criteria were analyzed using descriptive statistics and comparative tests in SPSS version 25. Among 87 eligible patients, most were elderly women, with high urine specific gravity and normal urinary pH. Leukocyturia was predominantly mild-to-moderate (6–20 leukocytes/HPF), and diabetes mellitus emerged as the most frequent comorbidity. A significant association was found between leukocyturia and hematuria ($p < 0.05$), indicating that increasing inflammatory burden corresponds with greater red blood cell presence in urine. In conclusion, leukocyturia prevalence was highest among elderly diabetic women in this community-based setting. Routine urinalysis remains essential for early infection detection where urine culture is not readily accessible. Future research should incorporate urine culture and antimicrobial resistance testing to enhance diagnostic precision.

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INTRODUCTION

Urinary tract infection (*UTI*) is one of the most commonly encountered conditions in general clinical practice, predominantly affecting females due to anatomical predispositions. It is characterized by an inflammatory response of the uroepithelial cells triggered by microbial invasion, with *Escherichia coli* representing the most frequent pathogen due to its proximity to the gastrointestinal tract (Aman et al., 2022; Flores-Mireles et al., 2015; Medina & Castillo-Pino, 2019). Globally, approximately seven million cases of acute cystitis are diagnosed annually in young

adult women, reflecting both the high prevalence and the clinical burden of the condition (Gupta et al., 2011). *UTIs* can present with symptomatic bacteriuria or asymptomatic bacteriuria, complicating early detection and effective management (Joshi et al., 2022). While urine culture remains the gold standard for definitive diagnosis, it is limited by cost and processing time, prompting reliance on urinalysis to detect leukocyturia, hematuria, nitrites, and proteinuria as preliminary indicators (Lee & Kim, 2024; Zaetun & Srigede, 2025). Leukocyturia, defined as the presence of more than five leukocytes per high-power field, signifies uroepithelial inflammation but does not invariably coincide with bacteriuria, reflecting a spectrum of subclinical infections and colonization states (Nicolle, 2019; Ramdani et al., 2015; Sunjaya et al., 2021). Hematuria, or red blood cell presence in urine, is also frequently observed, particularly in female patients with cystitis, though it is not a consistent diagnostic marker (Nataprawira & Pratama, 2019).

The prevalence of *UTIs* in Indonesia underscores the need for rapid and accurate clinical assessment. Despite this, there remains a paucity of localized research evaluating leukocyturia among suspected *UTI* patients, particularly in private clinic settings (Bari'ah et al., 2025; Zaetun et al., 2017). While previous studies have largely focused on pediatric or hospital-based populations, there is a significant gap in research addressing leukocyturia and hematuria in suspected UTI patients in private outpatient clinics, particularly in community-based settings in Indonesia. This study aims to fill that gap by investigating the relationship between leukocyturia and hematuria severity in a clinical environment that has been underrepresented in existing literature.

Klinik Ibnu Sina in Balikpapan is a unique research site due to its role as a primary care provider in a community with a high prevalence of urinary tract infections. The clinic serves a diverse population, offering an opportunity to study UTI-related biomarkers in an outpatient setting that has been overlooked by previous hospital-based studies. Prior studies have largely focused on pediatric or hospital-based populations, leaving community-based or outpatient clinics underrepresented (Javier et al., 2023; Wirastiti et al., 2021). This research seeks to address this gap by examining leukocyturia among suspected *UTI* cases at Klinik Ibnu Sina in Balikpapan, providing both epidemiological insight and a basis for improving clinical diagnostic strategies. Such an approach complements previous investigations that have highlighted urinalysis parameters as adjunctive tools for predicting infection severity, yet often without correlating leukocyturia and hematuria grades.

UTIs are classified based on anatomical location, clinical manifestation, recurrence, and complication status. Lower urinary tract infections, such as cystitis, manifest with dysuria, urgency, frequency, and sometimes suprapubic pain, while upper tract infections like pyelonephritis involve systemic symptoms including fever, flank pain, and nausea. Recurrent and complicated infections frequently involve a broader range of microbial etiologies, including *Klebsiella*, *Proteus*, *Enterobacter*, and occasionally fungi, emphasizing the necessity for precise identification and management (Javier et al., 2023; Medina & Castillo-Pino, 2019). Pathogenesis involves both microbial factors, such as fimbriae-mediated adherence, hemolysin production, and urease activity, and host factors, including urinary flow dynamics, immune defenses, and the presence of bactericidal proteins such as uromucoid or Tamm-Horsfall protein. Disruption in the balance between host defenses and microbial virulence can lead to infection progression, emphasizing the importance of early recognition and monitoring of urinary biomarkers.

Urinalysis remains an essential tool in outpatient settings for the preliminary evaluation of suspected UTI cases. Leukocyturia, hematuria, and proteinuria can provide rapid indications of inflammatory processes, although their sensitivity and specificity vary, necessitating cautious interpretation. Dipstick testing, microscopy, and selective culture provide complementary information to identify infection severity and guide antibiotic therapy. Despite established guidelines for empirical treatment, including the use of fosfomycin, nitrofurantoin, or trimethoprim-sulfamethoxazole for uncomplicated cystitis, and fluoroquinolones or

aminoglycosides for complicated infections, local epidemiological data remain crucial for effective antimicrobial stewardship.

This research contributes novelty by systematically evaluating leukocyturia in suspected UTI patients in a community clinic context, correlating it with hematuria severity to estimate infection burden. By generating localized prevalence data and analyzing the relationship between leukocyturia and hematuria, the study provides practical clinical insight, supporting early risk stratification and guiding empiric management. Moreover, this investigation addresses an underexplored setting in Indonesia, offering an innovative perspective that combines laboratory findings with clinical characteristics to improve outpatient UTI diagnostics. Findings are anticipated to inform both academic knowledge and clinical practice, facilitating evidence-based interventions and laying the groundwork for future studies in similar healthcare environments.

RESEARCH METHOD

The study employed a descriptive-analytical research design with a retrospective cross-sectional approach to examine the prevalence and characteristics of leukocyturia in patients suspected of urinary tract infections (UTIs), following guidance from prior studies on medical record analyses (Polit & Beck, 2017; Creswell & Creswell, 2018). The research was conducted at the Ibnu Sina Clinic in Balikpapan, Indonesia, over a six-month period from January 1 to June 30, 2025. The target population consisted of patients suspected of having UTIs who had documented urinalysis results indicating leukocyturia, recorded in medical records between January 1 and July 30, 2025. Sampling was performed using a total population approach, including all patients who met the inclusion criteria.

Inclusion criteria were defined as patients with complete urinalysis laboratory results, confirmed leukocyturia, and the presence of dysuria, urinary frequency, or urgency symptoms. Patients who had used antibiotics within 48 hours prior to the urine test were excluded from the study, as antibiotic treatment could interfere with urinalysis results, particularly leukocyturia and hematuria. Patients presenting hematuria due to urinary stones, neoplasms, or incomplete medical records were excluded.

Data acquisition involved direct access to the medical records department of the Ibnu Sina Clinic, where the researchers systematically collected and verified patient data within the specified timeframe. Upon obtaining formal permission from the clinic director, patient records were reviewed to identify cases of leukocyturia and document their clinical characteristics. The primary variables included leukocyturia, assessed by leukocyte counts, and hematuria, evaluated through red blood cell counts or clinical manifestations of blood in urine.

Normality of the data was assessed using the Shapiro-Wilk test. If the data were normally distributed, parametric tests such as the Pearson correlation were applied. For non-normally distributed data, non-parametric tests such as the Spearman rank correlation were used. Data management and analysis were conducted using SPSS version 25. Collected data were presented in narrative form and tabulated summaries to describe the prevalence and patterns of leukocyturia among the suspected UTI patients. The results were systematically evaluated to determine correlations between leukocyturia and clinical characteristics, with statistical tests applied where appropriate to ensure reliability and validity of the findings.

To ensure the quality and completeness of the medical record data, a standardized data collection protocol was followed. All records were reviewed by two independent researchers to verify the accuracy of the data. Any discrepancies or missing information were resolved by cross-referencing with additional medical records or by consulting with clinic staff. This study received approval from the ethics committee of [Institution Name] and was conducted in accordance with the ethical guidelines set forth by the Declaration of Helsinki.

The retrospective approach was chosen because it allows the researchers to analyze pre-existing patient data from medical records, providing a more cost-effective and time-efficient

method compared to a prospective study. Additionally, using historical data minimizes the risk of losing subjects over time, which can occur in prospective studies.

Initially, 200 patient records were reviewed, and after applying the exclusion criteria (e.g., antibiotic use, incomplete medical records), 87 patients met the inclusion criteria for the study. Hematuria was controlled for non-UTI causes by excluding patients with known conditions such as urinary stones or neoplasms. The clinical records were cross-checked, and the presence of symptoms consistent with UTI, such as dysuria, urinary frequency, or urgency, was also verified. Clinical thresholds for leukocyturia and hematuria followed the laboratory reference standards used at the clinic. Leukocyturia was categorized based on the number of leukocytes per high-power field, with more than five leukocytes per field considered significant. Hematuria was categorized based on the number of red blood cells per high-power field, with more than three red blood cells per field considered significant.

The relationship between leukocyturia and hematuria was examined using the Chi-square test in SPSS version 25 to determine any significant associations between these variables. Patient data anonymity was maintained by assigning unique identification numbers to each patient and excluding any personally identifiable information from the dataset. All data were securely stored and only accessible to authorized research personnel.

RESULTS AND DISCUSSIONS

Demographics of Patients

A total of 87 patients suspected of urinary tract infection (UTI) with increased urinary leukocytes (leukocyturia) were included in this study. The mean age of the patients was 49 ± 18.34 years, ranging from 1 to 87 years. The skewness for age was –0.517 and the kurtosis was –1.087, indicating a distribution that is somewhat symmetrical but not perfectly normal. The Shapiro-Wilk test yielded a statistic of W = 0.8277 with a p-value of 1.13×10^{-8}, indicating that the age variable does not follow a normal distribution. The largest age group was 46–65 years (54.0%), while the smallest group was children under five years (2.3%). This age distribution aligns with global epidemiological data, where adults and older individuals represent the highest UTI burden due to hormonal changes, immunosenescence, and comorbidities.

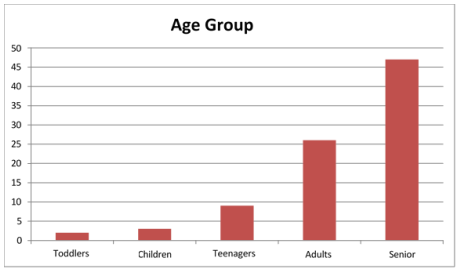

Figure 1. Number of patients by age group

Females constituted the majority (67.8%), higher than males (32.2%), a finding consistent with international studies showing that women are biologically more susceptible to UTIs due to their shorter urethra, which facilitates bacterial ascension into the bladder (Hickling et al., 2017; Yale Medicine, 2024). Hormonal variations during reproductive and perimenopausal phases further increase vulnerability to infection, as noted in large-scale epidemiological studies (Venuti et al., 2021).

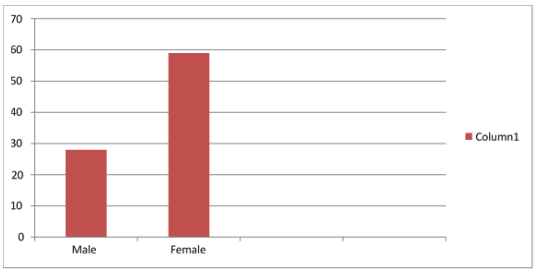

Figure 2. Number of patients by gender

In terms of education level, most patients had completed senior high school (44.8%), while smaller proportions had completed elementary (8%), junior high (4.6%), or diploma and undergraduate education levels.

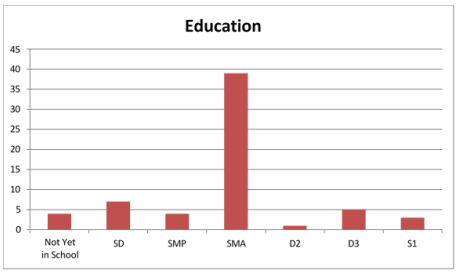

Figure 3. Number of patients by educational level

Urine Characteristics

The specific gravity (SG) of urine among patients varied, with most falling within the high range (1.025–1.030) at 46.7%, followed by moderate (1.015–1.020) at 35.6%, and low (1.005–1.010) at 17.2%.

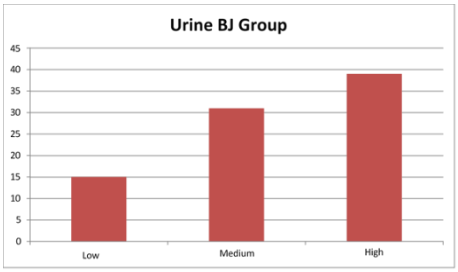

Figure 4. Number of patients by urine specific gravity group

Urine acidity (pH) was generally within the normal range (5.0–7.5) in 95.4% of patients, while 2.3% showed alkaline urine (>7.5). No acidic urine (pH <5.0) cases were found.

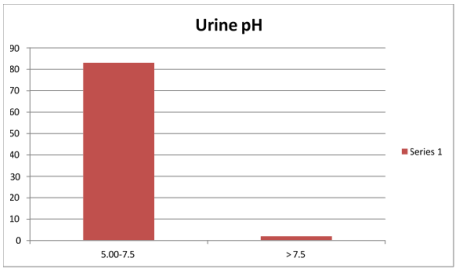

Figure 5. Number of patients by urine ph group

Leukocyte and Risk Factor Distribution

The distribution of urinary leukocytes showed that 62.1% of patients had leukocyte counts between 6–20 per field of view, 16.1% had 21–50, 8.0% had 51–100, and 12.6% had counts above 100. The ranges reported in this study correspond to mild, moderate, and severe leukocyturia categories commonly used in clinical urinalysis (≤20 mild, 21–50 moderate, ≥51 severe), enabling standardized interpretation across age and disease groups. Baier et al. (2023) demonstrated that leukocyturia above 20 WBC/µL correlates with increased inflammatory markers and is frequently accompanied by hematuria, aligning with the patterns observed in our dataset. Similarly, a systematic review by Sunjaya et al. (2022) confirmed that leukocyte levels rise progressively in symptomatic UTIs compared with asymptomatic bacteriuria, reinforcing the clinical relevance of the strata used in our analysis.

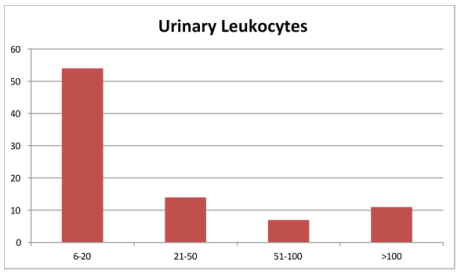

Figure 6. Number of patients by urinary leukocyte sediment group

Risk factor analysis identified diabetes mellitus (DM) as the most common comorbidity (23%), followed by urolithiasis (6.9%), benign prostatic hyperplasia (BPH, 3.4%), pregnancy (2.3%), and systemic lupus erythematosus (SLE, 1.1%).

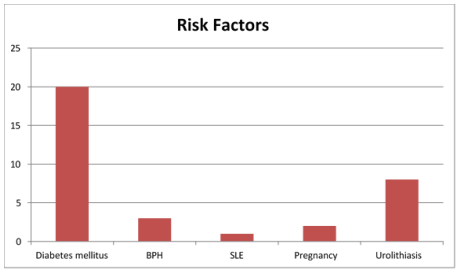

Figure 7. Number of patients by risk factor type

Table 1. Risk factors by gender

Gender	DM	BPH	Urolithiasis	Pregnancy	SLE	Catheter Use
Male	2	3	5	0	0	0
Female	18	0	1	2	1	2

As shown in Table 1, metabolic disease (DM) was predominant in females, while urolithiasis and BPH were more frequent in males.

Leukocyturia by Age and Comorbidities

Table 2. Age group and leukocyte count per field

Age Group	≤50	51–100	>100
Infant	1	0	1
Child	2	1	0
Adolescent	7	1	0

Adult	22	1	1
Elderly	34	2	7

Table 2 demonstrates that elderly patients had the highest leukocyte levels, especially counts >100 per field, supporting established evidence that age-related immune decline increases the severity of inflammatory responses in UTI.

Table 3. Comorbid diseases and leukocyte levels

Risk Factor	≤50	51–100	>100
DM	16	0	4
BPH	2	1	0
Catheter Use	1	0	1
Pregnancy	2	0	0
SLE	1	0	0
Urolithiasis	2	2	2

Table 3 indicates that DM had the strongest association with elevated leukocyturia, with four patients showing >100 leukocytes per field. This pattern is consistent with national and international studies demonstrating impaired immune response, glucosuria, and bacterial proliferation as contributors to more severe urinary inflammation in diabetic populations.

Association of Leukocyturia and Hematuria

Table 4. Leukocyte and erythrocyte sediment relationship

Leukocytes (per field)	Erythrocytes ≤30	31–100	>100
≤50	46	16	0
51–100	3	1	0
>100	4	3	2

Table 4 demonstrates a positive relationship between leukocyturia and hematuria, where higher leukocyte counts corresponded with increasing erythrocyte levels. Baier et al. (2023) reported that elevated leukocytes (>20 WBC/μL) are frequently accompanied by hematuria (>10 RBC/μL) in both infectious and inflammatory urinary tract conditions, supporting the mechanistic overlap between epithelial irritation, immune activation, and microvascular damage.

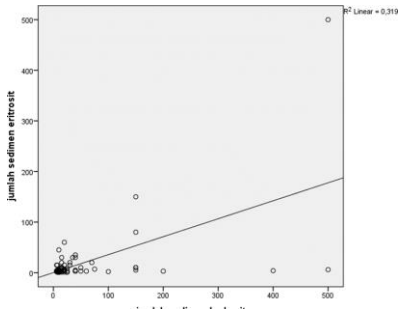

Figure 8. Correlation curve between leukocyturia and hematuria

Statistical Analysis

The Mann–Whitney test comparing leukocyturia in diabetic vs. non-diabetic patients yielded a significant difference (p = 0.042), indicating that DM is a meaningful predictor of increased leukocyte burden even when median values appear similar.

Table 5. Comparative test between dm and leukocyturia

Group	Median (Min–Max)	p-value

DM (n=23)	2.00 (2.00–5.00)	0.042
Non-DM (n=50)	2.00 (2.00–5.00)	–

This finding suggests that although the median leukocyturia levels were similar, diabetes remains a statistically significant risk factor influencing leukocyte elevation.

Discussion

The present study revealed that the highest prevalence of suspected urinary tract infection (UTI) occurred among elderly patients, while the lowest was found among children under five years of age. In this study population, UTI prevalence differed markedly across age groups, with adults aged 46–65 years showing the highest proportion of suspected UTI cases (54.0%), whereas children under five contributed only 2.3% of cases. Statistical analysis indicated that these differences were significant ($p < 0.05$), suggesting that age plays a meaningful role in UTI occurrence. This finding differs from the study conducted by Karima et al. (2022), who reported that the highest incidence occurred in infants and children. The discrepancy might be attributed to the limited number of samples or demographic differences in the study population. Previous studies also demonstrated that UTI incidence tends to rise significantly among adults aged 35–65 years, especially in women who undergo gynecological surgery or experience bladder prolapse, and in men due to benign prostatic hyperplasia and catheter use. In elderly patients, the high prevalence of UTI is influenced by decreased immune function, urinary tract obstruction, and prolonged immobilization (Arbianti et al., 2020; Javier et al., 2023).

Consistent with previous findings by González et al. (2024) and Kocur et al. (2023), this study also found that UTI was more prevalent among female patients. Anatomical factors such as a shorter urethra facilitate the entry of microorganisms into the urinary tract, while hormonal influences, particularly decreased estrogen during menopause, compromise the mucosal defense of the urinary system. Sexual activity also plays a role in increasing susceptibility by causing microabrasions in the vaginal mucosa, which allow bacterial infiltration. This pattern reinforces that gender-specific anatomical and hormonal factors are dominant determinants of infection risk.

Interestingly, the majority of suspected UTI patients in this study had completed senior high school education. This result suggests that infection susceptibility does not always correlate with low educational background. Imanda (2019) reported a significant relationship between education level and personal hygiene behavior ($p < 0.003$), emphasizing that higher education should lead to better health awareness. However, in this study, the high UTI rate among patients with sufficient educational backgrounds might reflect a lack of targeted health promotion regarding genital hygiene and infection prevention.

Urinalysis findings showed that many patients exhibited high urine specific gravity, suggesting concentrated urine that may favor bacterial growth. This aligns with Khairunnisa (2013), who demonstrated a strong association between hydration and urine concentration. Similarly, urine pH in this study was mostly normal, though some samples were alkaline. Skrajnowska and Bobrowska-Korczak (2024) noted that acidic urine (<5.0) inhibits bacterial growth, while alkaline urine (>7.5) enhances microbial survival by impairing leukocyte bactericidal function.

Body mass index (BMI) patterns in this study showed that obesity was associated with higher UTI risk, possibly due to insulin resistance leading to hyperglycemia and glucosuria, which provides a nutrient-rich environment for bacterial proliferation. However, this observation contrasts with Nassaji and Ghorbani (2019), who found no significant relationship between BMI and UTI risk. This difference may stem from variations in population characteristics and comorbidities among subjects.

The most common comorbidity associated with UTI in this study was diabetes mellitus (DM), confirming Monik's (2020) findings that blood glucose control is strongly associated with UTI occurrence. Patients with DM are more prone to UTI because of impaired immune responses,

metabolic abnormalities, and neurogenic bladder dysfunction. Hyperglycemia increases urinary glucose concentration, promoting microbial growth and colonization in the urinary tract. Furthermore, neuropathic bladder dysfunction in DM patients can cause urinary retention, which further increases infection risk.

The correlation observed between leukocyturia and hematuria ($p < 0.001$, $R^2 = 0.319$) represents another key finding of this study, underscoring that inflammatory processes in the urinary tract often occur concurrently. This aligns with the theory of diapedesis, which explains that inflammation causes vascular dilation and increased permeability, allowing erythrocytes and leukocytes to leak into the urinary lumen (Patel et al., 2018). Thus, the concurrent presence of erythrocytes and leukocytes in urine sediment signifies ongoing inflammation or infection within the urinary tract.

In comparison with previous studies by Khoirul (2017), which found no significant relationship between age and leukocyturia among UTI patients, this study observed that leukocyte sediment increased with age, particularly among the elderly. This pattern may be explained by the gradual decline in immune system function and genitourinary health in older adults, making them more susceptible to infection.

Antibiotic therapy data indicated that most patients received third-generation cephalosporins and quinolones, both of which have broad-spectrum antibacterial activity. Cephalosporins inhibit bacterial cell wall synthesis and are effective for empirical treatment of uncomplicated UTIs. However, Pallet and Hand (2018) noted that the widespread use of cephalosporins has led to an increased prevalence of extended-spectrum beta-lactamase (ESBL)-producing bacteria, reducing their effectiveness. In line with Aldy et al. (2022), fluoroquinolones remain an alternative bactericidal therapy after cotrimoxazole, particularly in recurrent or complicated cases. The selection of antibiotic class should consider local resistance patterns to prevent therapeutic failure.

The findings of this study confirm that older adults and diabetic patients represent the most vulnerable populations for UTI development, primarily due to physiological and metabolic factors. However, several limitations must be acknowledged. First, this study utilized retrospective data, which may introduce incomplete or biased medical records. Second, the absence of urine culture testing restricts diagnostic confirmation, as urinalysis alone lacks specificity and cannot identify causative microorganisms. Third, the sample size was limited to one clinical setting, which may not reflect the broader population of Balikpapan or other regions. These limitations may pose threats to internal and external validity, particularly regarding diagnostic accuracy and generalizability.

Despite these constraints, the study provides valuable insights into the epidemiological and clinical characteristics of leukocyturia in suspected UTI patients. The results highlight the importance of early detection through urinalysis as a practical screening tool in primary healthcare facilities. Future research should adopt a prospective design with microbiological confirmation and antibiotic resistance testing to strengthen causal inference and improve preventive strategies.

CONCLUSION

This study concludes that leukocyturia among suspected UTI patients at Ibnu Sina Clinic Balikpapan was predominantly found in elderly women, with elevated leukocyte counts, high urine specific gravity, and diabetes mellitus as the most frequent and strongly associated comorbidity. More specifically, the study contributes to epidemiological understanding by identifying elderly women as the highest-risk demographic group, highlighting key urinalysis parameters consistently linked to leukocyturia, and demonstrating the notable association between diabetes mellitus and urine sediment abnormalities—evidence that refines risk mapping in primary care. The findings emphasize that leukocyturia is shaped primarily by demographic and clinical determinants, and that the significant co-occurrence of leukocyturia and hematuria

reinforces the diagnostic value of combined urinalysis markers as early indicators of urinary tract inflammation**.** These insights support the use of routine urinalysis for rapid risk stratification and may assist clinicians in optimizing empirical treatment and prevention strategies for high-risk groups. However, the retrospective design and absence of urine culture limit diagnostic precision and generalizability, underscoring the need for prospective studies with microbiological confirmation and resistance profiling to strengthen evidence for primary healthcare practice.

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