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Diagnostic Accuracy of Urine Analysis in Diagnosis of Urinary Tract Infection in Malnourished Children Taking Urine Culture as Gold Standard

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ABSTRACT

Background: Urinary tract infection (UTI) is a frequent cause of morbidity in children, particularly in malnourished populations where immune compromise increases susceptibility and complications. Early diagnosis is essential to prevent renal damage; however, urine culture—the gold standard—is time-consuming and resource intensive. Urine analysis offers a rapid and economical alternative, but its diagnostic reliability in malnourished children in Peshawar remains insufficiently explored. **Objective:** To determine the diagnostic accuracy of urine analysis for detecting UTIs in malnourished children, using urine culture as the reference standard. **Methods:** The current cross-sectional validation study was carried out at the Department of Pediatrics, Lady reading Hospital, Peshawar, during the period between July 2024 and January 2025. The malnourished children who were aged 1-5 years and had suspected UTI were enrolled consecutively (290 in total). A urine sample was collected either in a clean-catch or suprapubic aspiration and placed under urine analysis and culture. Definitions of Pyuria were 10 or more WBC/mm 3 or 5 or more WBC/HPF. Sensitivity, specificity, predictive values, and accuracy were determined in terms of diagnostic indices. **Results:** UTI was established in 61 (21.0%) children by urine culture. Urine examination was affirmative in 86 (29.7) cases. The sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of urine measure stood at 80.3, 83.8, 57.0, 94.1, and 83.1 respectively. **Conclusion:** The sensitivity of urine analysis is high and the negative predictive is good, thus, it is a sensitive screening tool to rule out UTI in the malnourished child. Nevertheless, a urine culture must confirm positive results in order to proceed with the series of antimicrobial therapy.

INTRODUCTION

One of the most prevalent bacterial infections in children is urinary tract infections (UTIs)[1] and the leading cause of bacterial infections in infants,[2] but the incidence of the population among all the children remains largely unknown. antibiotics are generally used to treat urinary tract infections, which can result in hospitalization, genitourinary imaging, follow-up assessments, and surgery.1 The question of the optimum UTI diagnostic criteria, necessity of prompt diagnosis, and the use of imaging and prophylactic antibiotic therapy is still debated.[3,4]
UTI prevalence among pediatrics differs in terms of age, race, ethnicity, sex, and circumcision status. The incidences between the genders are very high and extend to their 1st year in life in the course of a 1st-time symptomatic UTI.[5] Boys show a higher rate than girls during the 1 st year of life and thereafter the rate decreases with girls bearing the UTI episodes that are 2-4 times higher than the African American child (2.4%) experiencing UTI.[7] UTI is more prevalent in uncircumcised boys (20.1) than in circumcised boys (2.4) (10-fold).[7]
In the case of acute UTIs, the patients sometimes stipulate that they need quick laboratory findings to enable prompt treatment.[8] Therefore, a fast technique of analyzing urine is discussed here. Automated urine flow cytometry has, in the recent past, been anticipated to deliver pertinent results very quickly and accurately in UTI screening.[9]
The urine culture is the standard of gold to demonstrate the causative microorganism of a UTI.10 Sterile technique is considered common where all collection procedures are related. Due to the discomfort of the patients and the standards of clinical setting, it is common to drop sterile collection procedures in favor of self-collection methods in which the patient holds control over his or her sample.[10]
A study conducted by Ali MA, et al has proven that, with a prevalence at 20.69, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the urine dipstick diagnostic tool in diagnosis of UTI in children with urine culture serving as the gold

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standard is 80.95, 62.42,35.98,92.63 and 66.26 respectively.[11]

One of the widespread bacterial infections among children (particularly malnourished children) is UTI. Urine analysis is a vital part of the diagnosis; however, its accuracy in comparison with urine culture as a gold standard has not been tested locally in Peshawar. Considering the high resistance of malnutrition and UTIs in this area, it is essential to identify the diagnostic value of urine analysis in detection of UTIs in malnourished children in Peshawar in particular. There are no past studies that have polluted this critical problem at the local level. Thus this research will address the gap by ascertaining the accuracy of naturally occurring urine diagnosis of UTIs with urine culture being the gold standard in malnourished children in Peshawar. The findings will contribute a lot of evidence regarding the trustworthiness of urine examination in diagnosing UTIs among this vulnerable group in this local area.

METHODOLOGY

The cross-sectional validation study presented took place at the Department of Pediatrics, Lady Reading Hospital (LRH), Peshawar, 3 July 2024 to 3 January 2025, to identify the diagnostic accuracy of urine analysis to predict urinary tract infection (UTI) in malnourished children where the gold standard was urine culture. There were 290 children aged 15 years of both genders with a clinical suspicion of UTI who were recruited using non-probability continuous sampling. The children who had antibiotics in the past 48 hours, children with congenital kidney abnormalities, obstructive uropathies, kidney tumors, renal disorders, and kidney failures were excluded. Informed written consent and ethical approval were obtained after which demographic and clinical data such as age, gender, weight, parental education, socioeconomic and residential status, and duration of symptoms were collected. Specimens were collected to represent urine by midstream clean-catch technique or suprapubic aspiration, under aseptic conditions and the samples were collected within an hour of collection and delivered to the hospital pathology laboratory. The urine analysis was conducted to identify the presence of pyuria, which is ≥10white blood cells/mm3 or ≥5white blood cells per high-power field, and urine culture was conducted to identify that UTI is present. The IBM SPSS version 22 was used to analyze data. Quantitative data was summarized in terms of means and standard deviation whilst frequencies and percentages were used to summarize qualitative data. Urine analysis diagnostic performance was assessed as sensitivity, specificity, positive predictive value, negative predictive value as well as an overall diagnostic accuracy calculated using a 2×2 contingency table using urine culture as the reference standard. The control of effect modifiers was done by stratifying the samples and post-stratification associations were measured by chi-square testing with p-value of 0.05 being deemed statistically significant.

RESULTS

There were 290 malnourished children who are between the age of 1 and 5. The mean age was 3.12 ± 1.21 years. The sample consisted of 158 (54.5% male and 132 (45.5% female). Most of the children were in low socioeconomic status 182 (62.8%), and 169 (58.3%) were rural residents. Body and mean weight were 10.6 and 2.4 kg respectively, and the mean symptom duration was 3.4 and 1.7 days respectively.

The urine culture confirmed urinary tract infection in 61 (21.0) children. Urine tests revealed the presence of pyuria in 86 (29.7) children. Cross-tabulation of urine analysis and urine culture indicated 49 true positives, 37 false positives, 12 false negatives and 192 true negative.

Urine test sensitivity was 80.3, specificity was 83.8, a positive prediction value of 57.0 and a negative prediction value of 94.1 showing a total diagnostic accuracy of 83.1.

Table 1

Baseline Characteristics of Study Population (n = 290)

Variable	Frequency (%) / Mean ± SD
Age (years)	3.12 ± 1.21
Male	158 (54.5%)
Female	132 (45.5%)
Weight (kg)	10.6 ± 2.4
Rural residence	169 (58.3%)
Urban residence	121 (41.7%)
Low socioeconomic status	182 (62.8%)
Middle/High socioeconomic	108 (37.2%)
Duration of symptoms (days)	3.4 ± 1.7

Table 2

Association Between Urine Analysis and Urine Culture with p-value (n = 290)

Urine Analysis	Urine Culture Positive	Urine Culture Negative	Total	p-value
Positive	49 (True Positive)	37 (False Positive)	86	
Negative	12 (False Negative)	192 (True Negative)	204	
Total	61	229	290	< 0.001

Figure 1

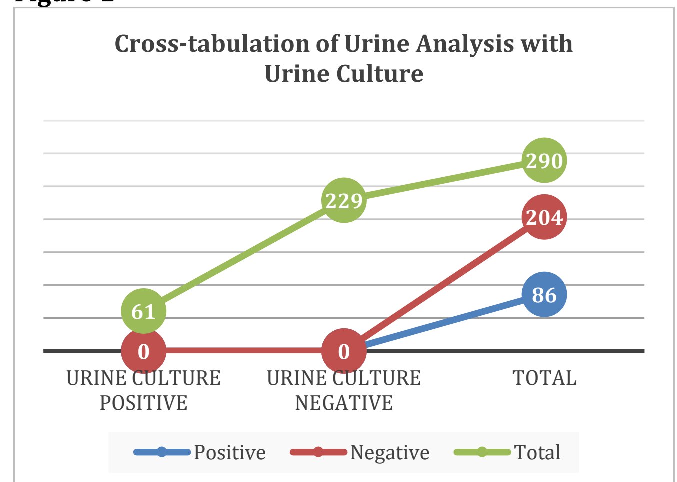

Table 3

Diagnostic Accuracy of Urine Analysis

Parameter	Value (%)
Sensitivity	80.3
Specificity	83.8
Positive Predictive Value (PPV)	57.0
Negative Predictive Value (NPV)	94.1
Diagnostic Accuracy	83.1

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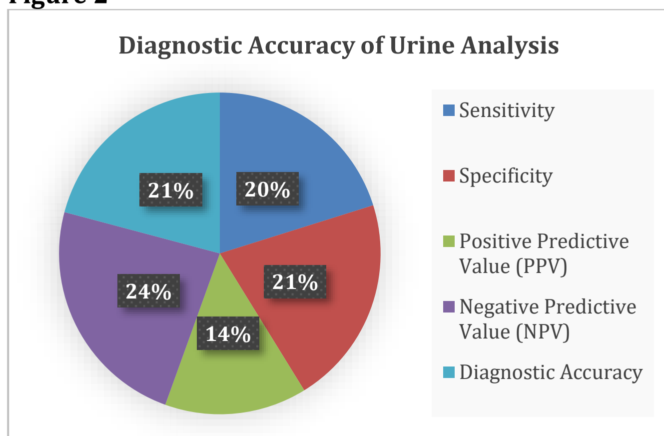
Figure 2



DISCUSSION

The current research assessed how well urine analysis is able to diagnose UTI in malnourished children based on urine culture as a reference standard in a tertiary care establishment in Peshawar and established that urine analysis can be classified to have a good overall diagnostic performance with a high sensitivity and an excellent false negative predictive value. The sensitivity of 80.3% can be used to show that UTIs that are proven by cultures can be detected by urine analysis, giving the tool an opportunity to be used as a valuable screening option in a resource-poor environment where immediate access to culture may not be easily accessible. Its good negative predictive value (94.1) also helps highlight its usefulness in clinical practice, indicating that a negative urine test is a strong predictor to rule out UTI in malnourished children, which could help to reduce the number of unnecessary antibiotic exposures and hospital stays.

Our findings are comparable to those reported by Ali et al., who documented a sensitivity of 80.95% for urine dipstick analysis in pediatric UTIs, reinforcing the consistency of urine analysis as a dependable preliminary diagnostic test.11 However, the positive predictive value in our study was relatively modest (57.0%), which may be attributed to the high burden of malnutrition in the studied population, where sterile pyuria and subclinical inflammation can occur even in the absence of bacteriologically confirmed infection. This highlights the importance of confirming positive urine analysis results with culture prior to initiating definitive antimicrobial therapy, particularly to avoid overtreatment and the development of antimicrobial resistance.

Malnutrition has been known to weaken immunity and mucosal defense, and thus predispose children to frequent and severe UTIs. Delayed reporting in this vulnerable group can cause extensive morbidity such as renal scarring, hypertension and chronic kidney disease. The present research includes locally generated evidence based on the integration of urine analysis as the initial screening modality in Malaysia amongst malnourished children who present with suspected UTIs in Peshawar. The short laboratory facilities in most hospitals within the Pakistani public sector implies that the turnaround time was minimal, and the urine analysis was cheap; this makes it a useful diagnostic adjunct.

Although the study has a number of strengths, it is constrained by its one-centre design and non-probability sampling, both of which can compromise the generalizability. Nevertheless, sufficient sample size and standard laboratory practices increases the validity of our results. The integration of automatic urine flow cytometry and molecular diagnostics in future multicenter studies could help to redirect the UTI screening of malnourished childhood patients.

To sum up, urine analysis proves to be highly sensitive and has a high negative predictive value, which shows it is a valid screening method to exclude UTI among malnourished children. Nonetheless, positive results must never be accepted without a culture of the urine to give proper and specific antimicrobial treatment because the positive predictive value is moderate.

CONCLUSION

This paper shows that urine examination can be used as effective screening methodology in early identification and diagnosis of urinary tract infection in malnourished children. The sensitivity and negative predictive value obtained are high, and thus, a negative urine test can be considered reliable in ruling out UTI, thus reducing the use of antibiotics, hospitalization, and health expenses in the context of limited resources. Such results are especially applicable to tertiary care Peshawar hospitals, where the availability of on-site urine culture services might be limited. Nonetheless, moderate positive predictive value points to the possibility of false-positive outcomes, and urine culture validation of positive results of urine analysis is necessary before decisive antimicrobial therapy is implemented. The idea of urine analysis as a first-line diagnostic tool could improve the process of clinical decision-making at an early stage and promote reasonable antibiotic stewardship. It is suggested to conduct future multicenter research to better establish these results and enhance the diagnostic algorithms of pediatric UTI in populations with malnutrition.

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