



Original Article



Frequency of Urinary Tract Infections in Protein-Calorie Malnutrition Children in Mardan Medical Complex

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ABSTRACT

Protein-calorie malnutrition (PCM) remains a significant cause of morbidity and mortality in low- and middle-income countries, where it often coexists with infections such as urinary tract infections (UTIs). Malnourished children are immunologically vulnerable, and UTIs further complicate their clinical course. **Objectives:** To determine the frequency of UTIs and associated risk factors among children with PCM admitted to a tertiary care hospital in Mardan, Pakistan. **Methods:** This descriptive cross-sectional study was conducted in the Department of Pediatrics, Mardan Medical Complex, from August 2024 to January 2025. A total of 123 children aged 6 months to 12 years with PCM were included. Demographic, clinical, and laboratory data were collected using a structured proforma. Urinary investigations included microscopy, dipstick nitrite test, and culture. Associations between UTI and clinical-demographic variables were analyzed using the Chi-square test, with effect size reported by Cramer's V. **Results:** The prevalence of UTI was 48.0%. Significant associations were observed with age <24 months ($p < 0.001$, $V = 0.642$), rural residence ($p = 0.035$, $V = 0.190$), severe acute malnutrition ($p = 0.015$, $V = 0.219$), and edema ($p = 0.017$, $V = 0.216$). *Escherichia coli* (30.1%) was the most common pathogen isolated. Most children improved with treatment (89.4%), though complications such as sepsis (10.6%) and acute kidney injury (6.5%) were reported. **Conclusions:** UTIs are common among malnourished children, particularly those under 2 years, severely malnourished, or from rural areas. Early screening and targeted interventions may reduce morbidity and improve outcomes.

INTRODUCTION

Protein-calorie malnutrition (PCM) is a major public health problem and one of the leading contributors to childhood morbidity and mortality worldwide [1]. Malnutrition compromises immune defenses, increasing vulnerability to infections and prolonging recovery from common illnesses [2]. Among these infections, UTI is particularly concerning, as it may cause renal scarring, chronic kidney disease, and impaired growth in children [3]. International evidence has consistently highlighted a strong association between malnutrition and UTI. A multicenter study from

Sub-Saharan Africa reported that nearly one-third of hospitalized children with severe malnutrition had concurrent UTIs [4]. Similarly, research from South Asia has shown UTI prevalence rates ranging from 20% to 35% in malnourished children, with *Escherichia coli* identified as the predominant pathogen [5, 6]. Rising antimicrobial resistance further complicates management in these settings [7]. In Pakistan, the burden of malnutrition remains alarmingly high. The National Nutrition Survey (2019) documented stunting in 40.2% and wasting in 17.7%



of children under five years [8]. Local hospital-based studies have confirmed that infections such as pneumonia, diarrhea, and UTI frequently complicate PCM, but most of these studies are either outdated or limited to small cohorts from urban centers [9, 10]. Evidence from Khyber Pakhtunkhwa is particularly scarce, despite its large rural population, where poverty and limited healthcare access heighten risks. Although global literature recognizes UTI as a frequent comorbidity in malnourished children, little is known about how demographic (e.g., age, sex, residence) and clinical characteristics (e.g., severity of malnutrition, edema) influence UTI risk in Pakistan. This knowledge gap hampers the development of effective screening strategies tailored to high-risk subgroups. By addressing this gap, the findings aim to generate locally relevant evidence that can guide early diagnosis, timely management, and context-specific preventive strategies for malnourished children in Pakistan.

Despite the recognized link between malnutrition and increased infection risk, local data on the prevalence and determinants of urinary tract infections among malnourished children in Khyber Pakhtunkhwa remain limited. Most previous studies in Pakistan are either outdated, restricted to small urban cohorts, or do not explore key demographic and clinical risk factors. This paucity of region-specific evidence hampers the development of targeted screening and intervention strategies for high-risk pediatric populations. This study aimed to determine the frequency of UTI in children admitted with PCM at Mardan Medical Complex and to evaluate demographic and clinical factors associated with UTI.

METHODS

This descriptive cross-sectional study was conducted in the Department of Pediatrics, Mardan Medical Complex, a tertiary care hospital affiliated with Bacha Khan Medical College, Mardan, Pakistan. Ethical approval for this study was granted by the Institutional Review Board of Bacha Khan Medical College, Mardan (Ref. No. 404/BKMC). The study was carried out over a period of six months, from August 2024 to January 2025. The study was conducted in accordance with institutional and CPSP guidelines for postgraduate research. Written informed consent was obtained from the parents or guardians of all participating children before enrollment. The hospital caters to both urban and rural populations. For this study, children residing within Mardan city and its municipal limits were classified as urban, while those from surrounding tehsils and villages, including Takht Bhai, Katlang, and Rustam, were considered rural. The sample size was calculated using the single proportion formula: $n = (Z^2 \times p \times (1 - p)) / d^2$. For a 95% confidence level, Z was taken as 1.96. The

expected prevalence of UTI among malnourished children was assumed to be 30% ($p=0.30$), based on previously published studies [11], with a margin of error of 8% ($d=0.08$). Substituting these values, the required sample size was estimated to be 126. However, due to the availability of eligible cases during the study period, a total of 123 children fulfilling the inclusion criteria were recruited. This reduction represented only a 2.4% decrease from the planned sample size, minimally affecting statistical precision, with the achieved margin of error widening from 8.0% to 8.2%, which does not compromise the validity of the findings. Children aged between 6 months and 12 years, admitted with a clinical diagnosis of PCM confirmed by anthropometric assessment, were included in the study. Severity of malnutrition was defined using WHO criteria: moderate acute malnutrition (MAM) as a weight-for-height Z-score between -2 and -3 SD or MUAC 11.5–12.4 cm, and severe acute malnutrition (SAM) as a weight-for-height Z-score < -3 SD, MUAC < 11.5 cm, or the presence of bilateral pitting edema. Z-scores were calculated using the WHO Anthro software for standardization. Children with known chronic kidney disease, congenital urinary tract anomalies, recent antibiotic use (within two weeks), or incomplete clinical records were excluded from the study. Anthropometric measurements were performed by a single trained pediatric resident using calibrated instruments to minimize inter-observer variability. Data were collected using a structured proforma by trained pediatric residents under faculty supervision. Demographic details, including age, sex, residence, and parental education, were recorded at admission. Clinical characteristics such as PCM severity, MUAC, edema, fever, history of previous UTI, diarrhea, and pneumonia were documented after thorough clinical evaluation. Laboratory investigations included urine microscopy for pyuria, dipstick for nitrites, urine culture for bacteriuria, and pathogen identification. For UTI diagnosis, pyuria was defined as ≥ 5 white blood cells per high-power field (WBC/HPF), significant bacteriuria as $\geq 10^5$ colony-forming units (CFU)/mL on urine culture, and nitrite positivity on dipstick as supportive evidence. Urine was collected according to hospital SOPs: clean-catch midstream specimens for toilet-trained children and sterile catheterization when indicated in non-toilet-trained. Bag specimens were not used for culture-based diagnosis; if used for initial screening, confirmatory clean-catch or catheter samples were required. Clinical outcomes such as length of hospital stay, sepsis, acute kidney injury, electrolyte imbalance, and discharge status were also noted. Sepsis was defined using pediatric Sepsis-3 criteria, and acute kidney injury was classified according to Kidney Disease: Improving Global Outcomes (KDIGO)

guidelines to ensure reproducibility. To ensure reliability and validity, standardized WHO criteria were used for the classification of malnutrition, while all laboratory tests were performed in the hospital's diagnostic laboratory following standard operating procedures [12]. Internal validity was strengthened by using uniform definitions for outcome variables and by double-checking data entries for accuracy. Data were entered and analyzed using SPSS version 26.0. Descriptive statistics were applied to summarize demographic variables, including age, sex, residence, and parental education, as well as clinical characteristics such as severity of PCM, MUAC category, presence of edema, fever, history of previous UTI, diarrhea, and pneumonia. Urinary findings, including pyuria, nitrite test, bacteriuria, culture results, and pathogens isolated, were presented separately. Clinical outcomes, such as length of hospital stay, complications, and discharge status, were described in table 5. Inferential analysis included Chi-square tests and Cramer's V for effect sizes. In addition, multivariable logistic regression was performed to adjust for potential confounders (age, sex, residence, PCM severity, edema, fever, and diarrhea) when evaluating associations with UTI. A p-value of less than 0.050 was considered statistically significant.

RESULTS

Among 123 malnourished children, most were aged 24–59 months (39.8%), followed by <12 months (24.4%), 12–23 months (20.3%), and ≥60 months (15.4%). Males slightly outnumbered females (52.0% vs. 48.0%). Over half were from rural areas (52.8%), and nearly half of parents had no formal education (47.2%), reflecting the influence of rural background and low parental education on PCM prevalence. Among the malnourished children, the distribution of severity was nearly equal, with MAM observed in 50.4% and SAM in 49.6%. MUAC revealed that 42.3% had values between 11.5 and 12.4 cm, while 35.8% were severely malnourished with MUAC <11.5 cm. Oedema, a clinical marker of severe malnutrition, was present in 39.8% of the children. Fever was the most common presenting feature, reported in 72.4%, followed by diarrhea (41.5%) and pneumonia (26.8%). A history of previous UTI was noted in 22.8% of participants, suggesting recurrence in a subset of cases. Collectively, these findings highlight the burden of comorbidities and infections that often complicate malnutrition in children (Table 1).

Table 1: Demographic and Clinical Characteristics of Children with PCM (N=123)

Variables	N (%)
Age group (months)	
<12	30 (24.4%)
12–23	25 (20.3%)

24–59	49 (39.8%)
≥60	19 (15.4%)
Sex	
Female	59 (48.0%)
Male	64 (52.0%)
Residence	
Rural	65 (52.8%)
Urban	58 (47.2%)
Parental education	
None	58 (47.2%)
Primary–Secondary	47 (38.2%)
Higher	18 (14.6%)
PCM severity	
MAM	62 (50.4%)
SAM	61 (49.6%)
MUAC category (cm)	
<11.5	44 (35.8%)
11.5–12.4	52 (42.3%)
≥12.5	27 (22.0%)
Oedema	
Yes	49 (39.8%)
No	74 (60.2%)
Fever	
Yes	89 (72.4%)
No	34 (27.6%)
History of previous UTI	
Yes	28 (22.8%)
No	95 (77.2%)
Diarrhea	
Yes	51 (41.5%)
No	72 (58.5%)
Pneumonia	
Yes	33 (26.8%)
No	90 (73.2%)

Laboratory evaluation revealed urinary abnormalities in a significant proportion of children. Pyuria was present in 56.1%, while bacteriuria was documented in 55.3%. Urine nitrite was positive in nearly half of the cases (48.8%). Culture positivity was observed in 44.7% of children, confirming UTI as a frequent complication among malnourished children. Among the pathogens, *E. coli* was the predominant isolate (30.1%), followed by *Klebsiella* (8.9%), *Proteus* (4.9%), and *Pseudomonas* (0.8%). No organism was detected in 55.3% of cultures, likely reflecting either prior antibiotic use or non-bacterial causes. These results confirm that Gram-negative bacilli, particularly *E. coli*, remain the most common etiological agents of UTI in malnourished children (Table 2).

Table 2: Urinary Findings and Culture Results of Malnourished Children(N=123)

Variables	N (%)
Pyuria (WBC/HPF)	
Yes	69 (56.1%)
No	54 (43.9%)
Urine Nitrite	
Positive	60 (48.8%)
Negative	63 (51.2%)
Bacteriuria	
Yes	68 (55.3%)
No	55 (44.7%)
Culture Result	
Positive	55 (44.7%)
Negative	68 (55.3%)
Pathogen Isolated	
<i>E. coli</i>	37 (30.1%)
<i>Klebsiella</i>	11 (8.9%)
<i>Proteus</i>	6 (4.9%)
<i>Pseudomonas</i>	1 (0.8%)
None	68 (55.3%)

Significant associations were observed between UTI status and several clinical-demographic variables. Children under 24 months had a markedly higher prevalence of UTI (83.6%) compared to older children (19.1%, $\chi^2=50.7$, $p<0.001$, Cramer's $V=0.642$), indicating age as the strongest predictor. Residence also played a role, with rural children more affected (56.9% vs. 37.9%, $\chi^2=4.43$, $p=0.035$, $V=0.190$). Similarly, SAM cases had higher UTI rates (59.0%) compared to MAM (37.1%, $\chi^2=5.92$, $p=0.015$, $V=0.219$). The presence of oedema was also significantly linked with UTI (61.2% vs. 39.2%, $\chi^2=5.73$, $p=0.017$, $V=0.216$). In contrast, sex, fever, and diarrhea did not show significant associations. These findings reinforce that younger age, severe malnutrition, oedema, and rural residence are key risk factors for UTI among malnourished children (Table 3).

Table 3: Association of UTI with Demographic and Clinical Variables(N=123)

Variable	UTI Present N (%)	UTI Absent N (%)	χ^2 (DF=1)	p-Value	Cramer's V
Age <24 Months	46 (83.6%)	9 (16.4%)	50.7	<0.001*	0.642
Sex (Male)	33 (51.6%)	31 (48.4%)	0.69	0.406	–
Residence (Rural)	37 (56.9%)	28 (43.1%)	4.43	0.035*	0.190
Severe Pcm (SAM)	36 (59.0%)	25 (41.0%)	5.92	0.015*	0.219
Oedema Present	30 (61.2%)	19 (38.8%)	5.73	0.017*	0.216
Fever Present	46 (51.7%)	43 (48.3%)	1.78	0.182	–
Diarrhea Present	26 (51.0%)	25 (49.0%)	0.32	0.573	–

In multivariable logistic regression analysis (Table 5), age remained the strongest independent predictor of UTI. Compared to children aged 24–59 months, those aged 12–23 months had more than 200-fold higher odds of UTI (aOR 222.2, 95% CI 15.1–3266.5, $p < 0.001$), while children aged ≥ 60 months also showed significantly elevated odds

(aOR 444.4, 95% CI 22.8–8672.6, $p < 0.001$). Estimates for the <12-month group were unstable due to quasi-complete separation but consistently indicated a very high risk. Diarrhea was an additional independent predictor (aOR 4.72, 95% CI 1.01–22.1, $p = 0.049$). In contrast, sex, residence, PCM severity, oedema, and fever did not retain statistical significance after adjustment. The final model demonstrated good calibration (Hosmer-Lemeshow $\chi^2=1.04$, $p=0.998$), explained 79% of the variance (Nagelkerke $R^2 = 0.792$), and correctly classified 90.2% of cases (Table 4).

Table 4: Multivariable Logistic Regression for Predictors of UTI in Children with PCM(N=123)

Variables	Adjusted Odds Ratio (aOR)	95% CI for aOR	p-Value
<12 months	Estimation unstable*	–	0.997
12–23 months	222.2	15.1 – 3266.5	<0.001
≥ 60 months	444.4	22.8 – 8672.6	<0.001
Sex (ref: Male)	2.10	0.52 – 8.57	0.301
Residence (ref: Urban)	0.52	0.13 – 2.11	0.360
PCM severity (ref: MAM)	1.35	0.31 – 5.81	0.688
Oedema (ref: No)	1.14	0.30 – 4.41	0.846
Fever (ref: No)	5.66	0.93 – 34.64	0.061
Diarrhea (ref: No)	4.72	1.01 – 22.06	0.049

Model statistics: Omnibus χ^2 (9) =110.8, $p<0.001$; Nagelkerke $R^2=0.792$; Hosmer–Lemeshow χ^2 (8) =1.04, $p=0.998$; overall classification accuracy=90.2%. *Estimation for the <12 months group was unstable due to quasi-complete separation (very high UTI prevalence in this subgroup).

Nearly half of the children (48.0%) had hospital stays of 6–10 days, while 34.1% stayed ≤ 5 days and 17.9% >10 days. Complications were infrequent, with sepsis (10.6%), acute kidney injury (6.5%), and electrolyte imbalance (11.4%) observed; most children (over 85%) had no major complications. Outcomes were generally favorable, with 89.4% improving, though a minority were referred (4.9%), left against advice (2.4%), or died (3.3%), indicating that a subset remained at risk of adverse outcomes (Table 5).

Table 5: Clinical Outcomes of Children with PCM(N=123)

Outcome	N (%)
Length of Stay	
≤ 5 days	42 (34.1%)
6–10 days	59 (48.0%)
>10 days	22 (17.9%)
Sepsis	
No	110 (89.4%)
Yes	13 (10.6%)
Acute Kidney Injury	
No	115 (93.5%)
Yes	8 (6.5%)
Electrolyte Imbalance	
No	109 (88.6%)
Yes	14 (11.4%)

Discharge Status	
Improved	110 (89.4%)
Referred	6 (4.9%)
LAMA	3 (2.4%)
Death	4 (3.3%)

The clustered bar chart illustrates the relationship between UTI presence and key risk factors, including age, residence, severity of malnutrition, and presence of oedema. The chart demonstrates that younger children (<24 months) were significantly more prone to UTI, with 83.6% testing positive compared to only 19.1% in those aged ≥24 months. Similarly, residence showed a notable disparity, as 56.9% of rural children had UTI compared to 37.9% of urban children. Nutritional status also influenced outcomes: SAM was strongly associated with UTI (59.0%) compared to MAM (37.1%). Furthermore, oedema-positive children exhibited a higher UTI prevalence (61.2%) than those without oedema (39.2%) (Figure 1).

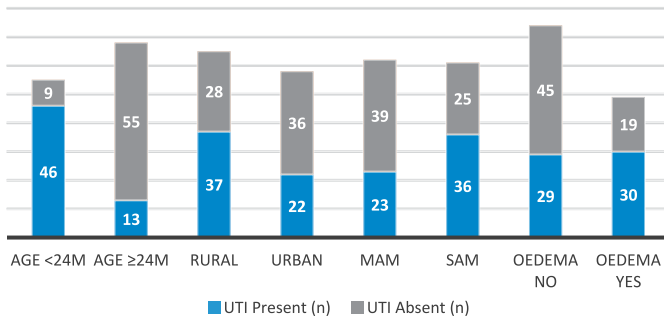


Figure 1: Distribution of UTI Status by Demographic and Clinical Factors among Malnourished Children (N=123)

DISCUSSION

This study found a high burden of urinary abnormalities among malnourished children, with culture-confirmed UTI in 44.7% and *E. coli* as the leading pathogen (30.1%). The organism pattern aligns with recent pediatric series and reviews in South Asia and sub-Saharan Africa, where *E. coli* dominates, followed by *Klebsiella* and *Proteus* among under-fives [12]. In severely malnourished populations, similar spectra have been reported, and gram-negative predominance is consistently linked to mucosal and innate immune compromise in wasting/SAM [13]. Pakistani datasets outside strictly malnourished cohorts also show *E. coli* leading and provide contemporary susceptibility context for empirical choices. [14] Age emerged as the strongest correlate: children <24 months carried markedly higher odds of UTI ($\chi^2=50.7$; Cramer's $V=0.642$). The age-gradient mirrors large observational series and meta-analyses showing peak UTI incidence in the youngest age groups and substantial recurrence in early childhood [15]. The finding was clinically relevant in malnourished settings because nonspecific febrile presentations are common and urinalysis may be falsely negative; recent pediatric studies caution that reliance on single screening tests can

miss cases in under-twos [12]. Nutritional severity also tracked with infection: SAM and oedema were significantly associated with UTI. These results are congruent with studies in SAM cohorts demonstrating higher UTI prevalence than in MAM or non-malnourished peers, and with multicountry work describing broad infection vulnerability (including UTI) among children admitted for SAM [16]. Recent scoping reviews and immunologic analyses reinforce biologic plausibility that protein-energy deficiency impairs barrier function, complement activity, and phagocytic killing, predisposing to gram-negative bacteremia and urosepsis. [17] Current WHO guidance on wasting underscores proactive infection screening and standardized treatment pathways in SAM, which supports the systematic urine testing approach used here [18]. A place-of-residence effect was observed: rural children had a greater UTI burden than their urban counterparts. Similar rural rural disadvantages have been described in recent pediatric UTI work from low- and middle-income settings, with proposed contributors including delayed care-seeking, water and sanitation constraints, and higher rates of over-the-counter/unsupervised antibiotic exposure [19, 20]. These contextual drivers matter for antimicrobial stewardship and may partly explain culture-negative pyuria when prior antibiotics are used before hospital presentation. Fever and diarrhea were frequent but not independently associated with UTI in this dataset, echoing reports that clinical features alone have limited predictive value in young or malnourished children and cannot replace laboratory testing [21]. Length of stay clustered around 6–10 days and most children improved, comparable to contemporary pediatric UTI series where early diagnosis and targeted therapy reduce complications [22]. Nonetheless, measurable rates of sepsis (10.6%) and electrolyte imbalance (11.4%) highlight the ongoing risk envelope in malnutrition and the need for standardized inpatient bundles recommended in the 2023 WHO guideline [23]. Antimicrobial susceptibility testing was not systematically performed in this study, which limits the ability to make definitive empirical therapy recommendations. While existing Pakistani pediatric datasets show *E. coli* as highly prevalent, resistance rates vary by province and healthcare setting. For this reason, it is recommended that future studies in malnourished populations incorporate standardized urine culture with susceptibility profiling. This will allow empirical regimens to be tailored more reliably, reduce inappropriate antibiotic use, and improve outcomes. The generalizability of these findings must be interpreted cautiously. This was a single-center study with a modest sample size, conducted in Mardan Medical Complex, a tertiary referral hospital serving both rural and urban catchments in Khyber

Pakhtunkhwa. While the prevalence and predictors identified here are consistent with regional and international data, they may not fully represent malnourished children in other Pakistani provinces where healthcare access, referral patterns, and pathogen ecology differ. Larger multicenter studies across diverse Pakistani regions are therefore essential to validate these results and provide nationally representative estimates. Taken together, the data reinforce three operational points: (1) routine urine testing is justified in all hospitalized malnourished children, particularly under-twos; (2) empirical therapy should primarily cover *E. coli* and other Enterobacterales while awaiting culture, but definitive recommendations require ongoing local susceptibility surveillance; and (3) rural outreach and stewardship interventions (safe water, timely referral, rational antibiotic use) are likely to reduce missed infections and resistance pressure.

This study was conducted at a single tertiary care center with a modest sample size, limiting the generalizability of findings across Pakistan. Antimicrobial susceptibility testing was not systematically performed, restricting guidance on empirical therapy. Future research should involve multicenter studies with larger cohorts and integrate standardized resistance profiling to inform context-specific management strategies and optimize preventive interventions for malnourished children at risk of UTIs.

CONCLUSIONS

This study demonstrated a high frequency of urinary tract infection among children with protein-calorie malnutrition admitted to a tertiary hospital in Mardan. The strongest independent predictor was younger age (<24 months), while diarrhea also remained significant after adjustment. Severe malnutrition, oedema, and rural residence showed crude associations but did not retain significance in multivariable analysis. *E. coli* was the predominant pathogen isolated. These findings support the integration of routine urine screening in the clinical care pathway for malnourished children, particularly the youngest age groups, and highlight the need for context-specific empirical therapy guided by local antimicrobial susceptibility data.

Authors' Contribution

Conceptualization: KU

Methodology: HS, ABK

Formal analysis: AH, RK

Writing and Drafting: SK, KU, HS, ABK, RK

Review and Editing: SK, KU, HS, ABK, RK, AH

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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