Pediatric sepsis in resource-limited settings: epidemiological profile, clinical course, and predictors of organ dysfunction

Le Sepsis pédiatrique en contexte à ressources limitées : profil épidémiologique, évolution et facteurs prédictifs de défaillance viscérale

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ABSTRACT

Introduction: Pediatric sepsis is a major health emergency and a leading cause of mortality worldwide. Severity scores provide improved tools for the identification of severe cases and prognostic assessment. Data are lacking in resource-limited settings.

Aims: To determine the prevalence of pediatric sepsis among hospitalized children, describe its epidemiological and clinical features, and identify factors associated with multiple organ dysfunction (MODS).

Materials and methods: This retrospective single-center study was conducted in the Department of Pediatrics at Fattouma Bourguiba Hospital, from January 2021 to June 2025. Children aged 1 month to 14 years with sepsis, defined according to the Phoenix criteria, were included. Disease severity was assessed using PELOD-2. Epidemiological, clinical, biological, therapeutic, and outcome data were evaluated.

Results: Up to 109 sepsis cases were identified (prevalence 1.04%), representing 12.9% of pediatric intensive care unit (PICU) admissions. Forty-eight patients met the inclusion criteria, with a mean age of 21.7 ± 38 months. Direct PICU admission occurred in 52.1%. Multiple organ dysfunction occurred in 70.8%, and mortality reached 41.7%. In univariate analysis, factors associated with MODS at PICU admission were failure to thrive, hypotension, oliguria, dysthermia, hypoxemia, hyperleukocytosis and elevated lactate. However, no independent predictors were identified in multivariate analysis. Indicators of disease severity, including the need for repeated fluid boluses and vasoactive drugs, were more frequently observed in patients with MODS. ROC curve analysis identified PELOD-2 ≥ 8 and Phoenix score ≥ 4 as thresholds more frequently observed in patients with MODS.

Conclusion : Pediatric sepsis remains associated with high mortality and frequent organ dysfunction. PELOD-2 and Phoenix scores may be useful for early risk stratification. However, these findings should be considered exploratory and require external validation in larger studies, particularly in resource-limited settings.

Keywords : Sepsis; Phoenix score; PELOD-2 score; Organ dysfunction; Intensive care; Pediatrics

RESUME

Introduction: Le sepsis est l'une des principales causes de mortalité pédiatrique. Les scores PELOD-2 et Phoenix permettent une estimation plus précise du pronostic. Les études demeurent rares dans les pays en développement.

Objectifs : Déterminer la prévalence du sepsis chez les enfants hospitalisés, décrire ses caractéristiques épidémiologiques et cliniques et identifier les facteurs associés à la défaillance multiviscérale.

Patients et méthodes : Il s'agit d'une étude rétrospective menée au service de pédiatrie de l'Hôpital Fattouma Bourguiba de janvier 2021 à juin 2025. Les enfants âgés de 1 mois à 14 ans présentant un sepsis selon les critères Phoenix ont été inclus. Les données épidémiologiques, cliniques, biologiques, thérapeutiques, évolutives et le score PELOD-2 ont été recueillis.

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Résultats : Un total de 109 cas de sepsis a été identifié (prévalence de 1,04 %), soit 12,9 % des admissions en unité de réanimation. Quarante-huit patients ont été inclus. L'âge moyen était de 21,7 ± 38 mois. Une admission directe en réanimation était observée chez 52,1 % des enfants. La mortalité était de 41,7 % et la défaillance multiviscérale était de 70,8 %. En analyse univariée, les facteurs associés à la défaillance multiviscérale à l'admission comprenaient le faible poids, l'hypotension, l'oligurie, la dysthermie, l'hypoxémie, l'hyperleucocytose et l'élévation du lactate. Cependant, aucun facteur indépendant n'a été identifié en analyse multivariée. Les indicateurs de gravité, notamment le recours aux remplissages vasculaires répétés et aux amines, étaient plus fréquemment observés chez les patients avec défaillance multiviscérale.
L'analyse des courbes ROC a identifié des seuils de PELOD-2 ≥ 8 et de score Phoenix ≥ 4, prédominants chez les patients présentant une défaillance multiviscérale.

Conclusion : Dans notre contexte, le sepsis reste associé à une mortalité pédiatrique élevée et à une forte incidence de défaillances d'organes. Les scores PELOD-2 et Phoenix pourraient être utiles pour la stratification précoce du risque. Cependant, ces résultats doivent être considérés comme exploratoires et nécessitent une validation externe dans des études de plus grande envergure, notamment en contexte de ressources limitées.

Mots-clés : Sepsis; Score Phoenix ; Score PELOD-2 ; Défaillance viscérale; Réanimation ; Pédiatrie

INTRODUCTION

Pediatric sepsis is a major global health emergency and remains one of the leading causes of morbidity and mortality among children, particularly in low- and middle-income countries. In 2017, an estimated 48.9 million sepsis cases and 11 million deaths were reported worldwide, accounting for nearly one in five deaths [1]. Early recognition in children remains challenging because clinical manifestations are often nonspecific, age-dependent, and may rapidly progress to circulatory failure and MODS [2–4] .
The 2005 International Pediatric Sepsis Consensus Conference (Sepsis-2) defined sepsis based on the presence of confirmed or suspected infection associated with age-adjusted SIRS criteria [4]. However, these criteria have shown limited diagnostic specificity and poor correlation with disease severity [5]. In adults, the introduction of Sepsis-3 in 2016 shifted the emphasis toward organ dysfunction quantified by the SOFA score [6], prompting a re-evaluation of pediatric definitions. Pediatric tools such as PELOD-2 and pSOFA have demonstrated stronger prognostic performance compared with SIRS, particularly in pediatric intensive care unit (PICU) settings [7].
In 2024, the Pediatric Sepsis Definition Task Force introduced the Phoenix criteria, an organ-dysfunction–based framework designed to improve the identification of severe pediatric sepsis and enhance mortality prediction [8–10]. These criteria represent an important step toward harmonizing pediatric sepsis definitions and may be particularly relevant in resource-limited settings, where early identification of organ dysfunction using clinically accessible parameters is essential and where reliance on complex or resource-intensive diagnostics may be challenging.
Globally, sepsis accounts for approximately 8% of PICU admissions, with higher prevalence reported in low-resource countries [3]. In Tunisia, available data remain limited, although mortality rates in pediatric septic shock have been reported to reach 50%, significantly higher than in high-income settings [11].
A recent national survey highlighted improved adherence to Surviving Sepsis Campaign recommendations among pediatric residents [12]. However, no Tunisian study has assessed the prevalence of pediatric sepsis using the newly proposed Phoenix criteria or examined factors associated with PICU admission and multiorgan dysfunction syndrome (MODS).
This study aimed to determine the prevalence of pediatric sepsis in hospitalized children at Fattouma Bourguiba University Hospital, Monastir and to describe its early epidemiological, clinical, and biological characteristics at PICU admission. A secondary objective was to identify factors associated with multiorgan dysfunction.

PATIENTS AND METHODS

Study design and setting

We conducted a single-center, retrospective, observational, and analytical study over 54 months (January 2021–June 2025) in the Pediatric Department of Fattouma Bourguiba University Hospital, Monastir,. The department admits approximately 2,500 patients annually and includes a seven-bed PICU, where all children requiring organ support or advanced monitoring are admitted.

Study population

Inclusion criteria

Children aged 1 month to 14 years diagnosed with sepsis according to the Phoenix Sepsis Score (PSS) Criteria (score ≥ 2) were included.

Non-inclusion criteria

Patients referred from other facilities with sepsis already diagnosed and treated before admission were not included. Cases with incomplete medical records preventing adequate data extraction were excluded.

Diagnostic definitions

Sepsis and septic shock were defined using the PSS, a pediatric-specific tool evaluating respiratory, cardiovascular, neurologic, and hematologic dysfunction [8–10]. Septic shock corresponded to sep-

sis with cardiovascular dysfunction (age-adjusted hypotension, lactate > 5 mmol/L, or vasoactive support). Severity of organ dysfunction was assessed using the PELOD-2 score, a validated mortality prediction tool in critically ill children [7]. Multiorgan dysfunction syndrome was defined as dysfunction of ≥ 2 organ systems. All scores were calculated at PICU admission.

Operational definitions

Underweight corresponded to a weight below the 10th percentile for age according to World Health Organization growth standards [13]. Fever and hypothermia were defined as body temperature ≥ 38 °C and < 36 °C, respectively [14]. Tachycardia and tachypnea were determined based on age-specific 95th percentile reference values [15]. Hypotension was assessed according to age-adjusted pediatric reference standards [16]. Altered consciousness was defined as a decreased level of consciousness based on age-appropriate Glasgow Coma Scale assessment [17]. Oliguria was defined as urine output < 1 mL/kg/h in infants and < 0.5 mL/kg/h in older children, according to KDIGO criteria [18].

Data collection

Data were extracted from medical records using a standardized collection form. All variables included in the analysis were collected at PICU admission.

1. Epidemiological characteristics: Age, sex, weight, and nutritional status.

2. Clinical variables: Vital signs, temperature abnormalities, hemodynamic status, neurological assessment, respiratory distress, perfusion parameters, urine output, and suspected site of infection. A SpO_2/FiO_2 threshold of <292 was used based on its definition in the Phoenix score.

3. Laboratory and imaging investigations: Complete blood count, inflammatory markers (CRP ± PCT), blood gases and lactate, renal and hepatic tests, coagulation profile, and microbiological cultures. Chest X-ray or additional imaging was performed when clinically indicated

4. Therapeutic interventions: Data on management included the timing and type of antibiotic therapy, fluid resuscitation, vasoactive support, respiratory support (oxygen therapy, non-invasive or invasive ventilation), and mode of PICU admission (direct or secondary). Fluid resuscitation was guided by clinical signs of hemodynamic instability, including tachycardia, prolonged capillary refill time, and mottling.
All variables were collected at PICU admission unless otherwise specified.

Ethical considerations

Confidentiality and data protection were ensured throughout the study in accordance with international ethical standards.

Statistical analysis

Data analysis was performed using SPSS version 25.0. Quantitative variables were expressed as mean ± standard deviation for normally distributed variables and as median [interquartile range] for non-normally distributed variables, qualitative variables as frequencies and percentages. Associations between variables and MODS were explored using Chi-square or Fisher's exact test for categorical variables and Student's t-test or Mann–Whitney U test for continuous variables. A p-value < 0.05 was considered statistically significant. Variables with a p-value ≤ 0.20 in univariate analysis were included in the multivariate model.

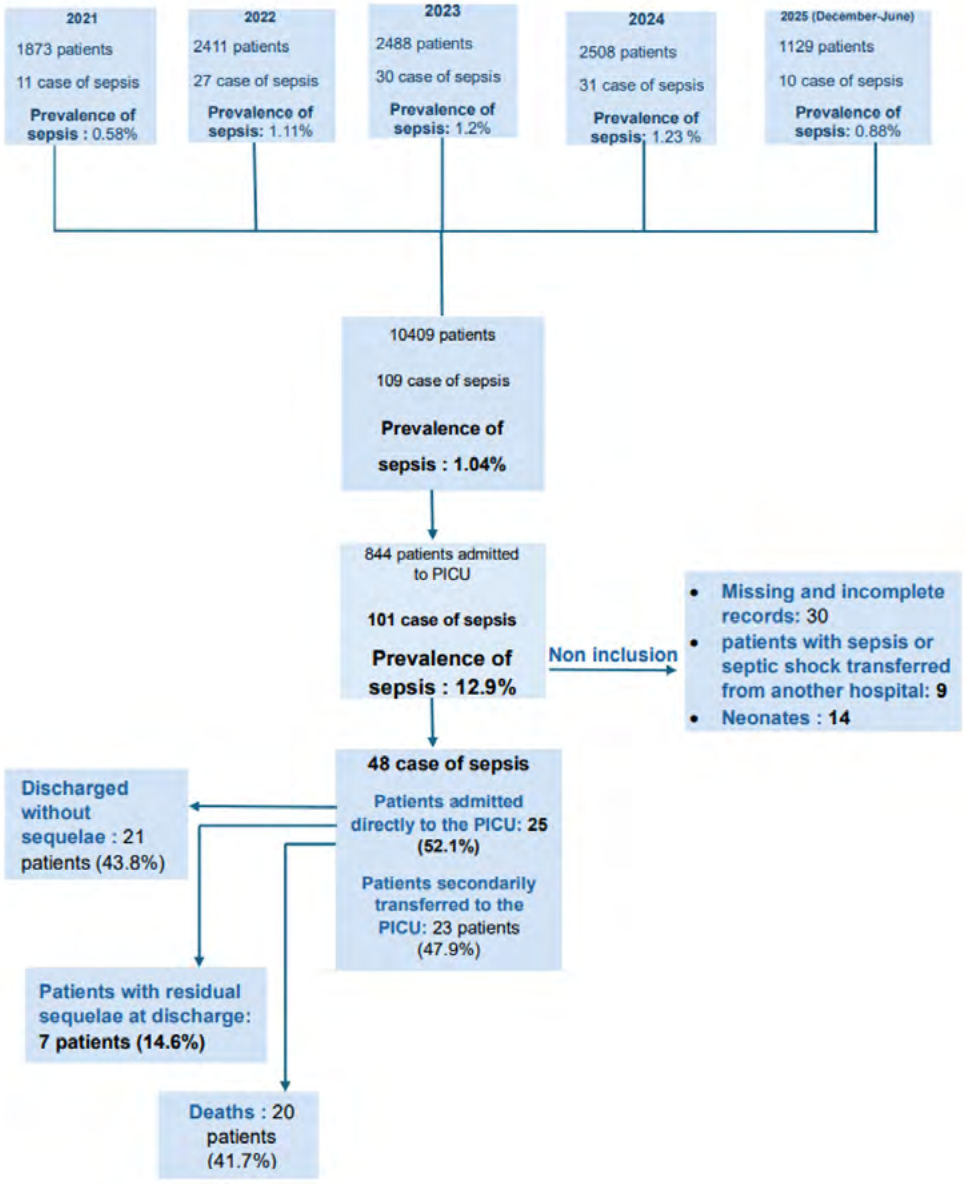
RESULTS

Descriptive study

1-Study population and sepsis prevalence

During the study period, a total of 10409 children were hospitalized, including 844 admissions to the PICU. Among these patients, 109 cases of sepsis were identified, corresponding to a prevalence of 1.04% among overall pediatric admissions and 12.9% among PICU admissions. Forty-eight patients met the inclusion criteria and were retained for analysis (Figure 1).

Figure 1 : Patient flow chart



2-Demographic characteristics:

The median age was 16.1 months (IQR: 10.9). The sex ratio was 1:1.
The median body weight was 8.09 kg (IQR: 5), ranging from 1.6 to 20 kg. Fourteen children (29.2%) had a weight below the 10th percentile.

3-Comorbidities :

Comorbidities were present in 26 patients (54.2%), including prematurity (n = 6), cerebral palsy (n = 5), congenital heart disease (n = 4), metabolic disorders (n = 2), congenital uropathies (n = 2), and leukemia (n = 1). A history of previous sepsis was noted in 4 children.

4-Clinical presentation:

At admission, temperature abnormalities were common, with fever ≥ 38.5 °C in 32 patients (66.7%) and hypothermia (< 36 °C) in 11 patients (22.9%). Hemodynamic instability was frequent, with tachycardia in 42 patients (87.5%), hypotension in 32 patients (66.7%), and clinical signs of impaired perfusion in the majority of patients (77.1%). Oliguria was observed in 19 patients (39.6%).
Respiratory evaluation showed a mean respiratory rate of 46± 16 breaths/min. Tachypnea was present in 25 patients (52.1%), whereas 3 patients (6.3%) exhibited bradypnea. Mean oxygen saturation was 90 ± 4 %, and 41 patients (85.4%) had a SpO_2 < 94% on room air.
Neurologically, 27 patients (56.3%) presented with altered consciousness at admission.

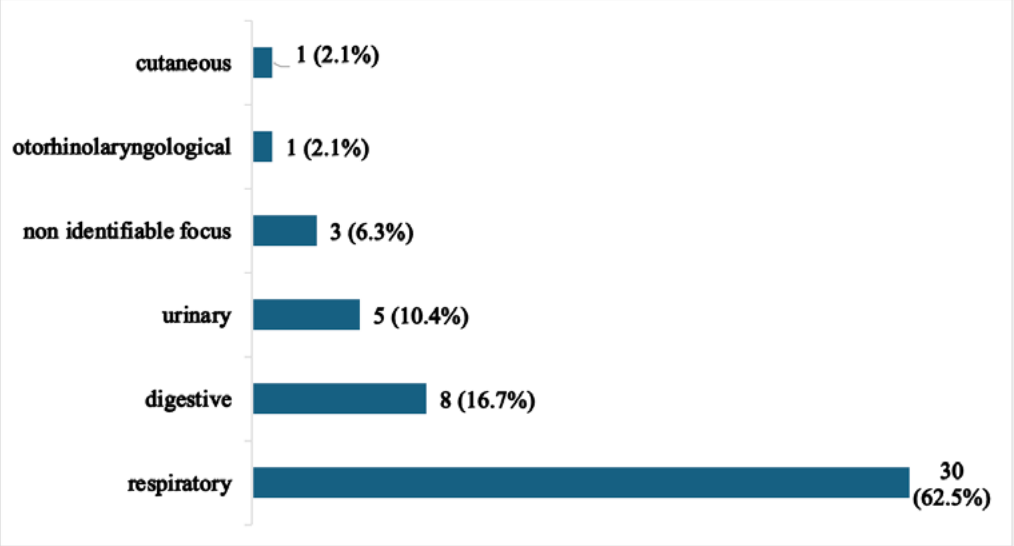
5-Laboratory investigation:

Laboratory findings revealed frequent hematological abnormalities, including leukocytosis (64.6%), lymphopenia (29.2%), thrombocytopenia (37.5%), and anemia (43.8%). Neutropenia and leukopenia were less frequent.
Coagulation abnormalities were frequent, with decreased prothrombin time 27 patients (52.1%) and prolonged INR in 24 patients (50%). Inflammatory markers were markedly elevated, with mean CRP level of 121.5± 96.3 mg/L and increased procalcitonin with a median concentration of 24.7 (IQR: 20.67) µg/L.
The mean lactate concentration was 6.11 ± 5.08 mmol/L. Blood gas analysis revealed metabolic acidosis in 21 patients (43.8%) and hypercapnia in 14 patients (29.2%). The mean pH was 7.25 ± 0.21, bicarbonate 18.01 ± 8.66 mmol/L and pCO_2 41.12 ± 19.84 mmHg.
Renal involvement was confirmed in 15 patients (31.3%), while hepatic cytolysis was reported in 12 patients (15%).

6-Documentation of the infection:

Microbiological documentation was obtained in 56.3% of patients. Blood cultures were positive in 37.5% of cases. Among positive blood cultures, Klebsiella pneumoniae accounted for 30% of isolates and Streptococcus pneumoniae for 17%. Respiratory samples were positive in 20.8% of patients. Among positive respiratory samples, Pseudomonas aeruginosa represented 30% of isolates. Other documented sources included urinary, intra-abdominal, catheter-related and cutaneous infections.
Radiological evaluation revealed findings consistent with pneumonia in 8 patients (16.7%).
Overall, respiratory and bloodstream infections were the most frequently documented sources, followed by urinary and intra-abdominal infections (Figure2).

Figure 2 : Distribution of infection sites among pediatric patients with sepsis (n = 48)



7-Severity scoring:

The PSS calculated for all included patients yielded a mean value of 5 ± 3. Septic shock was observed in 37 patients (77.1%). The mean PELOD-2 score was 9 ± 4.
Overall, 34 patients (70.8%) were classified in the multiorgan failure group, while 14 patients (29.2%) belonged to the non-failure group.

8-Therapeutic interventions:

At admission, 25 patients (52.1%) were directly admitted to the PICU, while 23 patients (47.9%) required secondary transfer to the PICU.
Fluid resuscitation was administered in 47 patients (97.9%), with a mean of 2 ± 1 boluses. Vasoactive agents were required in 29 patients (60.4%).
Empiric intravenous antibiotic therapy, subsequently adjusted according to culture results, was initiated within the first hour following PICU admission in 31 patients (64.6%).
Oxygen therapy was required in 46 patients (95.8%), ranging from simple nasal cannula in 6 patients (12.5%), non-rebreather mask in 1 patient (2.1%), and non-invasive ventilation in 7 patients (14.6%), to invasive mechanical ventilation in 32 patients (66.7%). A fraction of inspired oxygen (FiO_2) ≥ 50% was necessary in 33 patients (68.8%), while a SaO_2/FiO_2 ratio < 292 was observed in 40 patients (83.3%).

9-Patient outcome:

All patients exhibited hemodynamic instability at admission, defined by the presence of at least one of the following: tachycardia, hypotension or signs of impaired peripheral perfusion (prolonged capillary refill time, mottling, or cold extremities).
Respiratory failure developed in 35 patients, neurological failure in 23 patients, renal failure in 11 patients, and hepatic failure in 12 patients. Overall, 34 patients (70.8%) fulfilled the criteria for MODS and were classified as the multiorgan failure group, whereas 14 patients (29.2%) did not develop organ failure.
The median length of hospital stay was 19 days (IQR: 25), and the median duration of PICU stay was 11 days (IQR: 16).
Overall mortality was 41.7% (n = 20). Among survivors, 21 patients (43.8%) were discharged without sequelae, while 7 patients (14.6%) developed complications during hospitalization, corresponding to residual sequelae at discharge. These included post-anoxic ischemic neurological injury following cardiorespiratory arrest, seizures, withdrawal syndrome, and catheter-related thrombosis (femoral and iliac veins) requiring anticoagulation. All patients with complications were stabilized and discharged with appropriate management.

MODS Analytical study

1-Factors associated with MODS at PICU admission

No significant differences were observed regarding age, sex, comorbidities or underweight status.
Clinical parameters differed significantly between groups. Mean body temperature was lower in patients with MODS (37.4 ± 2.1°C vs. 39.1 ± 1.1°C, p = 0.006). Both hyperthermia (>38.5°C) and hypothermia (<36°C) were significantly associated with MODS (p = 0.014 and p = 0.015, respectively).
Mean arterial pressure was significantly lower in patients with MODS (39 ± 11 vs. 50 ± 7 mmHg, p = 0.04) and hypotension was more frequent in this group.
Oxygen saturation was significantly lower in patients with MODS (89 ± 3% vs. 94 ± 4%, p < 0.001), and SpO_2 < 94% was strongly associated with MODS (p = 0.001).
Oliguria was also significantly associated with MODS (p < 0.001).
Hyperleukocytosis was more frequent in patients with MODS (73.5% vs. 24%, p = 0.029), while mean leukocyte count did not differ significantly (p = 0.337).
Lactate levels were significantly higher in patients with MODS (7.1 ± 5.5 vs. 3.6 ± 2.3 mmol/L, p=0.034) Hypercapnia was also more pronounced in this group (44.6 ± 21 vs. 31 ± 11.5 mmHg, p = 0.041)..

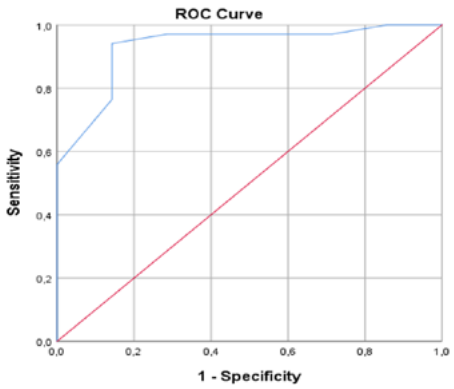
2-Indicators of disease severity:

Regarding management, patients with MODS required more intensive supportive care. Early antibiotic administration within the first hour of PICU admission was more frequent in this group, which may reflect greater severity at presentation or earlier clinical recognition.
They also received a higher number of fluid boluses, required vasoactive drugs more often and were more frequently treated with invasive mechanical ventilation. Impaired oxygenation parameters, including low SaO_2/FiO_2 <292 ratios and high FiO_2 ≥ 50% requirements, were more frequently observed in patients with MODS. Septic shock was more frequent among patients with MODS and the length of PICU stay was longer in this group.

3-Severity scores

The PELOD-2 score was higher in patients with MODS. ROC curve analysis appeared to show good discriminative performance (AUC = 0.931; 95% CI: 0.853–1), with a cutoff value of 8. Sensitivity and specificity of this cutoff were 85.3% and 85.3% (Figure 3).

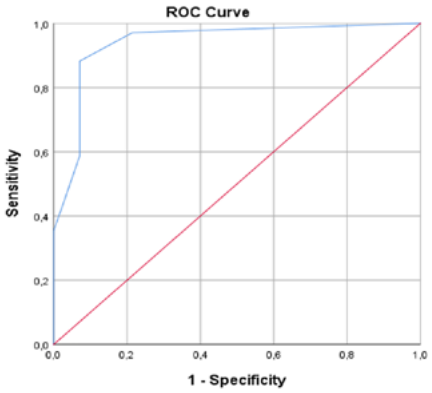
Figure 3 : ROC curve for determining the optimal PELOD-2 score for multiorgan failure



AUC	95% CI	Optimal cutoff	Sensitivity	Specificity	PPV	NPV
0.931	0.853 - 1	8	85.3%	85.3%	93.6%	70.6%

Similarly, the Phoenix Sepsis Score was higher in the MODS group, with an AUC of 0.913 (95% CI: 0.819–1) and an optimal cutoff of 4 . The corresponding sensitivity and specificity were 77.8% and 92%, respectively (Figure 4).

Figure 4 : ROC curve for determining the optimal Phoenix score for multiorgan failure



AUC	95% CI	Optimal cutoff	Sensitivity	Specificity	PPV	NPV
0.913	0.819 - 1	4	77.8%	92%	98%	62.3%

Factors associated with MODS in univariate analysis are summarized in Table I.
Multivariate logistic regression did not identify any independent predictors of MODS. Mean arterial pressure and lactate levels did not reach statistical significance (p = 0.053 and p = 0.057, respectively).

Table 1 : Factors associated with multiorgan failure at PICU admission in univariate analysis

Variable	Total (n=48)	Group 1 Non-failure (n=14)	Group 2 Multiorgan failure (n=34)	P value
Demographic characteristics				
Median age (months), median [IQR]	16.14 [10.88]	27.49 [60.60]	11.49 [8.88]	0.295
Male gender, n (%)	24 (50%)	8 (51%)	16 (47%)	0.525
Comorbidities, n (%)	26 (54.1%)	5 (35.7%)	21 (61.7%)	0.1
Clinical characteristics				
Underweight, n (%)	14 (29%)	4 (28%)	10 (29%)	0.954
Temperature ≥38.5°C, n (%)	32 (66%)	13 (92%)	19 (55%)	0.014
Temperature <36°C, n (%)	11 (22%)	0 (0%)	11 (32%)	0.015
Hypotension, n (%)	32 (66%)	5 (45%)	27 (79%)	0.04
Oliguria, n (%)	19 (39%)	0 (0%)	19 (55%)	<0.001
SpO2 <94%, n (%)	41 (85%)	8 (57%)	33 (97%)	<0.001
Altered consciousness, n (%)	27 (56%)	5 (35%)	22 (64%)	0.066
Laboratory findings				
Leukocytosis, n (%)	31 (64%)	6 (24%)	25 (73%)	0.029
Lactate (mmol/L), mean ± SD	6.11 ± 5.08	3.6 ± 2.3	7.1 ± 5.5	0.034
PCO2 (mmHg), mean ± SD	41.12 ± 19.84	31.1 ± 11.5	44.6 ± 21	0.041

DISCUSSION

To our knowledge, this study is the first in Tunisia to report the epidemiological profile and severity of pediatric sepsis using contemporary definitions and validated severity scores. It provides original data from a resource-limited setting and highlights the substantial burden and severity of pediatric sepsis. Pediatric sepsis accounted for 1.04% of hospital admissions and 12.9% of PICU admissions in our cohort and was associated with high rates of septic shock, MODS and mortality. These findings are consistent with reports from international cohorts, particularly low- and middle-income settings[3].

The use of the Phoenix criteria allowed identification of children with life-threatening organ dysfunction, addressing some limitations of earlier SIRS-based definitions that lacked specificity [19,20]. Despite recognized limitations, particularly in resource-limited settings [20–22], the PSS demonstrated good discriminative performance in this limited sample. A cutoff ≥ 4 was more frequently observed in patients with MODS, suggesting a potential role in early risk stratification, although these findings should be interpreted with caution.

As a recently developed score, external validation of the Phoenix Sepsis Score remains limited, and its performance may vary across different clinical settings and populations [8].

Similarly, the PELOD-2 score showed good discriminative performance in this limited sample, consistent with previous validation studies [5,23]. In our population, PELOD-2 ≥ 8 was more frequently observed in patients with MODS, supporting the potential value of organ dysfunction scores in assessing disease severity and predicting adverse outcomes in pediatric sepsis. Several studies have proposed different cutoff values for PELOD-2 depending on the outcome and study population. Reported thresholds vary widely, ranging from 6 for mortality prediction in large cohorts to 7 for organ dysfunction and up to 10 in smaller studies focusing on severe sepsis [23–25]. More recent data also suggest that optimal cutoffs may vary according to the timing of assessment, with values between 7 and 9 reported at different time points [26].

In this context, the cutoff value identified in our study (≥8) falls within the range reported in the literature. Differences across studies may be explained by variations in patient characteristics, severity at admission, timing of score calculation and sample size. Therefore, this threshold should be interpreted cautiously and requires external validation.

The interpretation of the predictive performance of the PELOD-2 and Phoenix scores should be made with caution, as both scores incorporate organ dysfunction parameters that overlap with the definition of MODS. This may introduce a degree of circularity and potentially overestimate their discriminative performance.

In resource-limited settings, the practical use of complex severity scores may be constrained by limited access to laboratory parameters. In such contexts, clinical assessment remains essential for early recognition of severe sepsis.

However, when available, structured scores such as PELOD-2 and Phoenix may support risk stratification and guide clinical decision-making, although their applicability should be adapted to local resource availability.

The mortality rate in our study (41.7%) remains high compared with high-income settings but is consistent with previously reported Tunisian and regional data [2,9,11,27]. This finding underscores the persistent lethality of pediatric sepsis in resource-limited environments, particularly when associated with septic shock and MODS.

Multiorgan dysfunction occurred in 70.8% of patients and was associated with hemodynamic instability, respiratory failure, metabolic derangements and elevated lactate levels. Respiratory dysfunction was the most frequent organ failure and was strongly associated with invasive mechanical ventilation, consistent with previous reports identifying respiratory failure as a major determinant of poor outcome in pediatric sepsis [28,29].

Although several variables were associated with MODS in univariate analysis, no independent predictor emerged in multivariate analysis. This may be explained by the relatively small sample size and the number of variables included, which may have resulted in overfitting and insufficient statistical power to identify independent predictors. This limitation highlights the need for larger multicentric studies to confirm these associations and refine predictive models in similar settings.

STRENGTHS AND LIMITATIONS

The main strengths of this study include the use of validated severity scores and the provision of novel data from a Tunisian PICU. However, the single-center design and small sample size limit generalizability and statistical power. An additional limitation concerns the distinction between baseline factors and the consequences of disease severity. Although the analysis was restricted to variables available at PICU admission, some clinical parameters may reflect early manifestations of organ dysfunction rather than true predictive factors. Furthermore, severity scores were calculated at PICU admission, which may influence their discriminative performance and limit comparisons with studies using serial assessments.

CONCLUSION

Pediatric sepsis in our setting is associated with high rates of septic shock, MODS and mortality. Early identification of severity using validated scores such as Phoenix and PELOD-2 may be useful for risk stratification and may help guide timely escalation of care in resource-limited environments. However, these findings should be considered exploratory and require external validation in larger and more diverse populations.

Conflict of interest statement

The authors declare that they have no conflicts of interest.

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REFERENCES :

[1] Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: analysis for the Global Burden of Disease Study. Lancet. 2020;395(10219):200–11.

[2] Weiss SL, Fitzgerald JC. Pediatric sepsis diagnosis, management, and subphenotypes. Pediatrics. 2024;153(1):e2023062967.

[3] Weiss SL, Fitzgerald JC, Pappachan J, Wheeler D, Jaramillo-Bustamante JC, Salloo A, et al. Global epidemiology of pediatric severe sepsis: the sepsis prevalence, outcomes, and therapies study. Am J Respir Crit Care Med. 2015;191(10):1147–57.

[4] Goldstein B, Giroir B, Randolph A, International Consensus Conference on Pediatric Sepsis. International pediatric sepsis consensus conference: definitions for sepsis and organ dysfunction in pediatrics. Pediatr Crit Care Med. 2005;6(1):2–8.

[5] Schlapbach LJ, Straney L, Bellomo R, MacLaren G, Pilcher D. Prognostic accuracy of age-adapted SOFA, SIRS, PELOD-2, and qSOFA for in-hospital mortality among children with suspected infection admitted to the intensive care unit. Intensive Care Med. 2018;44(2):179–88.

[6] Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315(8):801–10.

[7] Matics TJ, Sanchez-Pinto LN. Adaptation and validation of a pediatric sequential organ failure assessment score and evaluation of the Sepsis-3 definitions in critically ill children. JAMA Pediatr. 2017;171(10):e172352.

[8] Schlapbach LJ, Watson RS, Sorce LR, Argent AC, Menon K, Hall MW, et al. International consensus criteria for pediatric sepsis and septic shock. JAMA. 2024;331(8):665–74.

[9] Sanchez-Pinto LN, Daniels LA, Atreya M, Faustino EVS, Farris RWD, Geva A, et al. Phoenix sepsis criteria in critically ill children: retrospective validation using a United States nine-center dataset, 2012–2018. Pediatr Crit Care Med. 2025;26(2):e155.

[10] Hadzhieva-Hristova A, Krumova D, Stoeva T, Georgieva R, Iotova V. Assessment of Phoenix sepsis score, pSOFA, PELOD-2, and PRISM III in pediatric intensive care. Children (Basel). 2025;12(3):262.

[11] Bouziri A, Jaballah NB. The first hour resuscitation of pediatric septic shock. Tunis Med. 2011;89(2).

[12] Mestiri Y, Thabet F. Management of septic shock by pediatric residents: an area for quality improvement. Arch Pediatr. 2023;30(5):266–70.

[13] WHO Multicentre Growth Reference Study Group. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization; 2006.

[14] El-Radhi ASM. Why is the evidence not affecting the practice of fever management? Arch Dis Child. 2008;93(11):918–20.

[15] Bonafide CP, Brady PW, Keren R, Conway PH, Marsolo K, Daymont C. Development of heart and respiratory rate percentile curves for hospitalized children. Pediatrics. 2013;131(4):e1150–e1157.

[16] Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. Pediatrics. 2017;140(3):e20171904.

[17] Merck Manual Professional Edition. Modified Glasgow Coma Scale for infants and children.

[18] Kidney Disease: Improving Global Outcomes (KDIGO). KDIGO clinical practice guideline for acute kidney injury. Kidney Int Suppl. 2012;2(1):1–138.

[19] Schlapbach LJ, Kissoon N. Defining pediatric sepsis. JAMA Pediatr. 2018;172(4):312–4.

[20] Sanchez-Pinto LN, Bennett TD, DeWitt PE, Russell S, Rebull MN, Martin B, et al. Development and validation of the Phoenix criteria for pediatric sepsis and septic shock. JAMA. 2024;331(8):675–86.

[21] Rodriguez I, Deep A. Phoenix criteria for sepsis: are these enough to guide a clinician? Eur J Pediatr. 2024;183(11):5033–5.

[22] Long E, Borland ML, George S, Jani S, Tan E, Phillips N, et al. External validation of the Phoenix sepsis score in children with suspected community-acquired sepsis. JAMA Netw Open. 2025;8(3):e251412.

[23] Simanjuntak YR, Saputra I, Triratna S, Bakri A, Iriani Y. Validation of PELOD-2 score as a predictor of life-threatening organ dysfunction in pediatric sepsis. Paediatr Indones. 2020;60(5):227–32.

[24] Suari NMR, Latief A, Pudjiadi AH. New PELOD-2 cut-off score for predicting death in children with sepsis. Paediatr Indones. 2021;61(1):39–45.

[25] Yuniar I, Hafifah CN, Adilla SF, Shadrina AN, Darmawan AC, Nasution K, et al. Prognostic factors and models to predict pediatric sepsis mortality: a scoping review. Front Pediatr. 2023;10:1022110.

[26] Gallo-Motta LJ, Lince-Gonzalez AM, Bravo-Guerra DL, Pardo-Gonzalez CA, Perez-Morales R, Roa JD, et al. Utility of the Phoenix-8 and PELOD-2 scales in pediatric patients with sepsis and acute lymphoblastic leukemia admitted to a pediatric intensive care unit. Front Pediatr. 2026;14:1766687.

[27] Menif K, Khaldi A, Bouziri A, Kechaou W, Belhadj S, Hamdi A, et al. Mortalité au cours du choc septique de l'enfant secondaire à une infection communautaire: à propos de 70 cas. Med Mal Infect. 2009;39(12):896–900.

[28] Hamshary AAEE, Sherbini SAE, Elgebaly HF, Amin SA. Prevalence of multiple organ dysfunction in the pediatric intensive care unit: pediatric risk of mortality III versus pediatric logistic organ dysfunction scores for mortality prediction. Rev Bras Ter Intensiva. 2017;29(2):206–12.

[29] Song Y, Wang N, Xie X, Tian Y, Wang Y. Relationship between lactate levels and 28-day mortality in pediatric sepsis: results from the pediatric intensive care database. BMC Pediatr. 2024;24(1):712.