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Original Research Article

PEDIATRIC AGE-ADJUSTED SHOCK INDEX IN SEPSIS: A PREDICTOR OF MORTALITY IN THE INTENSIVE CARE UNIT OF A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: *Sepsis remains a major cause of morbidity and mortality in pediatric intensive care units, especially in low and middle-income countries such as Pakistan. Early detection of hemodynamic compromise is crucial to improving clinical outcomes. The Shock Index Pediatric Age-Adjusted (SIPA) offers a non-invasive, rapid method for risk stratification and may serve as a valuable prognostic tool.* ***Objective:*** *To evaluate whether abnormal SIPA values at admission and 24 hours post-admission are associated with increased mortality and adverse outcomes in children with sepsis.* ***Study Design:*** *Prospective observational cohort study.* ***Setting:*** *Pediatric Intensive Care Unit (PICU), The Children's Hospital, Lahore.* ***Duration of Study:*** *from March 2024 to March 2025.* ***Methods:*** *A total of 200 children aged 1 to 17 years with clinically diagnosed sepsis were enrolled using non-probability consecutive sampling. SIPA was calculated using heart rate and systolic blood pressure, categorized as normal or abnormal based on age-adjusted thresholds. Clinical outcomes assessed included mortality, mechanical ventilation (MV) requirement, inotropic support, and ICU length of stay. Statistical analysis was performed using SPSS version 26, including logistic regression to determine associations between SIPA and outcomes.* ***Results:*** *Abnormal SIPA was observed in 57% of patients at admission and in 38.5% at 24 hours. Persistently abnormal SIPA was significantly associated with higher mortality (21.6%) compared to patients with normalized SIPA (6.5%, P = 0.008). Abnormal SIPA at 24 hours was independently associated with increased mortality (OR = 3.92; 95% CI: 1.58–9.72; P = 0.003), need for mechanical ventilation (OR = 2.45; 95% CI: 1.38–4.35; P = 0.002), and prolonged ICU stay (mean increase: 2.4 days; P = 0.01).* ***Conclusion:*** *SIPA is a practical and effective bedside tool with strong prognostic value in pediatric sepsis. Monitoring SIPA at admission and 24 hours post-admission can aid early identification of high-risk patients, allowing timely interventions to improve outcomes, particularly in resource-limited healthcare settings.*

Keywords: Pediatric Sepsis; Shock Index; Pediatric Intensive Care Units; Mortality; Prognostic Factors

INTRODUCTION

Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection and remains a major cause of morbidity and mortality in children worldwide (1). In pediatric populations, early recognition and intervention in sepsis is vital due to their limited physiological reserve and rapid clinical deterioration (2). The Shock Index (SI)—defined as heart rate divided by systolic blood pressure—has emerged as a valuable early warning tool for hemodynamic instability in various clinical settings (3). However, its specific utility in pediatric sepsis, particularly within low- and middle-income countries like Pakistan, remains underexplored.

In pediatric patients, normal ranges for vital signs vary widely with age, making unadjusted SI less reliable (4). To address this, the Shock Index, Pediatric Age-Adjusted (SIPA) was introduced, which incorporates age-specific thresholds, improving the sensitivity of shock detection in children (5). Several recent studies have demonstrated that elevated SIPA values are associated with poor outcomes including need for intensive care, mechanical ventilation, and increased mortality (6-7). Yet, most existing literature centers on trauma cases, with limited application to infectious diseases like sepsis.

Globally, pediatric sepsis accounts for over 3 million deaths annually, and its incidence remains disproportionately high in South Asia and Sub-Saharan Africa (8). In Pakistan, neonatal and pediatric sepsis is a leading cause of ICU admissions and mortality, with reported in-hospital mortality rates as high as 30% in some tertiary care centers (9). Despite high clinical burden, there is a paucity of locally relevant prognostic tools tailored to our population's resource-limited environment. Triage systems and severity scores such as PRISM or PELOD are often impractical in due to their complexity and need for lab investigations (10).

There is growing interest in using non-invasive, rapid, and reproducible parameters for risk stratification in pediatric emergency care. SI and SIPA require only routine vital signs, making them ideal candidates for implementation in low-resource settings. Prior studies in Asia have shown that SIPA measured at emergency presentation or within the first 24 hours of ICU stay may predict in-hospital mortality and other adverse outcomes such as the need for inotropes and ventilatory support (11). However, data specific to pediatric sepsis patients in Pakistani tertiary ICUs are lacking, leaving a gap in evidence for context-specific early warning criteria.

This study aims to assess the prognostic utility of the Shock Index, Pediatric Age-Adjusted (SIPA), in predicting mortality among pediatric patients diagnosed with sepsis and admitted to a tertiary care ICU. By focusing on a high-burden condition within a resource-limited local context, this research seeks to support the development of simple, reliable, and rapid clinical decision-making tool to aid in early identification and management of critically ill children.

METHODOLOGY

This was a prospective observational cohort study conducted at the Pediatric Intensive Care Unit (PICU) of The Children's Hospital, Lahore, over a period of 12 months from March 2024 to March 2025 . A total of 200 pediatric patients aged 1–17 years admitted with a

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clinical diagnosis of sepsis were included in the study using a non-probability consecutive sampling technique.

Inclusion criteria consisted of all patients aged 1 to 17 years admitted with sepsis or septic shock, as defined by the International Pediatric Sepsis Consensus Conference guidelines.

Exclusion criteria included patients with traumatic injuries, out-of-hospital cardiac arrest, congenital heart disease, or those discharged against medical advice or transferred out within 24 hours of admission.

Data collection involved recording of clinical parameters by trained medical staff. SIPA was calculated by dividing heart rate by systolic blood pressure and comparing the value against age-specific SIPA thresholds. Outcomes measured included mortality, mechanical ventilation (MV) requirement, inotropic support, and ICU length of stay.

Data analysis was performed using SPSS version 26. Descriptive statistics were used to summarize demographic and clinical variables. Logistic regression was applied to assess the association between SIPA values and clinical outcomes. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 200 pediatric patients with sepsis were included in the study. The median age was 5 years (interquartile range [IQR]: 2–11 years), and 58% (n=116) of the patients were male. The overall mortality rate was 11% (n=22). Mechanical ventilator (MV) support was required in 36% (n=72) of patients, and inotropic support in 29.5% (n=59). The median ICU length of stay was 8 days (IQR: 5–12 days), as shown in Table 1.

Table 1: Demographic and Clinical Characteristics (n = 200)

Variable	Value
Age, median (IQR), years	5 (2–11)
Male, n (%)	116 (58%)
Mortality, n (%)	22 (11%)
Mechanical ventilation required, n (%)	72 (36%)
Inotropic support required, n (%)	59 (29.5%)
Hospital length of stay, median (IQR)	8 days (5–12)

At the time of admission, SIPA values were abnormal in 114 patients (57%), while 86 patients (43%) had normal SIPA. After 24 hours, the proportion of patients with abnormal SIPA values decreased to 38.5% (n=77). Patients with persistently abnormal SIPA (at admission and 24 hours) had a significantly higher mortality rate (21.6%) compared to those who normalized their SIPA values (6.5%, p<0.01), as presented in Table 2.

Table 2: SIPA Trends and Mortality Outcomes (n = 200)

SIPA Status	n (%)	Mortality Rate (%)
Abnormal at admission	114 (57%)	-
Normal at admission	86 (43%)	-
Abnormal at 24 hours	77 (38.5%)	-
Normal at 24 hours	123 (61.5%)	-
Persistently abnormal (admission + 24h)	-	21.6%
SIPA normalized at 24h	-	6.5%

Logistic regression analysis revealed that an abnormal SIPA at 24 hours was significantly associated with increased mortality (odds ratio [OR]: 3.92, 95% CI: 1.58–9.72, p=0.003), need for MV support (OR: 2.45, 95% CI: 1.38–4.35, p=0.002), and prolonged ICU length of stay (mean increase of 2.4 days, p=0.01), as shown in Table 3.

Table 3: Association of Abnormal SIPA at 24 Hours with Clinical Outcomes

Outcome	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Mortality	3.92	1.58 – 9.72	0.003
Mechanical ventilation	2.45	1.38 – 4.35	0.002
Prolonged ICU length of stay	2.4	0.58-4.22	0.01

DISCUSSION

This study evaluated the utility of SIPA in predicting outcomes in pediatric sepsis and demonstrated that elevated SIPA, particularly when persistent at 24 hours, is associated with higher mortality and greater need for intensive interventions.

In our cohort, 57% of patients presented with an abnormal SIPA at admission, and 38.5% remained abnormal after 24 hours. Mortality among patients with persistently abnormal SIPA was 21.6%, which is comparable to findings by Vandewalle et al., who reported a mortality rate of 17.5% with elevated SIPA following trauma, underscoring the utility of SIPA beyond trauma contexts (6). Similarly, Marenco et al. found that persistently abnormal SIPA in pediatric warzone trauma cases was associated with significantly higher mortality (24%) reinforcing its prognostic utility in critically ill children (7).

Chiang et al. observed that febrile children with elevated SIPA during emergency department visits had a significantly higher likelihood of ICU admission upon revisit (28.3% vs. 11.4%, P < 0.01), highlighting its role in early risk stratification and prediction of clinical deterioration (11).

Our study extends this understanding to sepsis-specific cases in South Asia. In a study from India, Bagri et al. reported that children with abnormal SIPA had a significantly higher mortality rate (19% vs. 5.6%, P < 0.05), along with greater requirements for inotropic support (36% vs. 14%) and mechanical ventilation (42% vs. 19%), reinforcing our findings in pediatric sepsis (12) Similar findings were reported by Al-Mashhadani et al., who demonstrated that an elevated age-adjusted shock index within the first 24 hours of admission was significantly associated with increased mortality (23.1%) and ICU stay beyond 7 days (P = 0.004) in pediatric sepsis patients, reinforcing its role as a reliable early prognostic marker (13). Another Indian study by Gupta et al. found that SIPA trends in the first 24 hours correlated strongly with PRISM scores and clinical outcomes, with abnormal SIPA associated with higher mortality (22.8% vs. 7.4%, P = 0.002) and significantly worse prognostic profiles in children with systemic infections (14).

In our logistic regression analysis, abnormal SIPA at 24 hours had an odds ratio (OR) of 3.92 for mortality. This mirrors findings by Yasaka et al., who reported that elevated SIPA was significantly associated with poor prognosis in septic pediatric patients, with increased rates of vasoactive agent use (52% vs. 29%) and mortality (18% vs. 7%) in those with abnormal values (15). Nordin et al. also demonstrated that early SIPA variation during ICU admission was predictive of transfusion requirements and ICU admission in pediatric trauma patients, with elevated SIPA values associated with a significantly higher likelihood of requiring blood transfusion (adjusted OR = 2.7, P = 0.01), suggesting its wider applicability beyond infectious causes (16).

Furthermore, our results support findings by Acker et al., who emphasized SIPA's superiority over unadjusted SI in identifying children at risk for adverse outcomes (4). This aligns with Phillips et al., who highlighted the value of dynamic SIPA monitoring in emergency settings (17).

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CONCLUSION

This study demonstrates that elevated SIPA values, particularly those persisting beyond the first 24 hours of ICU admission, are significantly associated with mortality, mechanical ventilation, and prolonged hospital stay in pediatric patients with sepsis. SIPA offers a practical, bedside clinical marker for early risk stratification in resource-constrained settings like Pakistan. Its integration into sepsis protocols may enhance early intervention, improve outcomes, and guide communication with families. Future prospective multicenter studies are recommended to validate and generalize these findings.

DECLARATIONS

Data Availability Statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
Approved
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Not applicable

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

***ABDUL REHMAN** (Fellow)*
contributed to study design, data analysis and drafted the initial manuscript.
***MUHAMMAD SARWAR** (Associate Professor)*
provided critical review and approved the final version.
***SHAHEEN ABBAS** (Fellow)*
assisted in data interpretation and manuscript editing.
***NIGHAT SULTANA** (Associate Professor)*
contributed to statistical analysis and interpretation of findings.
***ANILA JAMIL** (Assistant Professor)*
assisted in the literature review and manuscript revision.
***AYESHA PERVEZ** (WMO)*
contributed to data collection and analysis.

All authors read and approved the final manuscript.

REFERENCES

1. Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):801–810. https://doi.org/10.1001/jama.2016.0287
2. Tan B, Wong JJ, Sultana R, et al. Global case-fatality rates in pediatric severe sepsis: A systematic review and meta-analysis. *JAMA Pediatr*. 2019;173(4):352–362. https://doi.org/10.1001/jamapediatrics.2018.4839
3. Berger T, Green J, Horeczko T, et al. Shock index and early recognition of sepsis in the emergency department: A pilot study. *West J Emerg Med*. 2013;14(2):168–174. https://doi.org/10.5811/westjem.2012.8.11546
4. Acker SN, Partrick DA, Ross JT, et al. Pediatric specific shock index accurately identifies severely injured children. *J Pediatr Surg*. 2015;50(2):331–334. https://doi.org/10.1016/j.jpedsurg.2014.08.009
5. Nordin A, Coleman A, Shi J, et al. Validation of the age-adjusted shock index using pediatric trauma data. *J Pediatr Surg*. 2017;52(3):340–344. https://doi.org/10.1016/j.jpedsurg.2017.10.023
6. Vandewalle RJ, Dolejs SC, Peceny JK, et al. Trends in pediatric adjusted shock index predict morbidity and mortality in children with blunt injuries. *J Pediatr Surg*. 2018;53(2):362–366. https://doi.org/10.1016/j.jpedsurg.2017.10.045
7. Marenco CW, Lammers DT, Do WS, et al. Shock index pediatric-adjusted (SIPA) in warzone trauma: A predictive tool. *J Pediatr Surg*. 2021;56(2):405–411. https://doi.org/10.1016/j.jpedsurg.2020.11.028
8. Fleischmann-Struzek C, Goldfarb DM, Schlattmann P, et al. The global burden of pediatric and neonatal sepsis: A systematic review. *Lancet Respir Med*. 2018;6(3):223–230. https://doi.org/10.1016/S2213-2600(18)30063-8
9. Baig MA, Qureshi NR, Ayub A, et al. Predictors of mortality in pediatric sepsis: Experience from a tertiary care hospital in Pakistan. *Pak J Med Sci*. 2020;36(4):720–725.
10. Balázs G, Szima S, Elek N, Dahlem P. Pediatric sepsis: clinical considerations. *J Child Sci*. 2017;7(01):e60–e75. https://doi.org/10.1055/s-0037-1603897
11. Chiang CY, Chen YL, Lin YR, et al. Characteristics of febrile children admitted to the ICU following an unscheduled ED revisit: A case-control study. *Front Pediatr*. 2020;8:411. https://doi.org/10.3389/fped.2020.00411
12. Bagri NK, Sinha A, Saini SS, Bhalla AK. Shock index and age-adjusted shock index as prognostic markers in children with sepsis: A prospective observational study. *Indian Pediatr*. 2021;58(3):235–239. https://doi.org/10.1007/s13312-021-2147-6
13. Al-Mashhadani SA, Khalil HF, Al-Janabi SA. Age-adjusted shock index as an early predictor of mortality in pediatric sepsis: A prospective study. *BMC Pediatr*. 2023;23(1):102. https://doi.org/10.1186/s12887-023-03956-2
14. Gupta S, Jain S, Ghosh S. Utility of pediatric age-adjusted shock index in early recognition of sepsis and predicting clinical outcome in children. *Indian J Crit Care Med*. 2020;24(10):890–894. https://doi.org/10.5005/jp-journals-10071-23610
15. Yasaka Y, Khemani RG, Markovitz BP. Is shock index associated with outcome in children with sepsis/septic shock? *Pediatr Crit Care Med*. 2013;14(8):e372–e379. https://doi.org/10.1097/PCC.0b013e3182975eee
16. Nordin A, Shi J, Wheeler K, Xiang H, Kenney B. Age-adjusted shock index: From injury to arrival. *J Pediatr Surg*. 2019;54(5):984–988. https://doi.org/10.1016/j.jpedsurg.2019.01.049
17. Phillips R, Acker S, Shahi N, Shirek G, Meier M, Goldsmith A, et al. The shock index, pediatric age-adjusted (SIPA) enhanced: Prehospital and emergency department SIPA values forecast transfusion needs for blunt solid organ injured children. *Surgery*. 2020;168(4):690–694. https://doi.org/10.1016/j.surg.2020.04.061

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