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A Prospective Observational Study to Evaluate Tops Score as an Outcome Predictor in Extramural Referred Neonates Admitted at a Tertiary Care Hospital, Jhalawar Medical College

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ABSTRACT

Introduction: Neonatal mortality remains a significant global health concern, particularly in low-resource settings where inadequate transport and stabilization lead to adverse outcomes. The TOPS (Temperature, Oxygen Saturation, Perfusion, Sugar) score is a simple and rapid bedside assessment tool that can help predict neonatal outcomes upon admission. This study evaluates the prognostic value of the TOPS score in predicting mortality and morbidity among extramural neonates referred to a tertiary care hospital. **Aim :** This study aims to assess the TOPS score's prognostic value in predicting mortality and morbidity in extramural neonates and evaluate the impact of transport conditions and pre-transport stabilization on outcomes. **Materials and Methods:** A prospective observational study was conducted in the NICU of Shrimati Heera Kunwar Baa Maheela Hospital, Jhalawar, over one year. A total of 402 referred neonates were included, and their TOPS scores were recorded at admission. The association between transport conditions, stabilization status, neonatal characteristics, and clinical outcomes was analyzed using SPSS version 21.0, with $p<0.05$ considered statistically significant. **Results:** Of the 402 neonates, 75.1% survived, while 24.9% died. Mortality was significantly higher in neonates with low birth weight, prolonged transport duration, lack of pre-transport stabilization, and severe respiratory distress. The mean TOPS score was lower among non-survivors (1.53 ± 1.05) compared to survivors (2.51 ± 0.86) ($p = 0.0001$). Abnormal TOPS parameters hypothermia, hypoxia, poor perfusion, and hypoglycemia were strongly associated with increased mortality. **Conclusion**: The TOPS score is an effective, low-cost predictor of neonatal mortality in resource-limited settings. Routine assessment of TOPS parameters during neonatal transport can aid in early risk stratification and improve stabilization efforts, potentially reducing neonatal deaths. Future studies are warranted to validate its applicability across different healthcare settings.

INTRODUCTION

The neonatal period, encompassing the first 28 days of life, represents the most critical phase for a child's survival. Neonatal mortality remains a significant public health challenge, particularly in low- and middle-income countries, despite global advancements in neonatal care. Specialized neonatal intensive care units (NICUs) are essential for managing critically ill neonates. However, not all medical centers have the necessary infrastructure or trained personnel to provide adequate neonatal care. As a result, many neonates, especially those born in resource-limited settings, require transfer to higher-level Sick Newborn Care Units (SNCUs) [1]. Effective neonatal transport plays a crucial role in determining survival outcomes, yet in many developing countries, neonatal transport systems remain inadequate, exposing neonates to additional risks during transit.

Neonatal mortality significantly influences overall child mortality, contributing to approximately 70% of total infant deaths and more than half of under-five mortality worldwide [2,3]. India, which accounts for one-fifth of global live births, bears a disproportionate burden of neonatal mortality, with an estimated 0.75 million neonatal deaths reported in 2013—the highest globally [4,5]. The Neonatal Mortality Rate (NMR) in India currently stands at 24.9 per 1,000 live births, with significant disparities observed between states and rural versus urban areas [6]. Uttar Pradesh, Madhya Pradesh, Bihar, and

Rajasthan collectively account for approximately 55% of India's neonatal deaths and 15% of global neonatal mortality [2,3]. Despite substantial government efforts to promote institutional deliveries, a notable proportion of births still occur in non-institutional settings, further increasing neonatal mortality risks due to inadequate postnatal care and emergency transport limitations.

Birth weight is a crucial determinant of neonatal survival, with very low birth weight (VLBW) infants (<1500 g) facing heightened risks of morbidity and mortality. Preterm birth, particularly in extremely preterm (<28 weeks) and very preterm (28–32 weeks) neonates, remains one of the leading causes of neonatal mortality, often resulting in complications such as respiratory distress syndrome, neonatal sepsis, and intraventricular hemorrhage [7]. Globally, VLBW neonates account for less than 2% of all births, whereas in India, they constitute 4-7% of live births and contribute to nearly 30% of neonatal deaths. The interplay between prematurity, perinatal asphyxia, and inadequate transport further complicates neonatal outcomes, emphasizing the need for efficient neonatal transport systems with proper pre-transport stabilization .

While several neonatal risk scoring systems have been developed to predict neonatal outcomes, many are time-consuming and require sophisticated equipment, limiting their applicability in resource-constrained settings. The TOPS (Temperature, Oxygen Saturation, Perfusion, and Sugar) score, developed by Mathur et al., has been proposed as a simple, quick, and effective prognostic tool for assessing neonatal outcomes in low-resource settings . Unlike other scoring systems such as CRIB (Clinical Risk Index for Babies) and SNAP (Score for Neonatal Acute Physiology), which require laboratory investigations and trained pers - onnel, the TOPS score provides an immediate bedside assessment of neonatal condition at admission [8-11]. Studies suggest that abnormalities in TOPS parameters significantly correlate with increased neonatal mortality and morbidity, making it a valuable tool for triage and early intervention.

This study aims to evaluate the correlation between the TOPS score and neonatal outcomes in referred neonates transported to higher-level care facilities. By assessing the prognostic value of TOPS in resource-limited settings, the study seeks to provide insights into its potential role in improving neonatal survival rates and guiding clinical decision-making. Understanding the predictive accuracy of the TOPS score can contribute to optimizing neonatal transport protocols and improving early neonatal care in developing regions .

MATERIALS AND METHODS

This prospective observational study was conducted in the NICU of Shrimati Heera Kunwar Baa Maheela Hospital, Jhalawar, over one year. A total of 402 extramural neonates were included, excluding those who left against medical advice or were transferred. Data on clinicodemographic details, transport, and admission status were collected using a structured proforma. The TOPS score (Temperature, Oxygen saturation, Perfusion, Sugar) was recorded on arrival. Statistical analysis was performed using SPSS version 21.0, with descriptive statistics, t-tests, and chi-square tests applied ($p<0.05$ considered significant). Ethical approval was obtained, and informed consent was secured from parents/guardians.

RESULTS

This study analyzed 402 neonates based on demographic, clinical, and transport-related factors. The majority of neonates (55.0%) were aged 0-24 hours, followed by 3-7 days (20.6%), 7-28 days (13.4%), 24-48 hours (7.2%), and 48-72 hours (3.7%). In terms of gender distribution, 57.7% were male, and 42.3% were female. The birth weight of neonates varied, with 44.5% weighing more than 2.5 kg, 29.9% between 1.5-2.49 kg, 19.4% between 1-1.49 kg, and 6.2% weighing less than 999 grams.

Among the neonates, 59.7% had received prior stabilization before transport, while 40.3% were transported without stabilization. IV access was established in 65.4% (n = 263) of neonates, whereas 34.6% (n = 139) did not receive IV access. A significant proportion of neonates (69.7%) required inotropic support, with 7.5% receiving it during or before transport and 62.2% after admission, while 30.3% did not require inotropes. Regarding respiratory support at admission, 50.5% required an oxygen hood or nasal prongs, 13.7% received CPAP, 18.2% required invasive mechanical ventilation, and 17.7% did not require respiratory support (Table 1).

Table 1: Distribution of Neonates Based on Respiratory Support and Inotropic Support

Category	Frequency	Percent (%)	Category	Frequency	Percent (%)
Respiratory Support			**Inotropic Support**		
Oxygen hood/Nasal prongs	203	50.5	During or before transport	30	7.5
CPAP (Non-invasive ventilation)	55	13.7	After admission	250	62.2
Mechanical invasive ventilation	73	18.2	Not required	122	30.3
None	71	17.7	**Total**	**402**	**100**
Total	**402**	**100**			

The TOPS (Temperature, Oxygen saturation, Perfusion, Sugar) score at admission showed that the most common score was 2 (48.5%), followed by 3 (21.4%), 4 (13.4%), 1 (11.4%) and 0 (5.2%) (Figure 1).

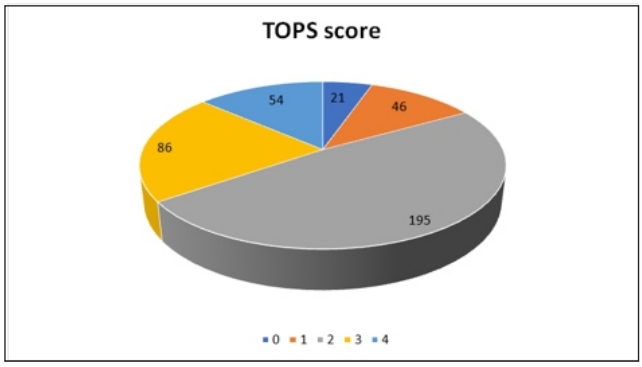

Figure 1 : TOPS Score at Admission

Regarding mode of delivery, 81.1% of neonates were born via normal vaginal delivery (NVD), whereas 18.9% were delivered through lower segment cesarean section (LSCS). Antenatal steroid administration was documented in 44.8% of mothers, while 55.2% did not receive steroids (Figure 2).

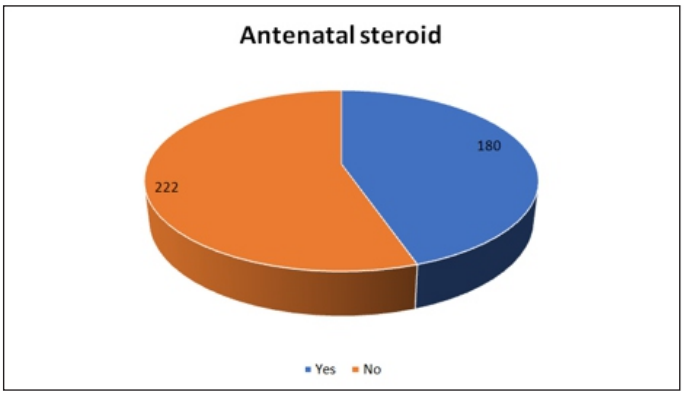

Figure 2: Antenatal Steroid Administration

The majority of neonates (92.0%) were delivered in an institutional setting, while 8.0% were born at home. At birth, 55.2% of neonates did not require resuscitation, whereas 44.8% required resuscitative measures.

The APGAR scores at 1 minute showed that 81.9% of neonates had a score >5, while 15.4% had a score ≤5, and 2.7% had missing data. Similarly, at 5 minutes, 84.9% had an APGAR score >5, 12.4% had a score ≤5, and 2.7% had missing data. The majority of mothers (73.1%) were aged 26-30 years, followed by 16.4% aged ≤25 years, 8.2% aged 31-35 years, and 2.2% aged >35 years. Gestational age analysis indicated that 47.0% of neonates were born at term (37-42weeks), 46.7% were preterm (<37 weeks), and 6.3% were post-term (>42 weeks).

Among the neonates, 57.7% were appropriate for gestational age (AGA), 40.3% were small for gestational age (SGA)/intrauterine growth restriction (IUGR), and 2.0% were large for gestational age (LGA). The presence of maternal complications was reported in 11.5% of cases, with pregnancy-induced hypertension (PIH) being the most common (4.7%), followed by hypothyroidism (4.0%) and other complications (2.7%) (Figure 3).

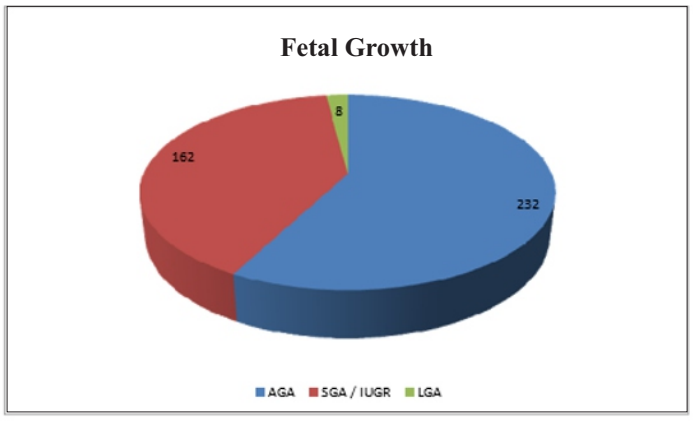

Figure 3 : Fetal Growth Among AGA, SGA, and LGA

At admission, 54.5% of neonates presented with hypothermia, 69.4% had oxygen saturation below 90%, 28.6% exhibited prolonged perfusion time (>3 seconds), and 21.9% had capillary blood sugar levels below 40 mg/dL. These findings indicate a high prevalence of critical conditions among neonates upon arrival (Figure 4).

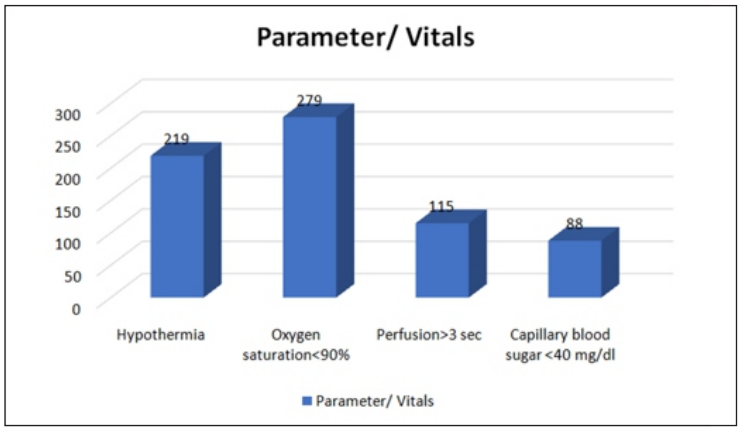

Figure 4: Neonatal Vitals (TOPS Parameters)

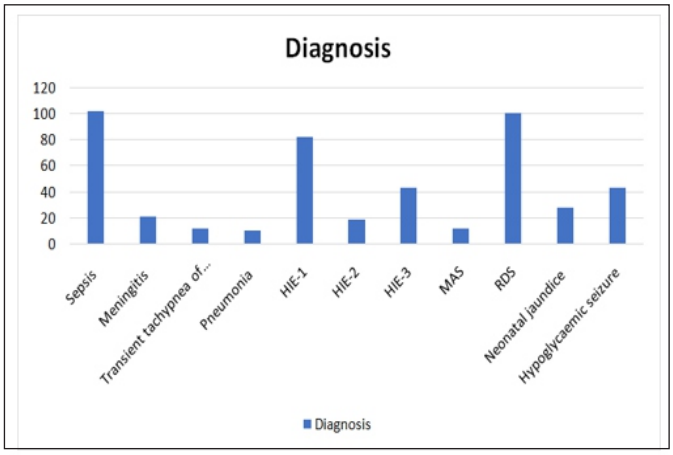

Figure 6 : Common Neonatal Diagnosis

The length of ICU stay varied, with 11.2% staying ≤3 days, 35.6% staying 3-7 days, 31.3% staying 7-10 days, and 21.9% staying >10 days.

Among the 402 neonates studied, 302 (75.1%) survived and were discharged, while 100 (24.9%) died. Mortality washighest among neonates aged 0-24 hours (57.0%), and it significantly decreased with increasing neonatal age (p = 0.0001) (Figure 7). Males had a slightly higher mortality rate (57.0%) compared to females (43.0%), but this association was not statistically significant (p = 0.098).

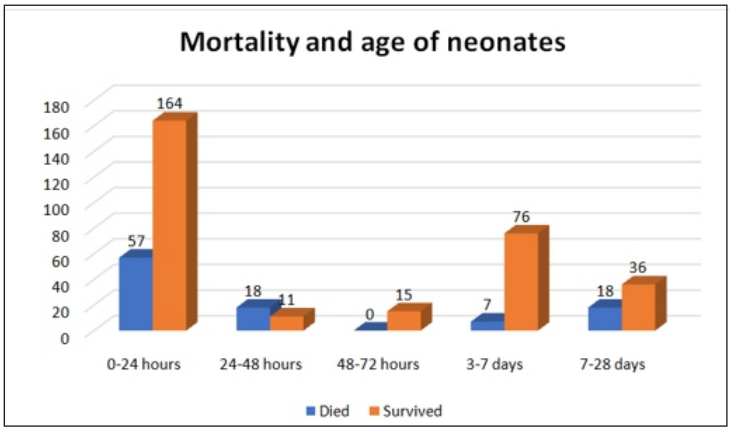

Figure 7 : Mortality and age of Neonates

Birth weight was significantly associated with mortality (p = 0.0001), with 21.0% mortality among neonates weighing <999 g and the lowest mortality observed in neonates weighing >2.5 kg (Figure 8). Transport-related factors also influenced mortality, as neonates transported for >2 hours had a 30.0% mortality rate, compared to 22.0% for those transported within 1 hour (p = 0.0001). Additionally, neonates who traveled >100 km had a 40.0% mortality rate, compared to 20.0% among those traveling <50 km (p = 0.0001).

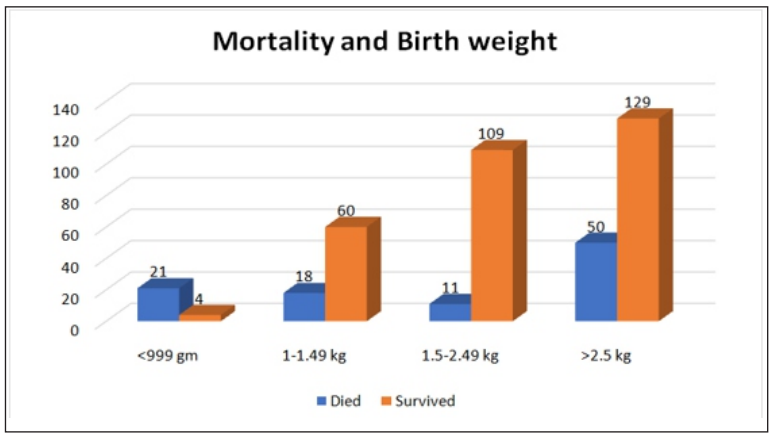

Figure 8 : Mortality and Birth Weight

Prior stabilization played a crucial role, as neonates who did not receive stabilization had significantly higher mortality (p = 0.0001). Among the deceased neonates, 61.0% had not received stabilization, whereas 66.6% of survivors had been stabilized before transport. The need for inotropic support was also linked to mortality, with 88.0% of deaths occurring in neonates who required inotropes after admission, compared to 12.0% among those who received them before or during transport (p = 0.001).

Respiratory support at admission was another significant factor influencing mortality (p = 0.014). Among neonates who died, 26.0% required invasive mechanical ventilation, 7.0% received CPAP, and 53.0% were on oxygen hood/nasal prongs.

Table 2: Relationship Between Clinical Interventions and Neonatal Outcomes

Variable	Category	Died (n=100)	%	Survived (n=302)	%	p-value
Use of Inotropes	During or before transport	12	12	18	5.9	0.001
	After admission	88	88	162	53.6	0.001
IV Access	Yes	57	57	206	68.2	0.141
	No	43	43	96	31.8	
Prior Stabilization	Yes	39	39	201	66.6	0.0001
	No	61	61	101	33.4	
Respiratory Support	Oxygen hood/Nasal prone	53	53	150	49.7	—
	CPAP (Non-invasive ventilation)	7	7	48	15.9	—
	Mechanical invasive ventilation	26	26	47	15.6	—
	None	14	14	57	18.9	

Mode of delivery, antenatal steroid administration, and gestational age were not significantly associated with mortality (p > 0.05). However, place of delivery showed a strong association with neonatal mortality (p = 0.0001), with home-delivered neonates having a 28.0% mortality rate, compared to 1.3% among those born in institutions.

Fetal growth status also played a role, as SGA/IUGR neonates had a significantly higher mortality rate (61.0%) compared to 33.4% among survivors (p = 0.0001) (Table 3). The TOPS score was significantly lower among neonates who died (1.53 ± 1.05) compared to survivors (2.51 ± 0.86) (p = 0.0001), reinforcing the importance of early stabilization and monitoring in predicting neonatal outcomes (Table 4).

Table 3: Association of Neonatal Mortality with Fetal Growth

Fetal growth	Died		Survived		p-value
	Count	%	Count	%	
AGA	39	39.0%	193	63.9%	0.451
SGA/IUGR	61	61.0%	101	33.4%	0.0001
LGA	0	0.0%	8	2.7%	0.0001

Table 4: Association of Neonatal Mortality with TOPS Score

TOPS score	Died		Survived		p-value
	Mean	SD	Mean	SD	
Score	1.53	1.05	2.51	0.86	0.0001

DISCUSSION

Our study aimed to evaluate the effectiveness of the TOPS (Temperature, Oxygenation, Perfusion, and Sugar) score in predicting neonatal outcomes among extramural neonates admitted to a tertiary care facility. By analyzing a cohort of 402 neonates, we identified key factors influencing neonatal morbidity and mortality, including transport conditions, neonatal stabilization, birth weight, and primary diagnoses. The findings of our study align with several existing studies while also highlighting unique regional challenges and opportunities for improving neonatal care.

The majority of neonates (55.0%) in our study were admitted within the first 24 hours of life, with another 20.6% admitted between 3-7 days. This distribution highlights the critical nature of the immediate postnatal period, during which neonates are most vulnerable to complications. A similar pattern was reported by Ayesha Begum et al. [12], who studied outborn neonates and observed a high rate of admissions in the early neonatal period. The slight male predominance (57.7%) in our study is consistent with global trends in neonatal admissions, as seen in studies such as Wu et al. [13] and Ozdemir et al. [14].

A significant proportion (55.5%) of neonates in our study had low birth weight (LBW), with 25.6% categorized as very low birth weight (VLBW) (<1500g). This is concerning, as LBW is strongly associated with increased neonatal morbidity and mortality. The high prevalence of LBW neonates in our study aligns with findings from Ozdemir et al. [14], who focused on VLBW infants, as well as Wu et al. [13], who studied extremely preterm neonates. These findings underscore the need for improved antenatal care and interventions to reduce preterm births, particularly in resource-limited settings.

Sepsis (25.6%) and respiratory distress syndrome (RDS) (24.8%) were the most prevalent diagnoses, followed by hypoxic-ischemic encephalopathy (HIE) (35.8% across all stages). This pattern of neonatal morbidities is consistent with studies like Ayesha Begum et al. [12], which identified birth asphyxia and prematurity as major contributors to neonatal mortality. The high incidence of RDS in our study reinforces the importance of antenatal steroid administration, as emphasized in studies such as Riskin et al. [15]. Additionally, our study found that respiratory distress (50.0%) was the most common reason for referral, which aligns with findings from Suresh Kumar Verma et al. [16].

Our study revealed that 57.7% of neonates had a transport duration of one hour or less, while 42.3% had longer transport times, including 9.0% exceeding two hours. This highlights the importance of optimizing neonatal transport systems. Longer transport times were associated with worse outcomes, which is consistent with findings from Firuzeh Faridpour et al. [17]. Additionally, we found that only 59.7% of neonates received prior stabilization, reinforcing the need for improved pre-transport resuscitation. The requirement for respiratory support was high, with 82.4% needing oxygen, CPAP, or mechanical ventilation. This finding aligns with Verma et al. [18], who reported similar hypoxia rates among transported neonates.

The majority of mothers (73.1%) were between 26-30 years old, and 92.0% had institutional deliveries, suggesting good healthcare access. However, antenatal steroid administration was only 44.8%, indicating room for improvement in preterm birth management. The prevalence of pregnancy-induced hypertension (4.7%) was lower than some other studies, potentially reflecting regional differences in maternal care. Our findings regarding the distribution of neonates based on gestational age 46.7% preterm, 47.0% term, and 6.3% post-term are consistent with studies by Dorey et al. [19] and Wu et al. [14], which highlighted the vulnerability of preterm neonates.

Our study found high rates of physiological disturbances, with 54.5% experiencing hypothermia, 69.4% having oxygen saturation below 90%, and 21.9% exhibiting hypoglycemia. The prevalence of hypothermia in our study was higher than that reported by Verma et al. [16] (46.67%), possibly due to differences in transport conditions or stabilization practices. Additionally, ICU stays were prolonged for many neonates, with 66.9% requiring more

than seven days of intensive care. This aligns with previous studies that reported extended NICU stays for high-risk neonates [13,17].

The overall survival rate in our study was 75.1%, with a mortality rate of 24.9%. Lower birth weights, longer transport times, lack of prior stabilization, and severe respiratory distress were significantly associated with higher mortality. These findings are consistent with studies like Amruta Phatak et al. [20], who reported a higher mortality rate (47.1%), but with a different study population. The association between transport conditions and mortality underscores the need for better neonatal transport infrastructure, as emphasized by Firuzeh Faridpour et al. [13].

Our study demonstrated that the TOPS score is a useful predictor of neonatal mortality, with an area under the ROC curve (AUC) of 0.755. This is comparable to the AUC of 0.764 reported by Ayesha Begum et al. [12], confirming the reliability of the TOPS score in different settings. While some scoring systems like CRIB-II and SNAPPE-II have reported higher AUCs (e.g., 0.828 in Ozdemir et al. [13] and 0.84 in Faridpour et al. [17], the simplicity of the TOPS score makes it a practical alternative for rapid risk assessment. The significant difference in mean TOPS scores between survivors (2.51 ± 0.86) and non-survivors (1.53 ± 1.05, p=0.0001) reinforces its predictive validity.

Overall, our study underscores the importance of early neonatal stabilization, improved transport conditions, and the clinical utility of the TOPS score in predicting neonatal outcomes. Further research is needed to optimize neonatal transport and refine risk prediction models to enhance neonatal survival in tertiary care settings

CONCLUSION

This study evaluates the TOPS score as a predictor of neonatal outcomes in extramural referrals, demonstrating good predictive accuracy for mortality (AUC 0.755). The significant difference in mean TOPS scores between survivors (2.51) and non-survivors (1.53) supports its clinical utility. Key challenges identified include high rates of low birth weight, sepsis, respiratory distress syndrome, and hypoxic-ischemic encephalopathy, with mortality associated with lower birth weight, longer transport times, and lack of stabilization. Given its simplicity and effectiveness, the TOPS score serves as a valuable tool for rapid neonatal risk assessment, especially in resource-limited settings where complex scoring systems are impractical.

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