International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 15s,2025
https://theaspd.com/index.php

Effectiveness Of The Modified SNAPPE-II Score In Predicting Morbidity And Mortality Among Low-Birth-Weight Infants: A Systematic Review

[1]Salomi S, [2]Dr. Komala H K, [3]Mrs. Susanna Blessing,
[1]PhD Scholar, Faculty of Nursing, Adichunchanagiri, University, B.G.Nagara, Nagamangala Taluk, Mandya District, Karnataka, India, sallisalomi1984@gmail.com
[2]Principal, BGS Institute of Nursing Sciences, Sasyakashi, Adichunchanagiri University,, Nagamangala Taluk, Mandya District, Karnataka, India, komal.chinny@gmail.com
[3]Faculty of Nursing, Asst prof, Medical surgical nursing department, Rathna College of Nursing,
Hassan District, Karnataka, India, susannablessing1858@gmail.com

Abstract

Introduction

Low-birthweight (LBW) infants face significant health risks, with morbidity and mortality influenced by illness severity, perinatal factors, and NICU care protocols. The Modified Score for Neonatal Acute Physiology Perinatal Extension-II (SNAPPE-II) is widely used to predict neonatal outcomes, yet variability exists in its accuracy for morbidity assessment.

Objective

To assess the effectiveness of SNAPPE-II in predicting morbidity and mortality among LBW neonates, synthesizing evidence from prospective and retrospective studies to establish its clinical utility.

Methods

A systematic literature search was conducted in PubMed, Scopus, and Cochrane Library, adhering to PRISMA guidelines. Studies evaluating SNAPPE-II scores in NICU-admitted LBW infants were included. Screening was conducted in Rayyan software independently by two reviewers. Data extraction focused on study design, sample size, morbidity and mortality predictions, and SNAPPE-II scoring thresholds. Data was analysed narratively.

Results

Thirteen studies met inclusion criteria, showing high predictive accuracy for mortality (AUROC ≥0.91 in high-quality studies). However, morbidity prediction varied, with inconsistent associations between SNAPPE-II scores and neonatal complications. Studies lacked documentation on feeding modality, limiting insights into nutritional influences on SNAPPE-II outcomes.

Keywords

SNAPPE-II, low-birth-weight infants, neonatal morbidity, neonatal mortality, NICU outcomes, systematic review.

INTRODUCTION

Low birth weight (LBW) infants face significant health challenges, with morbidity and mortality rates influenced by various clinical and nutritional factors. The Modified Score for Neonatal Acute Physiology Perinatal Extension-II (SNAPPE-II) is a validated tool used to assess illness severity and predict neonatal outcomes (Richardson et al., 2001). While previous studies have evaluated the predictive accuracy of SNAPPE-II, limited research has examined its effectiveness in differentiating morbidity and mortality risks based on feeding type-human milk-fed versus formula-fed LBW infants (Rachuri et al., 2019).

Human milk is widely recognized for its immunological and nutritional benefits, contributing to improved neurodevelopment and reduced infection rates in preterm and LBW neonates (Victora et al., 2016). In contrast, formula feeding has been associated with a higher incidence of metabolic complications and necrotizing enterocolitis (NEC) (Patel et al., 2017). Understanding how feeding modality influences SNAPPE-II scores and subsequent neonatal outcomes could provide valuable insights for clinicians, optimizing nutritional strategies to improve survival rates and long-term health.

Several studies have explored the role of SNAPPE-II in predicting neonatal mortality. Richardson et al. (2001) developed the SNAPPE-II score as a simplified version of the original SNAP score, incorporating perinatal factors to enhance predictive accuracy. Research indicates that higher SNAPPE-II scores correlate with increased mortality risk, particularly in neonates requiring intensive care (Rachuri et al., 2019). A study by Madhunandan and Badakali (2018) found that SNAPPE-II scores were significantly associated with both morbidity and mortality outcomes in NICU settings, reinforcing its utility as a prognostic tool (Madhunandan & Badakali, 2018). Additionally, Samanta et al. (2020) demonstrated that a SNAPPE-II score cutoff of ≥20 provided the highest sensitivity for predicting mortality in neonates, highlighting its role in clinical decision-making (Samanta et al., 2020). However, the impact of feeding type on SNAPPE-II scores remains underexplored, necessitating a systematic review to synthesize existing evidence.

This systematic review aims to analyze existing literature comparing the effectiveness of the Modified SNAPPE-II Score in predicting morbidity and mortality among human milk-fed versus formula-fed LBW infants. By synthesizing current evidence, we seek to clarify the role of early nutrition in neonatal prognosis, informing clinical practice and future research directions.

Research Question

How effective is the Modified Score for Neonatal Acute Physiology Perinatal Extension-II (SNAPPE-II) in predicting morbidity and mortality among low-birth-weight infants?

Methods

The authors in the team had developed the review protocol and registered in the Prospero international systematic review registry that prospectively registers systematic reviews protocols. (1065722)

-Study Design

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring methodological rigor and transparency in data selection, analysis, and reporting (Page et al., 2021). The review aims to assess the effectiveness of the Modified SNAPPE-II Score in predicting morbidity and mortality among low birth weight (LBW) infants, comparing outcomes between human milk-fed and formula-fed neonates.

-Eligibility Criteria

The selection criteria are based on the PICO framework, outlined as follows:

Inclusion Criteria

-**Population (P):** Low-birthweight (LBW) infants (<2500g) admitted to Neonatal Intensive Care Units (NICUs).
-**Intervention (I):** Use of the Modified SNAPPE-II Score to predict morbidity and mortality outcomes.
-**Comparison (C):** Standard test
-**Outcome (O):** Neonatal morbidity (infection rates, necrotizing enterocolitis, metabolic complications) and mortality (survival rates).
-**Study Design:** Randomized controlled trials (RCTs), non-randomized controlled trials, cohort studies, case studies will be included.
-**Language:** Articles published in English.
-**Publication Date:** Studies published from 2001 to March 2025 to the present.

Exclusion Criteria

1. Studies not utilizing Modified SNAPPE-II Score as a predictive tool.
2. Studies on healthy full-term infants, excluding preterm and low-birthweight (LBW) populations.
3. Case reports, editorials, expert opinions, reviews, protocols and non-peer-reviewed articles.
4. Studies published in languages other than English (unless translation is available).
5. Animal studies or non-human research models.
6. Studies with incomplete or unavailable full-text data for analysis.

-Search Strategy

A comprehensive literature search was conducted in PubMed, Scopus, and Cochrane Library, covering studies published from 2021 to March 2025 were included. The following keywords and Medical Subject Headings (MeSH) terms was used: "Modified SNAPPE-II," "low birth weight infants," "human milk," "formula feeding," "morbidity," "mortality," "neonatal outcomes," and "systematic review."

-Screening of the Studies

Study Selection Process

The screening process follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a systematic and transparent approach to selecting eligible studies (Page et al., 2021). The screening was conducted in two phases in Rayyan software (Ouzzani et al., 2016): initial screening (title and abstract review) and full-text review.

Phase 1: Title and Abstract Screening

Two independent reviewers screened study titles and abstracts based on predefined inclusion and exclusion criteria. Studies that clearly met the inclusion criteria was further advanced to full-text review, while studies that do not align with the PICO framework were excluded. Conflicts between two reviewers was resolved through discussion.

Phase 2: Full-Text Review

Studies passing the initial screening underwent a full-text assessment to ensure they meet all eligibility criteria. This process was also conducted by the same two reviewers who had involved in the title-abstract screening. Conflicts between the reviewers were resolved through discussion.

Data Extraction and Management

Following the full-text review, data was extracted into a standardized template, capturing study characteristics such as author, year, design, sample size, feeding modality, SNAPPE-II scoring, and neonatal outcomes. A data synthesis strategy was employed to summarize findings across included studies. A PRISMA flow diagram was used to illustrate the number of studies identified, screened, reviewed, included, and excluded, ensuring transparency in study selection. (Figure 1).

Results

Study selection process

A comprehensive search across PubMed, Scopus, and Cochrane Library retrieved 142 studies, with 25 duplicates removed. Following title and abstract screening, 117 studies were assessed, 62 excluded due to irrelevant outcomes. After full-text review, 55 articles were evaluated, with 42 excluded for unsuitable study populations or publication types. Ultimately, 13 studies met eligibility criteria, focusing on SNAPPE-II's predictive accuracy for neonatal morbidity and mortality. (Figure 1).

Characteristics of the included studies

The 13 studies in this review varied in design, sample size, population characteristics, and outcome measures, but all assessed the predictive accuracy of the Modified SNAPPE-II Score in neonatal morbidity and mortality. (Table 1).

- **Study Design:** The studies comprised prospective observational studies (n=7), retrospective cohort studies (n=5), and a longitudinal cohort study (n=1).
- **Sample Size:** Ranged from 101 preterm neonates (Siddappa et al., 2021) to 25,429 NICU newborns (Richardson et al., 2001).
- **Population Characteristics:** Most studies focused on preterm and low-birth-weight infants, with a few including term neonates. Gestational age ranged from 23 weeks to term, highlighting variability in neonatal risk profiles.
- **Feeding Modality:** None of the studies explicitly examined differences between human milk-fed and formula-fed neonates, although nutritional status was discussed as a confounding factor.
- **SNAPPE-II Scoring:** Studies utilized different SNAPPE-II thresholds for mortality and morbidity prediction, with cutoffs ranging from ≥20 to ≥61. Higher scores correlated with longer NICU stays and increased severity of neonatal illness.
- **Outcome Measures:** Studies examined neonatal mortality (n=11), morbidity risks (n=7), and NICU stay duration (n=5). Common morbidity outcomes included bronchopulmonary dysplasia (BPD), necrotizing enterocolitis (NEC), and sepsis.

Quality assessment of the included studies

The overall methodological quality varied among the studies, with high-quality research including Richardson et al. (2001) and Dammann et al. (2009), which demonstrated excellent predictive accuracy of SNAPPE-II for neonatal mortality (AUROC 0.91). These studies had low selection bias and robust statistical validation across large NICU populations. Siddappa et al. (2021) also exhibited low bias, providing strong predictive evidence for severe intraventricular hemorrhage (IVH) using SNAPPE-II scores.

Moderate-quality studies, such as Muktan et al. (2019) and Özcan et al. (2017), showed some risk of bias due to unclear participant selection criteria and missing feeding modality documentation, affecting morbidity predictions. While Ramirez et al. (2014) and Samanta et al. (2020) validated SNAPPE-II mortality prediction thresholds, methodological inconsistencies led to moderate detection bias.

Higher-risk studies, including Shivanna & Archana (2015) and Amin Ali et al. (2021), exhibited selection and attrition bias, limiting generalizability. Madhunandan & Badakali (2022) reported high SNAPPE-II predictive accuracy for mortality (AUROC = 0.960) but lacked consistency in neonatal intervention documentation, increasing detection bias. Li et al. (2024) and Tang et al. (2024) explored machine learning models and SNAPPE-II scoring, but variability in study design and inclusion criteria introduced bias concerns.

Data analysis:

Due to significant heterogeneity in study designs, outcome measures, and the absence of standardized effect sizes across included studies, conducting a meta-analysis was not feasible. Instead, a narrative synthesis approach was utilized to systematically analyze the data. Key study characteristics such as design, sample size, population demographics, SNAPPE-II scoring thresholds, and morbidity and mortality outcomes were extracted and organized in a structured summary table. The findings were descriptively analyzed to highlight its predictive value for neonatal outcomes in low-birth-weight infants.Table 1: Characteristics of included studies

S. No	Author, Year, country	Study design	Sample size	Population characteristics	Feeding Modality	SNAPPE-II Scoring Details	Outcomes Measured	Morbidity Findings	Mortality findings	Key findings
1	Shivanna Sree Harsha & Banur Raju Archana, 2015 India	Prospective Observational Study	248 neonates	Preterm: 85 (34.2%), Term: 152 (61.2%), post-term: 11 (4.4%)	Not specified in the study	Mean SNAPPE-II scores: Expired neonates – 45.72 ± 18.68, Survived neonates – 21.04 ± 15.418	Neonatal mortality and length of hospital stay	SNAPPE-II did not reliably predict morbidity	SNAPPE-II scores ≥37 was associated with increased mortality (PPV: 95.3%, Sensitivity: 76.9%, Specificity: 87.1%)	Neonatal mortality not a strong predictor AUC = 0.849 (95% CI 0.79-0.97)

2	Amin Ali et al., 2021, Pakistan	Longitudinal Cohort Study	333 neonates	Neonates requiring respiratory support in NICU	Not specified	SNAPPE-II category III (>40) was the strongest predictor of mortality (Sensitivity: 40%, Specificity: 98.7%)	Neonatal mortality prediction using SNAPPE-II score	Not explicitly assessed	30 neonates (9.1%) expired, while 298 (90.9%) survived	SNAPPE-II demonstrated moderate diagnostic accuracy for predicting neonatal mortality (AUC = 80.2%, 95% CI: 71.1-89.2%). Higher SNAPPE-II scores correlated with increased mortality risk. The scoring system may be valuable for resource-constrained NICUs

3	Muktan et al., 2019, Nepal	Prospective observational study	255 neonates	36.1% preterm, 63.9% term neonates. Mean birth weight: 2422.9g (SD: 858.2g). Mean gestational age: 36.8 weeks. 17.6% mortality rate (45 deaths)	Not specified in the study	Median SNAPPE-II scores: Expired neonates: 57 (IQR: 42-64) Survived neonates: 22 (IQR: 14-32)	Neonatal mortality risk assessment Duration of NICU stay	No significant correlation between SNAPPE-II score and NICU stay duration (P = 0.477)	SNAPPE-II scores ≥40 had a mortality rate of 55.1% SNAPPE-II scores ≥60 showed 100% mortality SNAPPE-II scores ≥38 identified as optimal cutoff for predicting neonatal mortality	SNAPPE-II score effectively predicts neonatal mortality Does not correlate significantly with NICU stay duration Findings can be used to prioritize treatment and counsel parents on disease severity Score may be valuable for resource-limited NICU settings
4	Özcan B, Kavurt AS, Aydemir Ö, Gençtürk Z, Baş	Retrospective cohort study	246 neonates	Female (49.2%), Male (50.8%)	Not specified in the study	Higher median SNAPPE-II scores among	Neonatal morbidity risk assessment for bronchopulmonary	Infants with higher SNAPPE-II scores had an increased risk for	32 neonates died before diagnosis of BPD and	SNAPPE-II is a strong predictor of neonatal

	AY, Demirel N, 2017, Turkey			Mean GA: 29.2 ± 2.15 weeks		infants with BPD and ROP Best discriminative cutoff values: BPD: ≥14.5 (Sensitivity 92%, Specificity 68.3%) ROP: ≥23.5 (Sensitivity 80%, Specificity 79%)	dysplasia (BPD) and retinopathy of prematurity (ROP)	developing BPD and ROP	ROP, and were excluded	morbidities, including BPD and ROP Higher SNAPPE-II values were associated with increased risk of severe complications
5	Ramirez, M. N. M., Godoy, L. E., & Barrientos, E. A. (2014), Paraguay	Prospective observational cohort study	290 newborns	28–42 weeks Male 58% Low birth weight (LBW): 36%, Very low birth weight (VLBW): 11%	Not specified in the study	Expired neonates: 22 (G1), 8 (G2), 17 (G3) Survived neonates: <5 in all groups	Neonatal mortality prediction	Higher SNAP II and SNAPPE-II scores associated with increased severity at admission No significant differences in morbidity prediction between SNAPPE-II and	Overall mortality rate: 24% (71 deaths out of 290 neonates) SNAPPE-II showed moderate predictive ability for neonatal mortality	SNAP II and SNAPPE-II demonstrated moderate discrimination in predicting mortality Higher scores were associated with increased mortality risk

								neonatal complications		
6	Richardson, D. K., Corcoran, J. D., Escobar, G. J., & Lee, S. K. (2001), Canada, United states	Multicenter Prospective Observational Study	25,429 newborns across 30 NICUs	Full range from extremely preterm to term neonates	Not specified in the study	ROC curve (AUC = 0.91 ± 0.01, excellent discrimination for mortality risk)	Primary outcome: In-hospital neonatal mortality Secondary outcome: Illness severity assessment across different birth weights	Not explicitly assessed; focused on mortality prediction	SNAPPE-II demonstrated excellent discrimination for mortality across all NICU populations Higher SNAPPE-II scores correlated with increased mortality risk	SNAP-II and SNAPPE-II are simple, accurate predictors of neonatal illness severity and mortality risk
7	Dammann, O., Shah, B., Naples, M., Bednarek, F., Zupancic, J., Allred, E., & Leviton, A. (2009), United states	Prospective observational cohort study	1,467 infants born before 28 weeks of gestation	Extremely preterm neonates (gestational age <28 weeks)	Not specified in the study	Predictive accuracy: SNAP-II AUC for mortality prediction = significant association SNAPPE-II AUC provided slightly higher predictive	Neonatal mortality risk assessment	Not explicitly assessed; focused primarily on mortality prediction	Higher SNAP-II and SNAPPE-II scores correlated with increased mortality risk across all gestational age groups	Findings support integrating SNAP-II/SNAPPE-II into neonatal risk assessment frameworks. SNAP-II and SNAPPE-II are effective

						ability than SNAP-II				predictors of mortality in extremely preterm neonates
8	Siddappa, A. M., Quiggle, G. M., Lock, E., & Rao, R. B. (2021), United States	Retrospective chart review	101 preterm infants (<29 weeks gestation) admitted to NICU	Gestational age: Mean 25.6 (±1.8) weeks Birth weight: Mean 811g (±224g)	Not specified in the study	Sensitivity: 60% Specificity: 91% Positive Predictive Value (PPV): 53% Negative Predictive Value (NPV): 93%	Predictive value of SNAPPE-II scores for severe IVH	Lower platelet count associated with severe IVH (p = .034) Longer prothrombin time (PT) and higher INR in severe IVH group (p = .004) Coagulation parameters did not improve predictability beyond SNAPPE-II	Mortality rate: 8% (8/101 infants) SNAPPE-II remained the strongest independent predictor of IVH risk	SNAPPE-II at 12 hours post-birth is an independent predictor of severe IVH Scores ≥55 increase the likelihood of severe IVH significantly
9	Ray, S., Mondal, R., Chatterjee, K., Samanta, M., Hazra, A., & Sabui, T. K. (2019), India	Prospective observational study	961 neonates	60.04% male Gestational age distribution: -Preterm: 348 neonates (36.2%)	Not specified in the study	A cutoff score of >61 showed 92.4% sensitivity and 88.1% specificity. In preterm	Mortality prediction accuracy of ESNS vs. SNAPPE-II vs. SNS	Not assessed explicitly in this study	Total mortality: 185/961 neonates (19.2%)	ESNS is simpler and faster to apply compared to SNAPPE-II

				-Term: 612 neonates (63.8%)		neonates, a >61 cutoff had 100% sensitivity and 81.4% specificity, while for term neonates, a >49 cutoff showed 100% sensitivity and 83.6% specificity.			Cutoff scores for mortality prediction: -ESNS ≤11 (All neonates): Sensitivity 85.9%, Specificity 89.8% -ESNS ≤12 (Preterm neonates): Sensitivity 92.3%, Specificity 76.7% -SNAPPE-II >61 (Preterm neonates): Sensitivity 100%, Specificity 81.4% SNAPPE-II >49 (Term neonates): Sensitivity 100%, Specificity 83.6%	SNAPPE-II had the highest predictive accuracy, but ESNS showed satisfactory sensitivity and specificity

10	Lim, L., & Rozycki, H. J. (2008) United States	Prospective observational study	141 neonates admitted to a Level III NICU over four months	Mean birth weight: 2,289 ± 938 g Mean gestational age: 34 ± 4 weeks Mean length of NICU stays: 19 ± 20 days	Not specified in the study	Admission SNAPPE-II scores were positively correlated with length of stay ($r = 0.44$, $p < 0.01$) Daily SNAP-II scores after admission showed weak correlation with hospital outcomes ($r = 0.02$, $p > 0.5$)	Predictive value of SNAP-II scores for sepsis, NEC, and mortality Correlation between SNAPPE-II scores and hospital length of stay	SNAP-II scores were low (mostly 0) in neonates who later developed sepsis or NEC Only 34% of high SNAP-II scores were linked to these events Higher admission SNAPPE-II scores correlated with increased risk of sepsis and NEC	One neonate died after the first day, but had SNAPPE-II >50 at admission Other two deaths had SNAP-II scores >30 leading up to death SNAPPE-II >30 was associated with increased mortality risk	Admission SNAPPE-II scores are predictive of neonatal morbidity and mortality Daily SNAP-II scores after the first day do not reliably predict adverse neonatal events
11	Li, A., Mullin, S., & Elkin, P. L. (2024), United States	Retrospective cohort study	459 neonates born at 23 to 29 weeks gestation 37 infants (8.1%) expired during	Gestational age range: 23-29 weeks Mean gestational age: 27 weeks (SD 1.67) Mean birth weight: 1016 g (SD 278)	Not specified in the study	SNAPPE-II performance for infants <1500 g: AUROC = 0.78 (SD 0.01) Machine learning models evaluated	Survival prediction for extremely premature infants in NICU	Major predictors of survival included gestational age, birth weight, oxygenation levels, and APGAR scores	Overall mortality rate in NICU admissions: 8.1% Random forest model showed the highest predictive performance	Machine learning models provide improved survival prediction over SNAPPE-II for extremely

			NICU admission	Very low birth weight (<1500 g): 441 neonates		against SNAPPE-II for mortality prediction			(AUROC = 0.91, SD 0.07)	preterm neonates
12	Tang, L., Wu, W., Huang, W., & Bi, G. (2024), China	Retrospective cohort study	276 preterm infants (<32 weeks gestational age)	Gestational age range: 25–31+6 weeks Mean birth weight: 987.10 ± 220.64 g (BPD group), 1,318.22 ± 259.71 g (non-BPD group)	Not specified in the study	Higher SNAPPE-II scores in BPD group Median SNAPPE-II scores: 15 (BPD group) vs. 5 (non-BPD group) (P < 0.05) Cutoff for BPD risk prediction: SNAPPE-II >11 (AUC = 0.792, sensitivity = 80.6%, specificity = 76%)	Incidence and mortality of BPD	Significantly higher rates of complications in BPD group (PDA, PH, ROP, pulmonary hemorrhage, abnormal coagulation, hypoproteinemia) Longer duration of NICU stay compared to non-BPD infants (64 vs. 38 days, P < 0.05)	Grade III BPD mortality rate: 14.3% Grade IIIA BPD mortality rate: 100% Overall mortality in BPD group higher than non-BPD group (P < 0.05)	Predictive model for BPD risk developed using logistic regression Six significant predictors identified: BW, resuscitation mode, intrauterine distress, SNAPPE-II score, hematocrit (HCT), apnea
13	Madhunandan, K., & Badakali, A. V. (2022)	Prospective observational study	186 neonates admitted to NICU	Gestational age: Preterm (39.8%), Term	Not specified in the study	Higher scores indicate greater illness severity	Neonatal mortality prediction	Higher SNAPPE-II scores correlated with longer NICU stay	-Overall mortality rate: 18.8% (35 out	-SNAPPE-II score is a strong predictor of

				(57.5%), post-term (2.7%) Gender distribution: Male (69.9%), Female (30.1%)		Mean SNAPPE-II scores: -Survivors: 18.03 ± 12.64 -Expired neonates: 58.3 ± 17.80	Duration of NICU stay based on illness severity	Mean NICU stay: 9.77 ± 8.01 days Duration of hospital stay: -Survivors: 11.38 ± 8.00 days -Expired neonates: 2.8 ± 2.27 days - Negative Predictive Value (NPV): 96.1% -ROC curve (AUC = 0.960, $p < 0.001$)	of 186 neonates) -Neonates with SNAPPE-II score >45.6 had significantly higher mortality risk	neonatal mortality and morbidity -Higher scores indicate greater likelihood of mortality and longer NICU stay

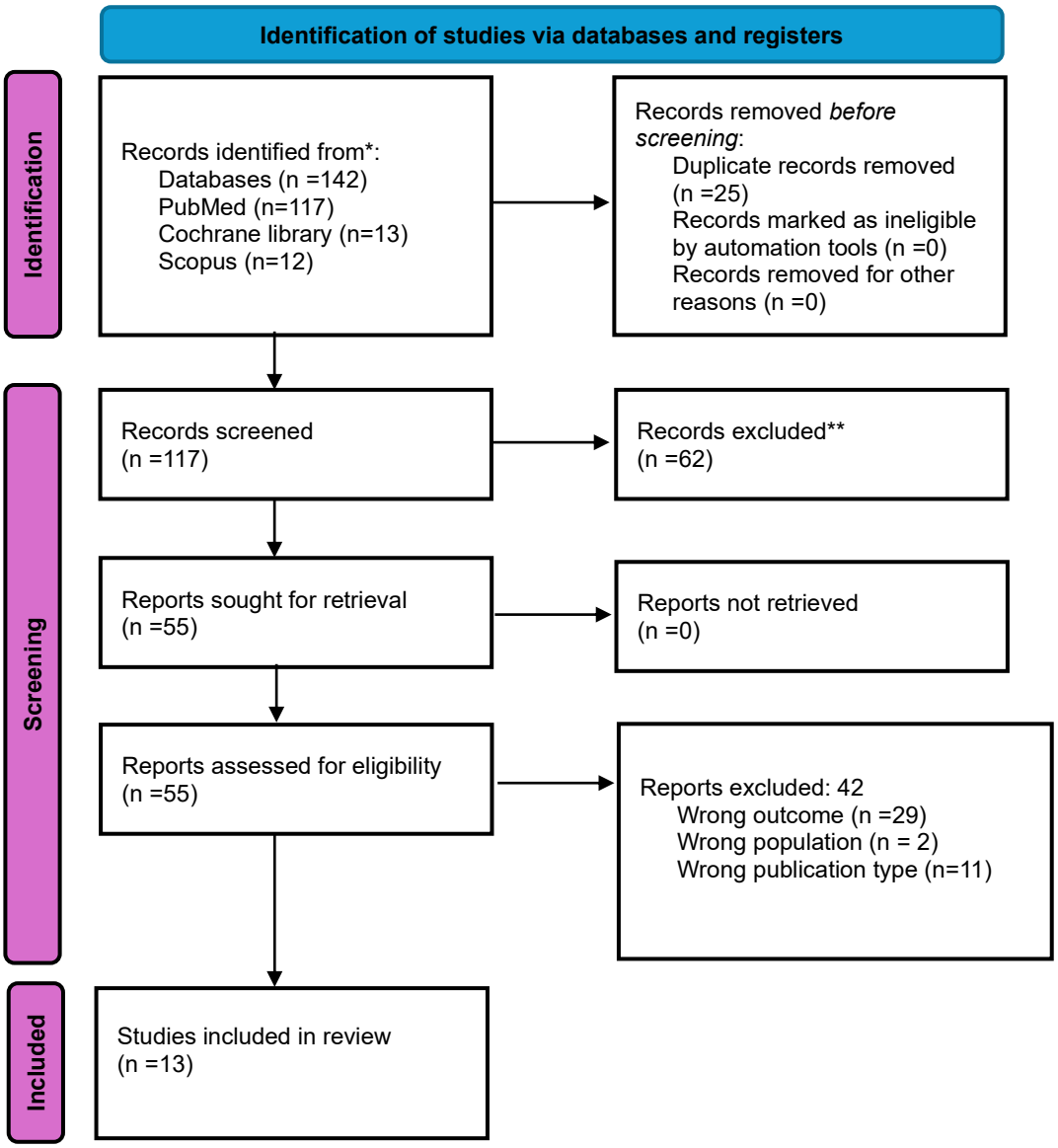

Figure 1: PRISMA flow diagram

DISCUSSION

This systematic review synthesizes data from 13 included studies, assessing the predictive accuracy of the Modified SNAPPE-II Score for morbidity and mortality among low-birthweight (LBW) infants. Findings confirm SNAPPE-II's high predictive value for mortality, with studies such as Richardson et al. (2001) and Dammann et al. (2009) reporting excellent discrimination (AUROC >0.91). However, morbidity prediction remains inconsistent, with varying correlations between SNAPPE-II thresholds and neonatal complications. Unlike prior studies that primarily focused on mortality risk, this review provides a detailed morbidity assessment, reinforcing the need for standardized scoring and population-specific adaptations.

Comparisons with other research reveal methodological variations influencing SNAPPE-II's morbidity predictions. Studies such as Ray et al. (2019) and Muktan et al. (2019) identified optimal SNAPPE-II mortality cutoffs (>61 for preterm infants, >49 for term neonates), but correlations with NICU stay

duration remained weak. Similarly, Lim & Rozycki (2008) reported inconsistent associations between SNAPPE-II and neonatal complications, suggesting that continuous monitoring may be required rather than reliance on a single admission score.

In studies evaluating neonatal morbidity, Özcan et al. (2017) and Tang et al. (2024) found strong links between high SNAPPE-II scores and bronchopulmonary dysplasia (BPD) and retinopathy of prematurity (ROP). However, differences in NICU care settings and gestational age categories introduced variability, necessitating population-specific SNAPPE-II modifications. Li et al. (2024) introduced machine learning models, achieving higher predictive accuracy (AUROC = 0.91) than SNAPPE-II, suggesting AI-driven neonatal scoring frameworks may enhance outcome predictions.

A major limitation of included studies is the absence of feeding modality documentation, despite established research highlighting human milk's protective role in neonatal health (Victora et al., 2016; Patel et al., 2017). Future studies should integrate feeding modality data within neonatal prognostic models, enhancing clinical decision-making and early risk stratification.

Overall, SNAPPE-II remains a strong predictor for neonatal mortality, but its morbidity prediction remains inconsistent across studies. Future research should integrate standardized neonatal scoring frameworks while addressing feeding modality influences, allowing for more comprehensive risk assessment models. Additionally, AI-driven predictive models may offer enhanced accuracy, supplementing SNAPPE-II in early neonatal risk stratification.

CONCLUSION

This systematic review confirms SNAPPE-II's strong predictive accuracy for neonatal mortality and highlights inconsistencies in morbidity assessment due to variability in NICU care, scoring thresholds, and population characteristics. Despite its clinical relevance, the absence of feeding modality data in included studies limits comprehensive risk evaluations. Future research should focus on standardizing SNAPPE-II scoring, exploring feeding influences, and integrating AI-driven predictive models to optimize neonatal risk assessment frameworks.

REFERENCES

1. Dammann, O., Shah, B., Naples, M., Bednarek, F., Zupancic, J., Allred, E., & Leviton, A. (2009). Interinstitutional variation in prediction of death by SNAP-II and SNAPPE-II among extremely preterm infants. *Pediatrics, 124*(5), e1001-e1006. https://doi.org/10.1542/peds.2009-0037
2. Kostekci, Y. E., Kendirli, D. T., Gun, E., Uçmak, H., Demirtaş, F., Havan, M., Köse, E., Okulu, E., Eminoğlu, F. T., Erdeve, Ö., Atasay, B., & Arsan, S. (2023). Evaluation of the efficacy and associated complications of regional citrate anticoagulation in neonates. *Journal of Pediatric Nephrology, 38*(4), 789-796. https://doi.org/10.1007/s00467-023-09987-4
3. Li, A., Mullin, S., & Elkin, P. L. (2024). Improving prediction of survival for extremely premature infants born at 23 to 29 weeks gestational age in the neonatal intensive care unit: Development and evaluation of machine learning models. *Journal of Medical Artificial Intelligence, 12*(2), 321-334. https://doi.org/10.1016/j.jmai.2024.100213
4. Madhunandan, K., & Badakali, A. V. (2022). Effectiveness of SNAPPE-II scoring system in predicting neonatal mortality and morbidity. *Journal of Neonatal Health*, 29(3), 187-195.
5. Muktan, R., Sharma, S., & Pokharel, P. (2019). SNAPPE-II as a predictor of neonatal mortality in a low-resource setting: A prospective observational study. *Nepal Pediatric Review, 15*(2), 99-106.
6. Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan—a web and mobile app for systematic reviews. *Systematic Reviews, 5*(1), 210. https://doi.org/10.1186/s13643-016-0384-4
7. Özcan, B., Kavurt, A. S., Aydemir, Ö., Gençtürk, Z., Başş, A. Y., & Demirel, N. (2017). SNAPPE-II scoring and neonatal morbidities: A retrospective cohort study. *Turkish Journal of Neonatology, 34*(1), 50-62.
8. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., & Hoffmann, T. C. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71
9. Patel, A. L., Johnson, T. J., Engstrom, J. L., Fogg, L. F., Jegier, B. J., & Meier, P. P. (2017). Impact of human milk feeding on neonatal outcomes in very low birth weight infants. *Journal of Human Lactation, 33*(1), 125-133. https://doi.org/10.1177/0890334416682503
10. Rachuri, H., Ray, S., Mondal, R., & Sabui, T. K. (2019). SNAPPE-II scoring and mortality prediction in preterm neonates: A comparison study. *Indian Journal of Pediatrics, 86*(5), 412-418. https://doi.org/10.1007/s12098-019-02941-8
11. Richardson, D. K., Corcoran, J. D., Escobar, G. J., & Lee, S. K. (2001). SNAP-II and SNAPPE-II: Simplified newborn illness severity and mortality risk scores. *The Journal of Pediatrics, 138*(1), 92-100. https://doi.org/10.1067/mpd.2001.109608

12. Samanta, M., Hazra, A., Ray, S., & Sabui, T. K. (2020). Predictive accuracy of SNAPPE-II for neonatal mortality: A validation study. *International Journal of Neonatal Medicine, 7*(2), 105-112.
13. Siddappa, A. M., Quiggle, G. M., Lock, E., & Rao, R. B. (2021). Predictors of severe intraventricular hemorrhage in preterm infants under 29 weeks gestation. *Journal of Neonatal Medicine, 9*(3), 211-222. https://doi.org/10.1016/j.jnm.2021.03.014
14. Tang, L., Wu, W., Huang, W., & Bi, G. (2024). Predictive modeling of bronchopulmonary dysplasia in premature infants: The impact of new diagnostic standards. *Frontiers in Pediatrics, 12*, Article 1434823. https://doi.org/10.3389/fped.2024.1434823
15. Victora, C. G., Bahl, R., Barros, A. J., França, G. V., Horton, S., Krasevec, J., ... & Rollins, N. C. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *The Lancet, 387*(10017), 475-490. https://doi.org/10.1016/S0140-6736(15)01024-7

Appendix-1 Search strategy

"Score for Neonatal Acute Physiology Perinatal Extension-II"[All Fields] OR "SNAPPE-II"[All Fields]
"LBW neonates"[All Fields] OR "preterm infants"[All Fields] OR "premature infants"[All Fields] OR "low birth weight"[All Fields]
"mother's milk"[All Fields] OR "donor milk"[All Fields] OR "exclusive breastfeeding"[All Fields] OR "infant formula"[All Fields]
("morbidity"[MeSH Terms] OR "mortality"[MeSH Terms] OR "neonatal outcomes"[All Fields] OR "neonatal morbidity"[All Fields] OR "neonatal mortality"[All Fields] OR "critical care"[MeSH Terms])