
# SpO2/FiO2 versus PaO2/FiO2 Ratio for Assessing Oxygenation in Critically Ill Children Requiring Respiratory Support: A Prospective Observational Study in a Pediatric Intensive Care Unit

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**Abstract**

**Background:** The PaO2/FiO2 (PF) ratio derived from arterial blood gas analysis is the reference standard for grading oxygenation in critically ill children, but repeated arterial sampling is invasive and frequently impractical in the pediatric intensive care unit (PICU). The SpO2/FiO2 (SF) ratio obtained from pulse oximetry offers a non-invasive, continuous alternative.

**Aim:** To compare the SF and PF ratios and evaluate the SF ratio as a surrogate marker of oxygenation, disease severity and outcome in critically ill children requiring respiratory support.

**Methods:** This prospective observational study enrolled 125 children aged 2 months to 16 years requiring respiratory support (invasive ventilation, non-invasive ventilation or high-flow nasal cannula) in the PICU of a tertiary care hospital over 24 months. SpO2, PaO2 and FiO2 were recorded simultaneously at admission and again at clinical deterioration or 24 hours, whichever was earlier. SF and PF ratios were calculated and compared across ARDS severity, respiratory support modality and clinical outcome. Analysis was performed in SPSS v29.0; $p < 0.05$ was significant.

**Results:** Mean age was 4.6 ± 4.4 years; bronchiolitis (23.2%) and pneumonia (12.0%) were the commonest diagnoses. SF and PF ratios fell in parallel with increasing ARDS severity at admission (non-ARDS SF 319.1/PF 393.1 vs severe SF 193.9/PF 209.5; $p < 0.001$ for both) and at 24 hours ($p < 0.001$). Both ratios were lowest in mechanically ventilated children and in non-survivors (admission SF 203.7/PF 202.0 in those who died vs SF 255.2/PF 276.5 in those discharged; $p = 0.013$ and 0.008). The prognostic separation widened at 24 hours (PF $p < 0.001$).

**Conclusion:** The SF ratio paralleled the PF ratio across severity, support modality and outcome, supporting its use as a reliable non-invasive surrogate that may reduce arterial sampling and aid early risk stratification in the PICU.

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**Keywords:** SpO2/FiO2 ratio, PaO2/FiO2 ratio, pediatric ARDS, pulse oximetry, oxygenation index, pediatric intensive care unit

## 1. Introduction

Accurate assessment of oxygenation is central to the management and prognosis of critically ill children requiring respiratory support. The PaO2/FiO2 (PF) ratio remains the reference standard for grading the severity of acute hypoxemic respiratory failure, yet it depends on arterial blood gas sampling, which is invasive, intermittent and technically demanding in young children [1]. The SpO2/FiO2 (SF) ratio, derived from continuous pulse oximetry, has emerged as a practical non-invasive marker of lung oxygenation that can be measured at the bedside without repeated arterial puncture. Several studies report a moderate-

to-strong correlation between the SF and PF ratios in critically ill children, supporting SF-based monitoring where arterial access is limited [2, 3] Reliance on the SF ratio may also facilitate earlier recognition of deterioration and guide escalation of ventilatory support while reducing the risks of arterial catheterization [4].

Given the clinical value of a validated non-invasive index, the present study compared the SF and PF ratios in critically ill children requiring respiratory support in a PICU and examined the behaviour of both indices across ARDS severity, mode of respiratory support and clinical outcome.

## 2. Materials and Methods

**Study design and setting:** This prospective observational study was conducted in the Pediatric Intensive Care Unit of Saraswathi Institute of Medical Sciences, Hapur, over 24 months after institutional ethics committee approval and written informed parental consent.

**Sample size:** Using an expected ARDS prevalence of 21.8% (Lodha *et al*.), 95% confidence and 7.5% absolute precision, the required sample was 125 children[5].

**Participants:** Children aged 2 months to 16 years requiring oxygen supplementation and respiratory support (invasive ventilation, non-invasive ventilation or high-flow nasal cannula), including those meeting PARDS criteria, were eligible. Children with congenital heart disease or anatomical lung anomalies, chronic lung disease, methemoglobinemia, or whose parents declined consent were excluded.

**Procedure:** At admission, during the first arterial blood gas, SpO2 and PaO2 were recorded simultaneously together with the administered FiO2. A second set of values was obtained at clinical deterioration requiring escalation of support or at 24 hours, whichever occurred earlier. SF and PF ratios, oxygenation index (OI) and oxygen saturation index (OSI) were calculated, and ARDS severity classified using PARDS diagnostic criteria. The Pediatric Index of Mortality-2 (PIM-2) was computed at admission.

**Statistical analysis:** Data were analysed in SPSS v29.0. Continuous variables were summarised as mean ± SD and categorical variables as frequency (percentage). Groups were compared using the independent t-test or one-way ANOVA, and categorical associations using the chi-square test. ROC analysis was planned to identify SF-ratio thresholds corresponding to PF cut-offs of 200 and 300, and linear regression to model SF on PF. A two-sided $p < 0.05$ was considered significant.

## 3. Results

Of 125 children, 72 (57.6%) were female and 53 (42.4%) male; mean age was 4.6 ± 4.4 years, with 50.4% aged 1–5 years. Bronchiolitis was the leading admission diagnosis (23.2%), followed by pneumonia (12.0%) and croup (11.2%); 72.0% had no pre-existing morbidity (Table 1). The mean PIM-2 score was −7.0 ± 0.6, corresponding to a low predicted mortality of 0.1%.

**Table 1:** Baseline characteristics and leading admission diagnoses (N = 125).

| Variable | Category | n (%) |
|---|---|---|
| Sex | Female / Male | 72 (57.6) / 53 (42.4) |
| Age group (years) | <1 / 1–5 / >5 | 26 (20.8) / 63 (50.4) / 36 (28.8) |
| Leading diagnosis | Bronchiolitis | 29 (23.2) |
| | Pneumonia | 15 (12.0) |
| | Croup | 14 (11.2) |
| | Encephalitis | 13 (10.4) |
| Pre-existing morbidity | None | 90 (72.0) |
| | Cerebral palsy | 16 (12.8) |

Over the first 24 hours, oxygenation and haemodynamics improved: mean FiO2 fell from 0.40 to 0.30, PaO2 rose from 100.5 to 105.1 mmHg, SF ratio from 251.1 to 302.8 and PF ratio from 270.3 to 338.9 (Table 2). The proportion of children on conventional oxygen support rose from 33.6% to 60.0%, with de-escalation of HFNC and CPAP, indicating early clinical stabilisation.

**Table 2:** Physiological and oxygenation parameters at admission and at 24 hours (mean ± SD).

| Parameter | Admission | 24 hours |
|---|---|---|
| SpO2 (%) | 93.1 ± 3.8 | 93.6 ± 4.0 |
| FiO2 | 0.40 ± 0.00 | 0.30 ± 0.10 |
| PaO2 (mmHg) | 100.5 ± 16.3 | 105.1 ± 24.6 |
| Oxygenation index (OI) | 23.3 ± 6.6 | 22.5 ± 8.9 |
| Oxygen saturation index (OSI) | 24.6 ± 6.2 | 23.8 ± 6.5 |
| SF ratio | 251.1 ± 45.1 | 302.8 ± 69.5 |
| PF ratio | 270.3 ± 63.9 | 338.9 ± 102.8 |

Both indices declined in parallel with increasing ARDS severity. At admission, children without ARDS had the highest SF (319.1) and PF (393.1) ratios, falling progressively through mild and moderate disease to the lowest values in severe ARDS (SF 193.9; PF 209.5); differences were highly significant for both ratios ($p < 0.001$, Table 3). An identical gradient was seen at 24 hours (non-ARDS SF 334.0/PF 401.0 vs severe SF 212.8/PF 180.7; $p < 0.001$). Oxygenation indices also tracked the intensity of respiratory support, being lowest in mechanically ventilated children at both time points ($p < 0.001$).

**Table 3:** SF and PF ratios by ARDS severity at admission (mean ± SD).

| ARDS status | SF ratio | PF ratio |
|---|---|---|
| Absent | 319.1 ± 63.3 | 393.1 ± 81.3 |
| Present (non-invasive) | 246.5 ± 29.7 | 256.7 ± 30.9 |
| Mild | 234.8 ± 39.7 | 251.6 ± 42.1 |
| Moderate | 231.6 ± 22.8 | 249.5 ± 46.1 |
| Severe | 193.9 ± 11.3 | 209.5 ± 39.1 |
| p-value (ANOVA) | <0.001 | <0.001 |

Oxygenation indices were significantly associated with outcome (Table 4). Children who were discharged had the highest SF and PF ratios at admission and showed further improvement at 24 hours, whereas non-survivors had the lowest ratios at admission with minimal improvement. The prognostic separation strengthened over time, becoming most marked for the 24-hour PF ratio ($p < 0.001$).

**Table 4:** SF and PF ratios by clinical outcome (mean ± SD).

| Outcome | SF (adm.) | PF (adm.) | SF (24 h) | PF (24 h) |
|---|---|---|---|---|
| Discharged | 255.2 ± 46.1 | 276.5 ± 64.6 | 310.0 ± 67.6 | 353.0 ± 100.1 |
| DAMA | 237.0 ± 19.2 | 247.1 ± 31.6 | 281.9 ± 68.3 | 273.3 ± 64.8 |
| Died | 203.7 ± 26.0 | 202.0 ± 46.3 | 212.1 ± 22.7 | 205.6 ± 64.6 |
| p-value | 0.013 | 0.008 | 0.002 | <0.001 |

## 4. Discussion

In this cohort of 125 critically ill children, the SF ratio mirrored the PF ratio across every stratification examined — ARDS severity, mode of respiratory support and clinical outcome — supporting its use as a non-invasive surrogate for oxygenation assessment. Unusually, the cohort showed a female predominance (57.6%), in contrast to the male preponderance generally reported in PICU respiratory admissions[6,7,8,9,] a difference that may reflect local referral and care-seeking patterns. The diagnostic spectrum, led by bronchiolitis and pneumonia, is consistent with international PICU data while also including a notable neurological and metabolic burden [10,11,12]

The stepwise fall in both SF and PF ratios with worsening ARDS severity, significant at admission and at 24 hours ($p < 0.001$), aligns with reports validating saturation-based indices as reliable severity markers [13,14,15] The persistence of low ratios in mechanically ventilated children and the improvement seen in non-invasive groups echo evidence that 24-hour oxygenation metrics carry greater prognostic weight than admission values, and that failure to improve within the first day identifies a higher-risk subgroup [16,17]

The close parallel between SF and PF observed here is concordant with prior pediatric work describing strong SF–PF correlation and SF thresholds (approximately 235 and 181) corresponding to PF cut-offs of 300 and 200 for ALI and ARDS [18,19] The outcome data, with markedly lower admission ratios among non-survivors, are consistent with reports that low SF and PF values strongly predict mortality and the need for intensive care[20]. Together these findings reinforce the value of SF-based bedside monitoring, which avoids repeated arterial sampling while retaining the discriminative and prognostic properties of the PF ratio.

## 5. Limitations

This was a single-centre study with a modest sample, and the formal correlation coefficient and ROC-derived SF cut-off for this cohort were not finalised; quantifying these, together with multivariable adjustment for confounders, would strengthen the surrogate claim. SpO2 readings above 97% can saturate the pulse-oximetry signal and may attenuate SF performance at higher oxygenation levels.

## 6. Conclusion

The SpO2/FiO2 ratio closely paralleled the PaO2/FiO2 ratio across ARDS severity, respiratory support modality and clinical outcome in critically ill children. Because it is non-invasive, continuous and readily available, the SF ratio is a practical and reliable surrogate for the PF ratio that may reduce the need for repeated arterial blood gas sampling and assist early risk stratification and decision-making in the PICU.

## 7. Declarations

**Ethics approval:** Approved by the institutional ethics committee; written informed parental consent was obtained for every participant.

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**Conflict of interest:** The authors declare no conflict of interest.

**Author contributions:** All authors contributed to study design, data acquisition, analysis and manuscript preparation, and approved the final version.

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