



## Pediatric Trainees' Knowledge of Acute Oxygen Therapy in Sudan: A Cross-Sectional Study

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**Abstract Background:** Noninvasive Oxygen Therapy (NIOT) is a core pediatric acute-care intervention, yet training and guideline uptake may be inconsistent in resource-limited settings. **Methods:** We conducted a web-based cross-sectional survey of Sudanese pediatric residents using the previously validated Acute Oxygen Therapy Questionnaire (AOTQ). The questionnaire link was distributed via WhatsApp groups to the full resident body. Data were analyzed in Stata, with  $p < 0.05$  considered statistically significant. **Results:** A total of 126 residents participated; 114 (90.5%) were female. The mean AOTQ knowledge score was 74.1%. Female residents had significantly higher mean AOTQ scores than male residents, with a mean difference of 7.3 percentage points ( $74.8 \pm 9.7$  vs.  $67.5 \pm 10.5$ ;  $p = 0.015$ ). Residents with PICU experience also scored significantly higher than those without PICU experience, with a mean difference of 5.6 percentage points ( $78.3 \pm 10.3$  vs.  $72.7 \pm 9.6$ ;  $p = 0.006$ ). Scores did not differ by age, training level, years of experience, neonatal unit/emergency department experience, guideline awareness or information source. Most participants (62.7%) reported no awareness of oxygen therapy guidelines; verbal instruction was the commonest information source (53.2%), while only 4.0% reported courses. Knowledge levels were good in 32.5%, moderate in 57.9% and poor in 9.5%. **Conclusion:** Overall knowledge was moderate-to-good but with important gaps in guideline awareness and formal training. Structured, competency-based oxygen therapy training and improved guideline visibility are warranted.

**Key Words** Oxygen Therapy, Pediatric Residents, Knowledge, Training, Sudan, Cross-Sectional Study

### INTRODUCTION

Noninvasive Oxygen Therapy (NIOT) refers to the administration of oxygen without invasive procedures such as intubation, using devices like nasal cannulae or face masks. It is a cornerstone in pediatric acute care, particularly for critically ill children with conditions such as pneumonia, asthma and bronchiolitis, where adequate oxygenation is crucial for recovery and survival. Proper knowledge and skills in oxygen therapy are essential for pediatric practice to ensure effective management of hypoxemia, avoid respiratory failure and potentially reduce mortality [1].

Despite its critical role, studies have shown gaps in healthcare providers' knowledge and skills regarding oxygen therapy worldwide, often resulting in inappropriate administration [2]. In Sudan, formal training on acute oxygen therapy remains limited and anecdotal evidence suggests variability in the practices of pediatric residents, particularly in resource-limited clinical settings across the country. However, there is a lack of local evidence describing pediatric residents' knowledge of acute oxygen

therapy in Sudan and no previous study has systematically evaluated this issue among Sudanese pediatric trainees. This study was therefore conducted to address this national evidence gap.

### Objectives

This study aimed to assess Sudanese pediatric residents' knowledge of acute oxygen therapy using the Acute Oxygen Therapy Questionnaire (AOTQ), describe their awareness of oxygen therapy guidelines and primary sources of oxygen therapy information and examine associations between total AOTQ scores and demographic, training and clinical exposure characteristics.

### METHODS

This descriptive cross-sectional study was conducted among pediatric residents at the Sudan Medical Specialization Board (SMSB), across four training levels (R1-R4). The study was approved by the Ethical Committee of the Sudan Medical Specialization Board-Education Development Centre (SMSB-EDC). A web-based Google

Forms questionnaire link was distributed through official WhatsApp groups used by SMSB pediatric residents, which included the full resident body of 681 trainees across all training levels. The questionnaire was pilot tested before distribution to assess clarity, completeness and technical functionality of the online form and pilot responses were not included in the final analysis. All questionnaire items required for analysis were set as mandatory in Google Forms; therefore, no incomplete responses were submitted or excluded for missing data. Data were collected using a self-administered, semi-structured questionnaire closely adapted from the previously validated Acute Oxygen Therapy Questionnaire (AOTQ) [3] (supplementary material). Data were analyzed using Stata software (StataCorp. 2021. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC.). Continuous variables were summarized as means and standard deviations and categorical variables as frequencies and percentages. Between-group comparisons of total AOTQ scores were performed using parametric tests, with non-parametric Mann-Whitney U or Kruskal-Wallis tests used as sensitivity analyses because AOTQ scores may not meet normality assumptions across all subgroups. Non-parametric tests were applied to independent, mutually exclusive groups and interpreted as distributional comparisons. Statistical significance was set at  $p < 0.05$ . Effect sizes were reported for statistically significant two-group comparisons using mean differences and Cohen's *d*. All questionnaire items required for analysis were mandatory in Google

Forms; therefore, no missing data were present and all 126 submitted responses were included in the analysis.

## RESULTS

A total of 126 pediatric residents participated; 114 (90.5%) were female. The mean total AOTQ knowledge score was 74.1%. Female residents achieved higher mean scores than males, with a mean difference of 7.3 percentage points and a moderate-to-large standardized effect size (74.8 [SD 9.7] vs 67.5 [SD 10.5]; Cohen's *d* = 0.75;  $p = 0.015$  [non-parametric  $p = 0.025$ ]). Awareness of any oxygen therapy guideline was reported by 47 participants (37.3%), while 79 (62.7%) reported no guideline awareness; mean scores did not differ by guideline awareness (74.5 [SD 10.1] vs. 73.5 [SD 9.9];  $p = 0.572$  [0.494]).

Regarding primary sources of oxygen therapy information, 67 participants (53.2%) reported verbal instructions from another professional/senior colleague, 54 (42.9%) reported self-reading and 5 (4.0%) reported courses; mean scores did not differ by information source ( $p = 0.568$  [0.722]). Knowledge scores also did not differ significantly by age group ( $p = 0.784$  [0.651]), training level ( $p = 0.973$  [0.977]) or years of experience ( $p = 0.496$  [0.413]).

Residents with PICU experience scored higher than those without PICU experience, with a mean difference of 5.6 percentage points and a moderate standardized effect size (78.3 [SD 10.3] vs. 72.7 [SD 9.6]; Cohen's *d* = 0.57;  $p = 0.006$  [0.006]). Scores did not differ significantly by NICU experience ( $p = 0.117$  [0.080]), ED experience ( $p = 0.642$  [0.657]) or MRCPCH examination status ( $p = 0.382$  [0.386]) (Table 1).

Table 1: Participant Characteristics and Comparisons of Total Acute Oxygen Therapy Questionnaire (AOTQ) Knowledge Scores Among Sudanese Pediatric Residents

Variable	Category	Count (%)	Mean (SD)*	p-value <sup>†</sup>
Age	25-30	59 (46.8%)	73.5 (9.9)	0.784 (0.651)
	36-40	12 (9.5%)	74.6 (11.4)	
	31-35	50 (39.7%)	74.6 (9.9)	
	41-45	4 (3.2%)	72.6 (12.5)	
	> 45	1 (0.8%)	85.7 (NA)	
Gender	Female	114 (90.5%)	74.8 (9.7)	0.015 (0.025)
	Male	12 (9.5%)	67.5 (10.5)	
Training level	R 1	14 (11.1%)	73.1 (9.6)	0.973 (0.977)
	R 2	26 (20.6%)	74.7 (10.8)	
	R 3	22 (17.5%)	74.0 (7.9)	
	R 4	64 (50.8%)	74.1 (10.6)	
Experience in years	<2	13 (10.3%)	71.1 (10.7)	0.496 (0.413)
	5-Feb	66 (52.4%)	74.9 (9.4)	
	10-Jun	36 (28.6%)	73.1 (10.4)	
	>10	11 (8.7%)	76.2 (11.7)	
Awareness of any oxygen therapy guidelines	No	79 (62.7%)	74.5 (10.1)	0.572 (0.494)
	Yes	47 (37.3%)	73.5 (9.9)	
Primary source of information on the oxygen therapy	Self-reading	54 (42.9%)	74.1 (10.5)	0.568 (0.722)
	Course	5 (4.0%)	69.5 (16.0)	
	Verbal instructions from another professional/senior colleague	67 (53.2%)	74.5 (9.2)	
PICU experience	No	95 (75.4%)	72.7 (9.6)	0.006 (0.006)
	Yes	31 (24.6%)	78.3 (10.3)	
NICU experience	No	27 (21.4%)	71.4 (11.4)	0.117 (0.08)
	Yes	99 (78.6%)	74.8 (9.5)	
ED experience	No	18 (14.3%)	75.1 (12.0)	0.642 (0.657)
	Yes	108 (85.7%)	73.9 (9.7)	
MRCPCH (any exam)	No	94 (74.6%)	74.6 (10.0)	0.382 (0.386)
	Yes	32 (25.4%)	72.8 (10.1)	

\*AOTQ scores are expressed as percentages, with higher scores indicating greater knowledge, †Values in parentheses are p-values from non-parametric tests (Mann-Whitney U or Kruskal-Wallis). PICU, pediatric intensive care unit, NICU: Neonatal intensive care unit, ED: Emergency department, MRCPCH: Membership of the Royal College of Pediatrics and Child Health

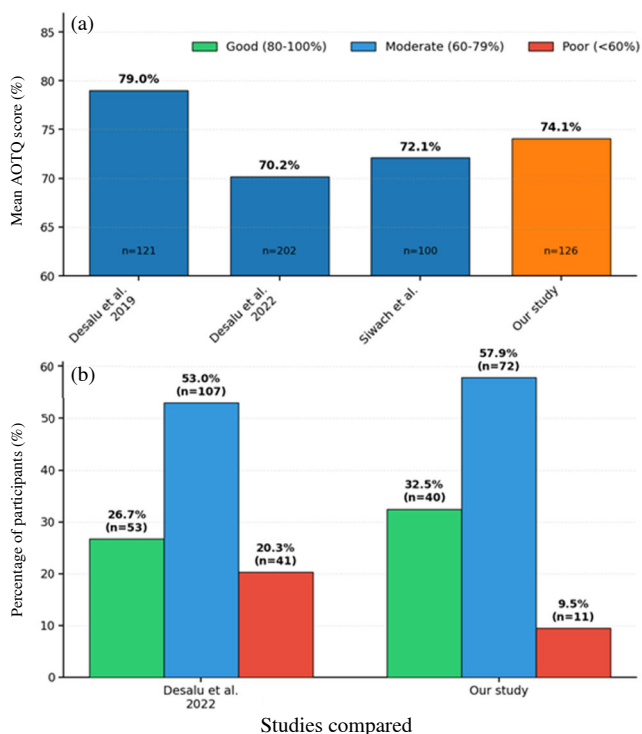


Figure 1(a-b): (a) Mean AOTQ Score Across 4 Studies and (b) Knowledge Levels in 2 Studies

## DISCUSSION

In this national sample of Sudanese pediatric residents, the mean AOTQ score (74.1%) indicates overall moderate-to-good knowledge of acute oxygen therapy. However, the presence of a poorly scoring subgroup (9.5%) remains clinically relevant because oxygen is a high-impact therapy whose inappropriate use can contribute to avoidable harm [1,2]. The finding that nearly two-thirds of participants reported no awareness of any oxygen therapy guideline, coupled with the very low proportion reporting formal courses (4.0%) and the predominance of informal verbal instruction as a main information source, suggests that knowledge acquisition may be occurring inconsistently rather than through standardized, competency-based training.

When compared with prior studies that used the same instrument in similar populations, the mean score in our sample (74.1%) was higher than that reported in Nigeria (70.2%) and India (72.1%), though lower than the original validation study (79.0) (Figure 1) [3-5]. Differences across settings may reflect variation in clinical exposure, supervision and access to structured teaching. Importantly, the distribution of knowledge levels in our sample (good 32.5%, moderate 57.9%, poor 9.5%) suggests a larger proportion with adequate knowledge than in the Nigerian report where poor knowledge was more common, while still leaving a meaningful proportion who may require targeted remediation.

Among participant characteristics, higher scores among residents with PICU exposure plausibly reflect greater hands-on experience with oxygen delivery devices, monitoring and escalation pathways in high-acuity

environments, which reinforces the educational value of structured critical care exposure for oxygen therapy competence [1]. By contrast, the absence of differences by training level or total years of experience suggests that progression through residency alone may not guarantee incremental gains in oxygen-therapy knowledge unless explicitly supported by formal teaching and supervised practice. The observed gender difference should be interpreted cautiously given the very small male subgroup and it may reflect sampling imbalance or unmeasured differences in exposure rather than a stable underlying effect.

These findings have direct implications for pediatric curriculum planning in Sudan. Acute oxygen therapy should be incorporated as a clearly defined core competency within residency training, with structured teaching, bedside coaching and skills-based assessment covering device selection, target oxygen saturation, monitoring, escalation, safe weaning and documentation. This is aligned with established guidance [2]. Given the low reported awareness of guidelines and limited exposure to formal courses, Sudanese training programs may benefit from standardized local protocols and periodic competency-based refresher sessions rather than reliance on informal verbal instruction alone.

## CONCLUSIONS

Overall, Sudanese pediatric residents demonstrated moderate to good knowledge of acute oxygen therapy but important gaps were identified in guideline awareness and formal training. Pediatric residency programs in Sudan should incorporate structured, competency-based oxygen therapy training, improve access to standardized local guidance and use periodic skills-based assessment to support safe and consistent practice.

## Limitations

This study has limitations. Voluntary participation in a web-based survey may have introduced selection bias. The predominance of female respondents limits the precision of gender-based comparisons. In addition, the AOTQ is a knowledge questionnaire and does not directly assess hands-on oxygen therapy skills or observed clinical practice. Nonetheless, the study's strengths include use of a previously validated instrument and inclusion of residents across training levels, providing an initial baseline for curriculum planning and targeted training evaluation.

## Future Recommendations

Future work and training initiatives should focus on:

- Integrating structured acute oxygen therapy teaching into the Sudanese pediatric residency curriculum
- Developing standardized local protocols for oxygen therapy in pediatric acute-care settings
- Implementing periodic competency-based assessment, including practical skills evaluation
- Evaluating whether targeted training improves residents' knowledge, clinical practice and patient care outcomes

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### Ethical Consideration

This study was conducted following the approval and permission granted by the Ethical Committee of the Sudan Medical Specialization Board-Education Development Centre (SMSB-EDC).

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