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Exploring pediatric residents' readiness for point-of-care ultrasound in two teaching hospitals in Addis Ababa, Ethiopia: insights into training, confidence, and practice

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Abstract

Background Point-of-care ultrasound is an evolving field in medical education and emergency practice. Numerous pieces of evidence support the use of point-of-care ultrasound in children to improve outcomes. Pediatrics as a specialty has been relatively late to adopt point-of-care ultrasound, with a significant gap in specific recommendations and implementation. Assessing pediatric residents' perception and knowledge is one of the crucial factors for successfully integrating point-of-care ultrasound into pediatric emergency and critical care practice. The objective of the study is to describe pediatric residents' perception toward pediatric point-of-care ultrasound practice and identify factors associated with knowledge of point-of-care ultrasound.

Method A cross-sectional study assessed the perception and knowledge of 97 pediatric residents from Year 1 to Year 3 in two tertiary hospitals in Addis Ababa. An online questionnaire was used to collect data on demographics, perception, and knowledge toward point-of-care ultrasound. The data was entered and analyzed using SPSS version 26 software, employing analytic and descriptive parameters. Binary and multivariable logistic regression analyses were conducted to identify factors associated with point-of-care ultrasound knowledge.

Result A majority (70.1%) of residents have a good understanding of the potential use of point-of-care ultrasound for pediatrics. A majority (67%) of residents rated point-of-care ultrasound as a valuable tool for improving diagnostic accuracy with a Good perception. Regarding the importance of integrating point-of-care ultrasound training into pediatric residency programs, 70.1% of residents have a positive perception. The most significant perceived barrier to point-of-care ultrasound practice is a lack of training (72.2%). Residents with any form of point-of-care ultrasound training were significantly more likely to score above the median knowledge assessment (AOR = 58.46; 95% CI: 5.835-585.858; P-value = 0.01). Residents who reported using point-of-care ultrasound once a month or once a week were significantly more likely to have good knowledge of point-of-care ultrasound compared to those who never or rarely

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used it (AOR = 9.000; 95% CI: 2.307–35.118; P-value = 0.020 and AOR = 7.661; 95% CI: 1.375–42.695; P-value = 0.039), respectively.

Conclusion and recommendation Our findings reflect a positive self-perception among pediatric residents toward integrating POCUS into residency training. This integration is likely to increase acceptance among pediatric residents. Our results highlight the importance of prior training and regular use of point-of-care ultrasound in enhancing the knowledge of pediatric residents. We recommend that further studies be conducted to assess the impact of educational interventions on the pre- and post-knowledge of pediatric residents toward point-of-care ultrasound. Another area of interest for future research would be the factors hindering the integration of point-of-care ultrasound into pediatric curricula.

Keywords Point of care ultrasound, Pediatrics and child health, Residents, Addis ababa

Introduction

In pediatric practice, point-of-care ultrasound allows for rapid, convenient serial reassessments aimed at improving diagnosis. The last two decades have witnessed substantial progress in the development and application of pediatric POCUS. Nevertheless, this advancement has been met with some degree of contention [1]. Point-of-care ultrasonography is the use of ultrasound imaging by a clinician at the patient's bedside or point of care for immediate diagnostic and therapeutic purposes [2]. This technique enables the physician to correlate real-time images with the patient's presenting signs and symptoms [3]. Pediatric emergency and Intensive Care Unit (ICU) patients often present with ultrasound-detectable abnormalities. It is also an ideal imaging modality for children due to its lack of radiation exposure and its ability to be performed without sedation [4]. A wide range of medical specialties, such as anesthesia, neonatology, internal medicine, family medicine, critical care medicine, and emergency medicine, employ ultrasound [5]. It is important to consider, however, that according to the American Academy of Pediatrics policy statement, "clinicians should be aware that point-of-care ultrasonography is better used as a rule-in and not a rule-out diagnostic modality" [6].

The first widespread implementation of pediatric POCUS into practice was urged in 2014 [2]. Following this initiation, a pediatric institutional POCUS training program was conducted in 2015 [7]. In the same year, the American Academy of Pediatrics recommended the integration of POCUS training into pediatric emergency fellowships and for physicians [8]. While guidelines for adult patients were published by the Society of Critical Care Medicine in 2015, the European Society for Pediatric and Neonatal Intensive Care has since published comprehensive, evidence-based guidelines [9]. Subsequently, advancements have been made in POCUS training and clinical implementation within both pediatric critical care and emergency medicine settings [10]. A curriculum standard and core POCUS content for Pediatric Emergency Medicine (PEM) fellowships were defined by the Pediatric Emergency Medicine POCUS Network in 2019 [11]. Point-of-care ultrasound program development emphasizes five key elements: training, credentialing, image storage, documentation, and quality assurance [10].

In light of the current status, more than 70% of pediatric fellowship programs in the United States provide formal ultrasound training, and less than 15% of residency programs offer it as an elective [1, 12]. A meta-analysis suggests pediatric emergency physicians should embrace POCUS as a safe and effective tool for diagnosis, critical care management, and procedural guidance, ultimately enhancing overall patient care [13]. Significant uncertainties persist regarding competency standards and training requirements, with variable implementation and adoption. A 2019 national Survey found that no pediatric residency programs had a mandatory POCUS curriculum, and less than 15% offered it as an elective [12]. Compared to ten years ago, there has been a notable rise in PEM fellowship training programs, with 77% reporting their inclusion in a 2020 survey of program directors [8]. The trend of implementation in more than a hundred surveyed academic pediatric critical care units was found to be low and varied, largely attributed to deficiencies in user training, competence, and confidence [14].

Several studies show the attitude, level of confidence, and comfort of performing POCUS among pediatric residents. According to these studies, pediatric residents have little POCUS training and perform poorly on POCUS knowledge testing. While most residents in one study reported a high likelihood of using POCUS in their clinical practice, their confidence levels remained relatively low, particularly in specific scan areas. Nevertheless, all residents agreed that the value of POCUS justified the time investment [15]. A basic POCUS curriculum can be instituted during the PICU and emergency rotation to improve resident knowledge and comfort [16]. Consequently, pediatric emergency and critical care medicine providers will embrace this technology in everyday practice.

In Ethiopia, there is no single study that shows the extent of pediatric POCUS practice, and most of the data are inconclusive. This gap could be a potential area of study for the future in the country. However, one study conducted in Addis Ababa demonstrated that POCUS is the most commonly performed procedure in adult emergency departments [17]. Assessing pediatric residents' perception and knowledge is one of the crucial factors for the successful integration of point-of-care ultrasound in pediatric emergency and critical care practice. This also aims to serve as an input for stakeholders for future implementation and curriculum development. The primary objective of this study was to describe pediatric and child health residents' perception and knowledge toward point-of-care ultrasound practice in two teaching hospitals in Addis Ababa. The secondary objectives were to identify factors associated with the knowledge of pediatric residents toward point-of-care ultrasound practice and describe the comfort and confidence level of pediatric residents toward point-of-care ultrasound practice.

Methods

A cross-sectional study on pediatric residents' perception and knowledge toward point-of-care ultrasound was conducted in the Pediatric departments of two tertiary hospitals. The study took place from May to November 2024. Pediatric Residents from Year 1 to Year 3 at Tikur Anbessa Specialized Hospital (TASH) and St. Paul's Hospital Millennium Medical College (SPHMMC) were included in the study after informed consent was obtained. A total of 170 pediatric residents were enrolled at the time of the study. Based on the inclusion criteria, residents were eligible if they had completed at least six months of pediatric training and had rotated through either the Intensive Care Unit (ICU) or Pediatric Emergency Medicine (PEM) settings. Exclusion criteria included no exposure to POCUS in any form (including incidental bedside exposure), inability to participate due to serious illness, or lack of contact information. The sampling procedure used in this study was non-probability sampling (a combination of convenience and quota sampling). The selection of the sample was based on ease of access and convenience. However, to avoid bias and ensure an even distribution of residents from years 1 to 3, a fixed, equal quota was used for each year. The Pediatric Resident Eligibility Diagram in Fig. 1 summarizes the recruitment and exclusion process. The primary investigator, in collaboration with pediatric chief residents, undertook the responsibility of data collection. Before entering the information into the SPSS program, responses were reviewed daily for completeness. Data was collected via online questionnaires using a Google Data Collection format from pediatric residents. Assessment questionnaires were provided to assess the perception and knowledge of pediatric residents toward POCUS. All the collected data were organized and analyzed by the principal investigator. Study participants' identification was not disclosed to a third party and remained confidential.The questionnaire was prepared in English. Informed consent, in written form, was obtained before physician data collection. Each participant was accessed through their respective hospital. Data was not collected from physicians who were not cooperative in giving consent. The questionnaire included demographics, evaluation of comfort, confidence, perception, and a knowledge assessment. At the end of the questionnaire, a graded knowledge test was provided to the participants. The data was entered and analyzed using SPSS version 26 software, employing analytic and descriptive parameters. Missing data was treated as missing during analysis. Descriptive data was presented using the mean with standard deviation, median with interquartile range, and mode. Perception and knowledge were assessed using ten and twenty questions, respectively, which were adopted from a previous similar study [18]. The computed median value was used to categorize good and poor perception and knowledge toward POCUS. Since the perception variables were categorical and measured on a Likert scale, they were dichotomized into two groups: above and below the median score. P-values of less than 0.2 in bivariate analysis were included in multivariable analysis, which was conducted to identify factors associated with the level of knowledge toward POCUS. A P-value less than 0.05 was considered statistically significant.

Result

Sociodemographic

In the study, there were a total of 97 residents. Participants were from Tikur Anbessa Specialized Hospital (TASH), 54.6%($n=55$), and St. Paulo's Hospital accounted (SPHMMC) for 45.4% ($n=42$). Further results are detailed in Table 1.

Pediatric residents' comfort and confidence with pediatric POCUS

The majority of residents (79.4%) reported poor comfort with POCUS practice. A similar trend is observed in self-reported confidence levels, with 78.4% of residents reporting poor confidence in interpreting POCUS images. Regarding the area of comfort to perform pediatric POCUS, a significant proportion (36.1%) felt uncomfortable with all areas of pediatric POCUS, and 35.1% felt comfortable with IVC POCUS. Forty-four point 3% (44.3%) of residents never used POCUS in their practice. A significant majority (68%) of residents have not received any formal or informal training in POCUS during their residency program. Table 2 provides further details.

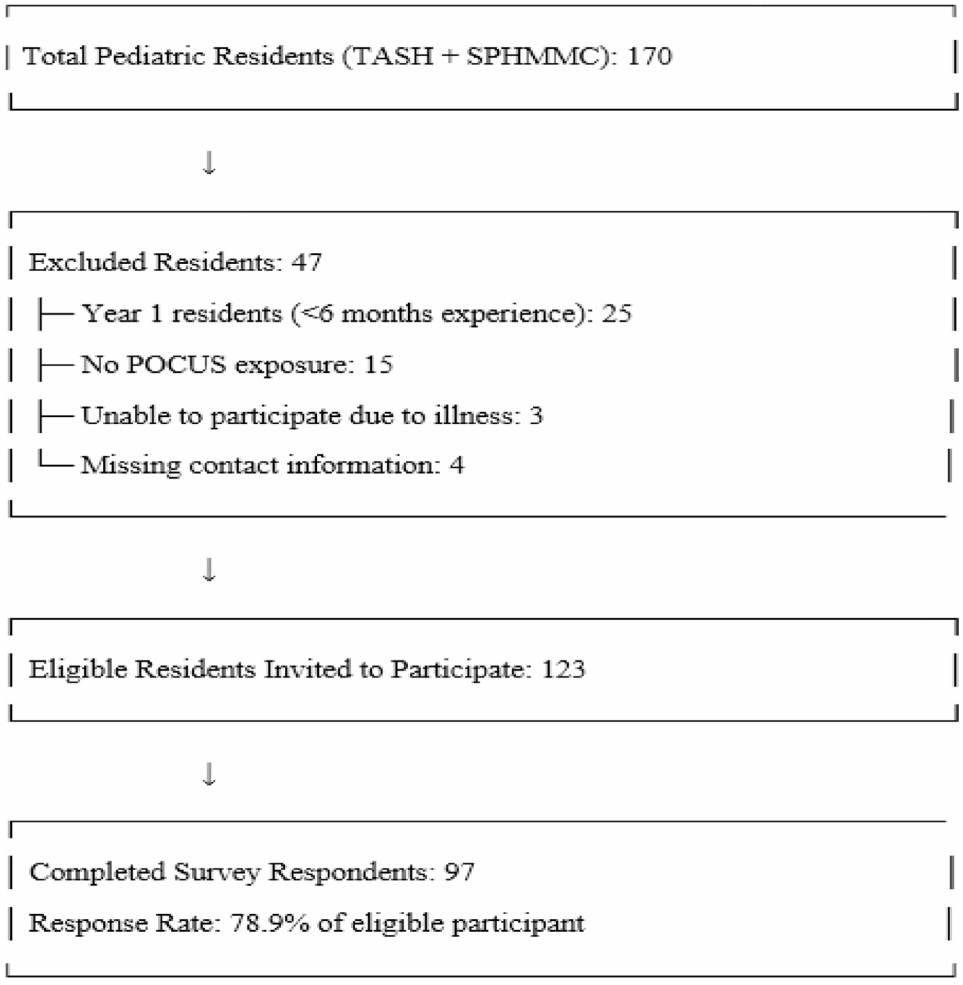


Fig. 1 Pediatric residents eligibility flow diagram

Table 1 Sociodemographic characteristics of pediatric residents (N = 97)

Characteristic	Category	Frequency (*n*)	Percentage (%)
Institution	TASH	55	56.7
	SPHMMC	42	43.3
Gender	Male	60	61.9%
	Female	37	38.1%
Year of Residency	Year 1	30	30.9%
	Year 2	34	35.1%
	Yaer 3	33	34.0%
Age	Mean ± SD	30.34 ± 2.37	
	95% CI	(29.84–30.85)	

Pediatric residents' perceptions towards POCUS practice

A significant majority (70.1%) of residents have a Good understanding of the potential use of POCUS for pediatric patients, while 29.9% rated it poor. A majority (67%) of residents agreed that POCUS was a valuable tool for improving diagnostic accuracy. Additionally, 70.1% of residents agreed on the importance of integrating POCUS training into the pediatric residency program. The most significant perceived barrier to POCUS practice is a lack of training (72.2%). The most preferred intervention to improve POCUS proficiency is dedicated practice with an ultrasound machine (40.2%). Table 3 provides a comprehensive overview of the remaining result section.

Factors contributing to pediatric residents' knowledge of POCUS

A total of 49(51%) of residents scored below the median(less than 50%) on the POCUS exam, while 47(49%) residents scored above the median. This Suggests that the majority of residents achieved a score below the lower threshold. Year 1 residents had the highest proportion (77%) scoring below the threshold. Year 3 residents had the highest proportion (73%) scoring above the threshold. 17 residents (52%) from year 2 scored above the median. Residents with previous POCUS training were significantly more likely to score above the median POCUS score with an AOR of 58.46 (95% CI: 5.835-585.858), indicating a strong positive association

Table 2 Comfort and confidence towards pediatric POCUS practice

	Frequency(Percent)	95%CI
Any formal/informal training on POCUS		
Yes	31(32.0%)	22.7-41.2
No	66(68.0%)	58.8-77.3
Self-reported level of comfort to practice		
Poor	77(79.4%)	71.1-87.6
Good	20(20.6%)	12.4-28.9
Self-reported level of confidence to interpret POCUS images		
Poor	76(78.4%)	69.1-86.6
Good	21(21.6%)	13.4-30.9
Area of comfort to perform pediatric POCUS		
FAST Exam	11(11.3%)	5.2-17.5
Lung Scan	14(14.4%)	7.2-20.6
IVC	34(35.1 %)	25.8-44.3
Cardiac	3(3.1%)	0-7.2
None of it	35(36.1%)	26.8-46.4
Self-reported frequency of POCUS practice		
Never	43(44.3%)	34.0-54.6
Once a year	12(12.4%)	6.2-19.6
Once a month	14(14.4%)	7.2-22.7
Once a week	28(28.9%)	20.6-37.1

Note: Point of care Ultrasound (POCUS)

between training and POCUS knowledge. Residents in Year 2 and Year 3 were found to have a higher likelihood of having Good knowledge of POCUS compared to Year 1 residents. Residents who reported using POCUS once a month or once a week were significantly more likely to have good knowledge of POCUS compared to those who never or rarely used it. (Table 4)

Discussion

The objective of this study is to describe pediatric residents' perceptions toward pediatric point-of-care ultrasound in government teaching hospitals in Addis Ababa, Ethiopia, and to identify factors associated with POCUS knowledge in two teaching government hospitals in Addis Ababa.

In this study's findings, the majority of residents demonstrated a good understanding of the potential use of POCUS for pediatric patients. They also rated highly in their perception of POCUS as a valuable tool for improving diagnostic accuracy, its potential applications in pediatrics, and the importance of integrating POCUS training into the pediatric residency program.

A significant majority of residents (79.4%) reported poor comfort and confidence with POCUS practice and interpretation of POCUS images. Residents with any form of POCUS training were more likely to score above the median on the POCUS knowledge assessment, which was statistically significant. However, a significant majority (68%) of residents had not received any formal or informal training in POCUS during their residency program. Another statistically significant finding of the study was that residents who reported using POCUS once a month or once a week were more likely to have Good knowledge of POCUS compared to those who never or rarely used it. Residents in Year 2 and Year 3 also showed a marginally significant likelihood of having Good knowledge of POCUS compared to Year 1 residents.

Our study Suggests that pediatric residents not only understand the potential use of POCUS but also regard it as crucial for enhancing diagnostic accuracy. They also rated highly the importance of integrating POCUS training into the pediatric residency program. This is Supported by a U.S.-based national survey indicating that 96% of pediatric trainees believe POCUS is an important skill in pediatrics, with 92% advocating for its inclusion in residency training programs [19]. A similar study found that 56% of pediatric residency program directors felt that all residents should be trained in POCUS, reflecting

Table 3 Pediatric residents' self-perception towards POCUS practice

Characteristics	Frequency(Percent)	95%CI
Understanding of the potential use of pediatric pocus for pediatric patients		
Poor	29(29.9%)	21.6–39.2
Good	68(70.1%)	60.8–78.4
Perception on use of POCUS for diagnostic accuracy		
Poor	32(33%)	23.7–42.3
Good	65(67%)	57.7–76.3
Perceived barriers to POCUS practice		
Lack of training	70(72.2%)	62.9–81.4
Lack of Equipment	14(14.4%)	8.2–21.6
Qualified faculty as educators	12(12.4%)	6.2–19.6
Not useful for my patient	1(1%)	0-3.1
Perception on the importance of integrating POCUS training to paediatric residency program		
Poor	29(29.9%)	20.6–39.2
Good	68(70.1%)	60.8–79.4
Perceived intervention to become more proficient on POCUS practice		
Dedicated practice with Ultrasound machine	39(40.2%)	30.9–50.5
Hands on Workshops with simulated scenario	28(28.8%)	19.6–40.2
Faculty mentorship for image acquisition and interpretation	16(16.5%)	9.3–23.7
Didactic lectures on POCUS applications	11(11.3%)	5.2–17.5
Access to online learning modules	3(3.1%)	0-7.2

a widespread acknowledgment of its value in clinical practice.

While our findings emphasize a positive perception of POCUS, they also underscore the need for structured training programs. In line with this, a study conducted at the University of Catania reported that 100% of participants expressed the necessity for formal POCUS training within their residency curriculum [20]. This parallels our results, showing that residents rated the integration of POCUS training as important for their education. Despite favorable attitudes toward POCUS, barriers to effective training persist. Our study reflected that the most perceived barrier to POCUS practice among pediatric residents was a lack of training (72.2%). Similar challenges were noted in other research, where 94% of pediatric residency program directors cited a lack of qualified instructors as a significant obstacle to implementing POCUS training [1, 19, 20].

The findings from our study showed that only 32% of pediatric residents had received previous training in POCUS, whether informal (such as bedside training) or formal. A national needs assessment Survey in the U.S. revealed variability in how this training is implemented across different residency programs. For instance, some programs offer informal bedside education, but only 37% provide formal POCUS training [14]. Pediatric residents with any form of POCUS training were more likely to score above the median on the POCUS knowledge assessment, which was statistically significant. For example, a study conducted at a large children's hospital found that after a two-week POCUS course, residents demonstrated significant improvements in self-reported confidence and knowledge across various POCUS competencies, including image acquisition and interpretation ($P<0.01$) [18]. Additionally, the majority of our participants reported poor comfort with POCUS practice and rated poor confidence in interpreting POCUS images. Thus, prior exposure to POCUS training can enhance both comfort and knowledge levels among pediatric residents.

Another statistically significant finding associated with POCUS knowledge is the self-reported frequency of use. Residents who used POCUS once a month or once a week were significantly more likely to have good knowledge of POCUS compared to those who never or rarely used it. The relationship between the frequency of POCUS use and self-reported confidence is well documented in other research. A study conducted on pediatric residents showed that those who regularly utilized POCUS in clinical settings felt significantly more confident in their skills compared to those with limited exposure. This aligns with our findings, as residents using POCUS weekly or monthly had markedly better knowledge scores than those who rarely or never used it [5, 20].

Conclusion and recommendation

Our findings highlight the need for ongoing POCUS training and integration into pediatric curricula to improve resident competence and confidence. These factors are crucial for the successful implementation of point-of-care ultrasound in pediatric training programs. While there is clear recognition of the value of POCUS training, addressing barriers to effective implementation will be essential for maximizing its benefits in pediatric education. Developing comprehensive curricula that emphasize hands-on experience could significantly improve both resident competence and patient care outcomes in pediatric settings. We recommend that further studies be conducted to assess the impact of educational interventions on the pre- and post-knowledge of pediatric residents regarding point-of-care ultrasound. Another

Table 4 Factors contributing to the knowledge of pediatric residents toward pediatric POCUS application

Score of POCUS Questions						
Characteristics		**Good**	**poor**	**COR95%CI**	**AOR 95%CI**	**P-Value**
Sex	Female	20(20.83%)	18(18.75%)	Reference	Reference	0.254
	Male	27(28.13%)	31(32.3%)	0.784(0.345–1.770)	0.447(0.112–1.783)	
Age	26–29	16(18.18%)	21(23.86%)	Reference	Reference	0.826
	30–33	21(23.86%)	15(17.04%)	1.837(0.726–4.650)	1.173(0.283–4.857)	0.514
	34–37	5 (5.68%)	10(11.36%)	0.656(0.187–2.302	0.512(0.069–3.826)	
Institution	St. Paulo's	20(23.95%)	22(19.79%)	Reference	Reference	0.153
	TASH	27(25%)	26(31.25%)	1.648(0.732–3.708)	3.305(0.642–17.023)	
Previous POCUS training	No	18(18.75%)	47(48.95%)	Reference	Reference	0.01
	Yes	29(30.20%)	2(2.08%)	58.46(5.835-585.858)	37.861(8.178-175.275)	
Year of Residency	Year 1	7(7.29%)	23(23.95%)	Reference	Reference	
	Year 2	17 (17.7%)	16(16.66%	3.092(1.043–9.171)	7.061(0.804–62.04)	0.078
	Year 3	24(25%)	9 (9.37%)	8.762(2.798–27.434)	8.254(0.968–70.373)	0.054
Self-reported frequency of POCUS practice	Never	7(7.29%)	35(36.45%)	Reference	Reference	
	Once a year	6(6.25%)	6(6.625%	5.000(1.24-20.124)	3.634(0.671–19.785)	0.134
	Once a month	9 (9.37)	5(5.2%)	9.000(2.307–35.118)	7.661(1.375–42.695)	0.020
	Once a week	25(26.04%)	3((3.12%)	57.5(10.964-301.562)	14.386(1.138-181.927)	0.039

AOR Adjusted Odds Ratio, *CI* Confidence Interval, *POCUS* Point-of-Care Ultrasound

area of interest for future research would be the factors hindering the integration of point-of-care ultrasound into pediatric curricula.

Limitations and strengths of the study

The strength of this study is that it is the first of its kind in Ethiopia to explore this specific aspect. Although selection bias could not be avoided as the method used is a convenience sampling method, the study's objective was to get a better understanding through exploration of the barriers to POCUS practice in pediatric and child health departments in the selected teaching hospitals. The other limitations of our study, the regression model produced wide confidence intervals, which may indicate instability due to small subgroup sizes or uneven variable distribution. This limits the precision of effect estimates and the fact that the study was conducted in only two teaching hospitals. This may limit the generalizability of our findings to the broader population.

Abbreviations

ACEP	American College of Emergency Physician; AAP--American Academy of Pediatrics
AAU	Addis Ababa University
AOR	Adjusted Odds ratio
COR	Crudes Odds ratio
CI	Confidence interval
ED	Emergency Department
EFAST	Extended Focused Assessment with Sonography for Trauma
ESPNIC	European Society of Pediatric and Neonatal Intensive Cares
FAST	Focused Assessment with Sonography for Trauma
PEM	Pediatric Emergency Medicine
PICU	Pediatric Intensive Care Unit
POCUS	Point-of-care ultrasonography
SD	Standard deviation
SPHMMC	St.Paulos Hospital Millennium Medical College
TASH	Tikur Anbessa Specialized Hospital

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Author Contributions Statement: R.S.- served as the principal investigator of this study and was responsible for developing the proposal, conceptual framework, and data collection tools before the study commenced. During the study, he conducted data collection, performed data analysis, and wrote the majority of the manuscript. He also prepared the tables for the publication. T.W.'s and Y.F. 's primary role throughout the study was to provide advice and guidance from its inception. They offered technical support, assisted with data analysis, and supervised the overall study's progress. Revising the manuscript, providing valuable feedback, and giving corrections.M.G. was involved in this study from its inception, contributing to the development of the proposal. He actively participated in data collection and analysis and provided significant assistance with the writing of this manuscript, particularly the results section. All authors reviewed the manuscript.

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Data availability

The data available not archived online, but available in a SPSS form.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. Permission to conduct the study was granted by the institutional ethical committees from the Addis Ababa University emergency department. under College of Health Sciences Institutional Review Board (Ref. No. 559/2015).

Consent for publication
Not applicable.

Conflict of interest
None of the authors has any competing interests to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication.

Competing interests
The authors declare no competing interests.

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