ORIGINAL ARTICLE

Annals of Agricultural and Environmental Medicine
www.aaem.pl

Simulation-based training to enhance emergency response in low-resource settings – a model for paramedic education in Ghana

Ewa Zieliński[1,A-F], Katarzyna Wojtysiak[2,A-F], Karolina Osowiecka[3,A-D,F], Agnieszka Pedrycz[4,C,E], Mansur Rahnama-Hezavah[5,D-F], Paulina Mertowska[6,C,E], Sebastian Mertowski[6,D-E]✉, Ewelina Grywalska[6,C-E], Anna Grzywacz[7,C-E], Marek Kowalczyk[8,A-F]

[1] *Department of Emergency Medical Services, Collegium Medicum, Bydgoszcz / Nicolaus Copernicus University, Torun, Poland*
[2] *Farmepo Sp. z o.o., Bydgoszcz, Poland*
[3] *Department of Psychology and Sociology of Health and Public Health, School of Public Health, University of Warmia and Mazury, Olsztyn, Poland*
[4] *Faculty of Medicine and Health Sciences, University of Applied Sciences, Tarnow, Poland*
[5] *Department of Dental Surgery, Medical University, Lublin, Poland*
[6] *Department of Experimental Immunology, Medical University, Lublin, Poland*
[7] *Independent Laboratory of Behaviour genetics and Epigenetics, Pomeranian Medical University, Szczecin, Poland*
[8] *Department of General, Minimally Invasive and Elderly Surgery, University of Warmia and Mazury, Olsztyn, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Zieliński E, Wojtysiak K, Osowiecka K, Pedrycz A, Rahnama-Hezavah M, Mertowska P, Mertowski S, Grywalska E, Grzywacz A, Kowalczyk M. Simulation-based training to enhance emergency response in low-resource settings – a model for paramedic education in Ghana. Ann Agric Environ Med. doi:10.26444/aaem/216872

Abstract

Introduction and Objective. Despite targeted investments in acute care in Ghana, significant challenges persist, including limited medical supplies, shortages of trained personnel, and restricted access to medications. A key barrier to effective prehospital care is the lack of formal education among paramedics. To address this gap, the Paramedics for Africa 3 programme was implemented between July – December 2020, aimed at improving emergency medical knowledge and skills among healthcare providers.

Materials and Method. A pre-post intervention design was used to evaluate the impact of the training. A total of 268 participants, including paramedics, hospital staff, and outpatient clinic workers, were enrolled. Each completed a 50-question multiple-choice test covering anatomy, diagnostics, and medical procedures. The programme included hands-on activities, simulation-based scenarios, and case-based learning. Statistical analysis was used to assess changes in test performance.

Results. Baseline test scores ranged from 14% – 76% (median: 40%), increasing post-training to 32% -100% (median: 76%; $p < 0.001$). The most notable improvements were observed in trauma care and resuscitation. Emergency service staff demonstrated the most significant gains ($p = 0.03$). No statistically significant differences were found in terms of age, gender, education, or residence.

Conclusions. The programme led to a significant improvement in participants' knowledge of emergency medicine. The positive impact of simulation-based learning highlights the importance of expanding such educational models in resource-limited healthcare settings.

Key words

medical training, developing countries, medical education

INTRODUCTION

Over the past decade, Ghana has significantly expanded its investment in acute care services, aiming to improve population health outcomes amid shifting epidemiological trends driven by urbanization, increased mobility, and a progressively aging population [1]. Despite these efforts, systemic challenges remain – most notably shortages of qualified personnel, limited access to medical equipment, and insufficient drug supplies [2]. These constraints, characteristic of many low- and middle-income countries (LMICs), hinder the ability of healthcare systemsforo provide timely and effective care. One well-established method for improving service quality is the continuous professional training of medical staff [3]. This is especially critical in the context of emergency medical services (EMS), where rapid decision-making and technical competence are vital for saving lives.

Although healthcare workers serve as the backbone of public health [4], many LMICs still lack structured EMS training systems [5]. More than 95% of hospitals report deficiencies in emergency care preparation. A study by Anto-Ocrah et al. [6] revealed that approximately one-in-four ambulance personnel in Ghana had never received training in basic life support, including cardiopulmonary resuscitation (CPR). Even among physicians, opportunities for specialized training in emergency medicine are scarce, as residency

✉ Address for correspondence: Sebastian Mertowski, Department of Experimental Immunology, Medical University, Lublin, Poland
E-mail: mertowskisebastian@gmail.com

Received: 20.08.2025; accepted: 12.01.2026; first published: 18.06.2026

programmes in this field are relatively new and currently available in only a handful of sub-Saharan countries [7]. Furthermore, disparities in access to educational resources disproportionately affect rural regions, where the need for trained EMS professionals is often greatest [8]. Despite these constraints, successful training programmes can be implemented even in resource-limited environments, especially when adapted to local healthcare realities [9].

In response to these challenges, the *Paramedics for Africa 3* programme was launched as a collaborative initiative between the *Paramedics for Africa Foundation* and local parishes in Ghana. Conducted between July – December 2020, the programme drew on lessons learned from earlier interventions across Africa. One key observation from these projects was the widespread lack of basic biomedical knowledge – particularly in human anatomy and physiology – among frontline emergency workers. This deficit is often the result of limited formal education and the absence of national EMS training standards. To address this gap, a dedicated module on the anatomical and physiological foundations was incorporated into the programme to improve clinical judgment and reduce procedural errors in high-pressure situations.

The training was structured to accommodate both novice and experienced participants. Instruction was adapted to trainees' levels of understanding, avoiding overly complex terminology while maintaining medical accuracy. In addition to core EMS content, the curriculum included context-specific modules on diarrheal and febrile illnesses, which are highly prevalent in tropical regions. Unlike Western emergency training programs, which often focus on advanced protocols, this initiative emphasized practical competencies, such as hydration management, temperature control, and rational use of antibiotics and antimalarials – skills essential for effective care in low-resource settings.

This study evaluates the impact of the *Paramedics for Africa 3* programme on the emergency care knowledge and practical skills of paramedics and hospital staff in Ghana. Particular attention is given to improvements in trauma response, basic diagnostics, and first aid, with an emphasis on tailoring emergency medical education to meet the specific needs of Ghana's healthcare system.

MATERIALS AND METHOD

The study was conducted in conjunction with the *Paramedics for Africa 3* training held between July – December 2020. Eligible participants were individuals fluent in English who were professionally or voluntarily involved in emergency services, hospital wards, or emergency departments. Only those who attended at least 95% of the course sessions were included in the post-training assessment.

The training combined theoretical and practical instruction, with an emphasis on active learning. Lectures, problem-solving, and brainstorming introduced key concepts, while the dominant practical component employed demonstrations, simulations, and guided instruction. The curriculum reflected a growing local preference for simulation-based training among healthcare professionals and students in Ghana [10].

Pre- and post-tests were voluntary and anonymous. Participants received random alphanumeric codes at registration, which they used on both test forms. In each round, 500 pre-tests (administered up to 7 days before training) and 500 post-tests (collected within 7 days after training) were submitted via secure ballot boxes. Instructors had no access to identifying information. All tests were gathered and subjected to statistical analysis.

Evaluation tools. Assessment was based on two identical multiple-choice tests (pre and post), each comprising 50 single-answer questions divided into 5 thematic sections:

- Part I: Anatomy (10 questions)
- Part II: Asepsis, antiseptics, and psychological aspects of rescue (5)
- Part III: Etiology of emergencies (5)
- Part IV: Emergency diagnostics (15)
- Part V: Emergency procedures (15).

The pre-test also collected demographic data: age, gender, education, place of residence, and workplace. The programme included 30 learning modules (Tab. 1), covering core clinical topics such as trauma, resuscitation, febrile and diarrheal diseases, as well as psychological support and documentation.

Statistical analysis. Basic descriptive statistics were calculated. The Shapiro-Wilk test assessed the normality of the data. Knowledge gains were evaluated using the Wilcoxon

Table 1. Scope of training and duration of modules

Paramedics for Africa Training Plan Module	Time [hours]
Anatomy and physiology	16
Scene safety	3
Aseptics and antiseptics	3
Casualty assessment & rapid trauma examination	8
Consciousness disorders	2
Resuscitation	8
Shock	3
Epilepsy and seizures	1
Diabetes	1
Heart attack	1
Stroke	1
Poisoning	1
Drowning	1
Febrile diseases	3
Diarrheal diseases	3
Wounds	3
ITLS chest injuries	2
ITLS abdominal injuries	2
ITLS spine injuries	2
ITLS head injuries	2
ITLS limb injuries	2
Burns (Thermal, Chemical, Electrical)	1
Evacuation and transport of injured persons	4
Polytrauma	3
Mass casualty incidents	6
Psychological support for victims	1
Medical documentation	3
EXAM	4

signed-rank test. The impact of demographic variables on test scores was analysed using the Mann-Whitney U test (2 groups) and the Kruskal-Wallis test (multiple groups). Changes in correct response rates to individual questions were compared using the McNemar test. A p-value <0.05 was considered statistically significant. Analyses were performed with Statistica v.13 (StatSoft Polska, 2025).

RESULTS

A total of 360 individuals from Ghana and neighbouring sub-Saharan countries took part in the *Paramedics for Africa 3* training programme, selected from an initial pool of 493 volunteers. Due to logistical challenges – primarily the significant distance between participants' homes and the training site – some candidates were unable to attend the course. Ultimately, 268 participants completed both the pre- and post-training assessments and met the inclusion criteria, thus constituting the final study group. This cohort comprised 161 men (60%) and 107 women (40%). Most respondents were between 18–30 years of age, with 93 individuals (34.7%) in the 18–22 age group and 103 (38.4%) aged 23–30. Participants aged 31–40 accounted for 14.6% of the group, whereas those aged 50 and older accounted for 4.5%.

Educational backgrounds were diverse. A total of 42 participants (15.7%) reported no formal education, 73 (27.2%) had incomplete primary education, and 89 (33.2%) had completed primary school. Secondary education was reported by 23 individuals (8.6%), and 41 (15.3%) held higher education degrees. Regarding place of residence, 101 participants (37.7%) lived in rural areas, 91 (34.0%) in towns with populations under 50,000, and 76 (28.3%) in larger cities. Regarding workplace distribution, the most significant proportion of participants were employed in outpatient clinics (52.2%), followed by hospitals (23.9%) and emergency medical services (23.5%). Only one respondent (0.4%) indicated employment in another setting. A detailed summary of the sociodemographic structure of the study group is presented in Figure 1.

Assessment of the training's impact on participants' knowledge revealed a substantial improvement. Before the

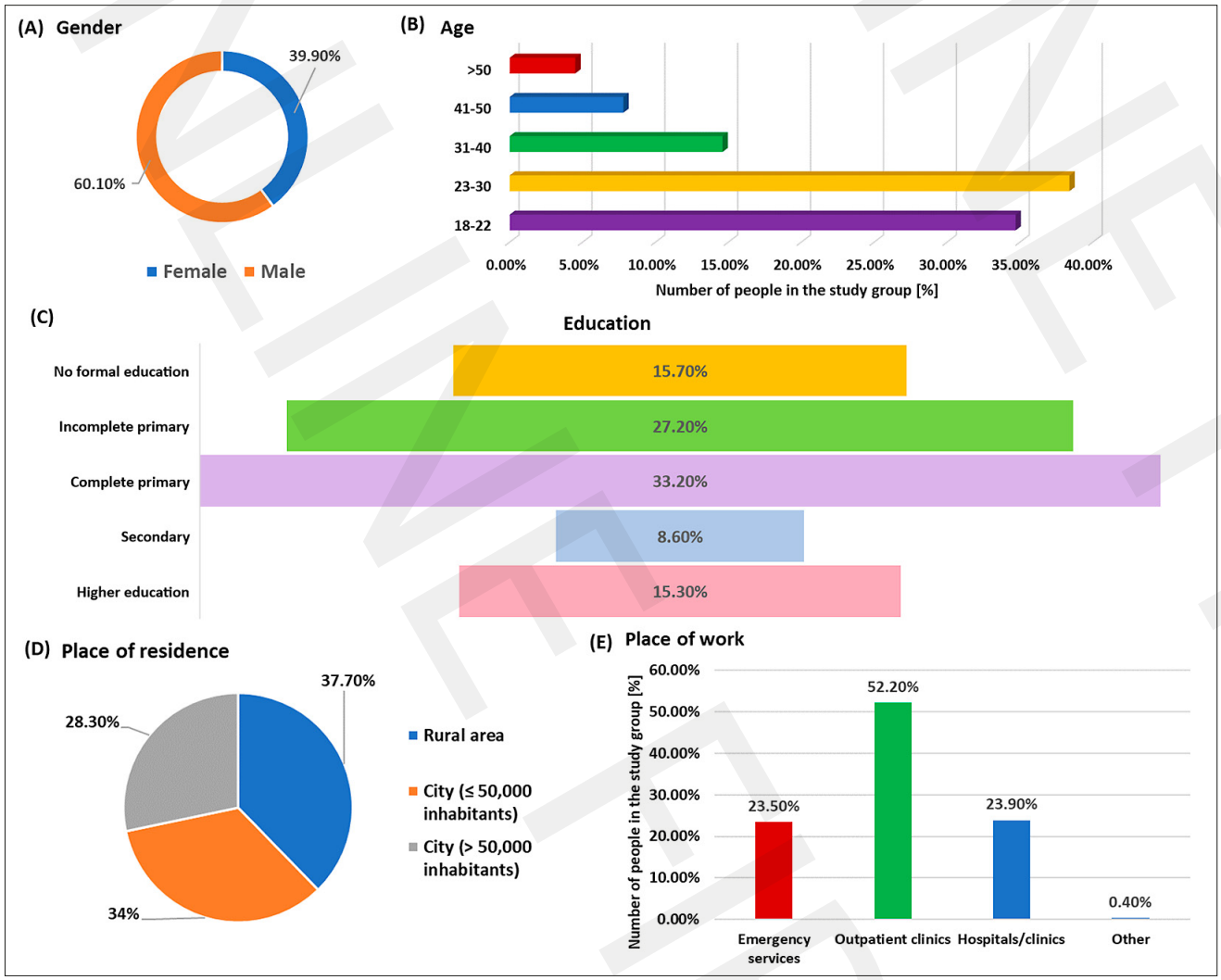

Figure 1. Socio-demographic characteristics of the study group (n = 268). (A) *Gender*: 60.1% of respondents were male, and 39.9% were female. (B) *Age*: The majority of participants were aged 23–30 years (38.4%) and 18–22 years (34.7%), with smaller percentages in the 31–40 (14.6%), 41–50 (7.8%), and >50 (4.5%) age groups. (C) *Education level*: Most participants had complete primary education (33.2%) or incomplete primary education (27.2%); 15.7% reported no formal education, 15.3% had higher education, and 8.6% had secondary education. (D) *Place of residence*: 37.7% lived in rural areas, 34.0% in cities with ≤50,000 inhabitants, and 28.3% in towns with >50,000 inhabitants. (E) *Place of work*: Over half of the respondents (52.2%) worked in outpatient clinics, followed by hospitals/clinics (23.9%), emergency services (23.5%), and other settings (0.4%)

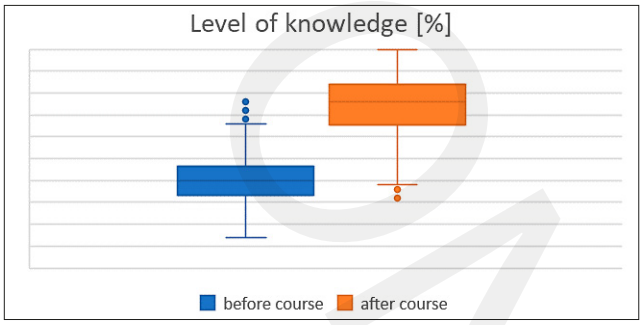

Figure 2. Level of knowledge before and after the course

training, scores ranged from 14% – 76%, with a median of 40% (IQR: 33–47%). After the course, scores increased significantly, ranging from 32% to 100%, with a median of 76% (IQR: 65–84%) ($p < 0.001$) (Fig. 2). Notably, each of the 50 individual test questions showed statistically significant improvement ($p < 0.001$). The pre-test results indicated a general lack of knowledge, with over 50% of participants responding incorrectly to 40 out of 50 questions (80%). The most pronounced deficits (≥70% incorrect responses) were observed in questions assessing trauma recognition, emergency procedures in life-threatening scenarios, and psychological support.

Following the training, the percentage of correct answers increased by 50–67 percentage points, depending on the question. The most significant improvements were noted in question 15 (provision of psychological support; +65 pp) and question 31 (correct frequency of chest compressions during CPR; +67 pp). Substantial gains were also observed in anatomy- and physiology-related items – such as questions 1 and 2 (bone identification), question 8 (light-reactive eye structures), and question 33 (normal body temperature). These results suggest that the inclusion of basic biomedical modules was effective in addressing widespread knowledge gaps among participants.

Further analysis revealed that the participant's professional background significantly affected training outcomes. Emergency service workers demonstrated greater improvement in test scores (median increase of 40%) compared to their peers employed in clinics or outpatient care settings (median increase of 32%; $p = 0.03$). This may reflect the more frequent exposure to real-life emergencies among EMS professionals, which could enhance the contextual understanding and application of newly acquired knowledge. However, demographic variables such as gender ($p = 0.89$), age ($p = 0.58$), education level ($p = 0.26$), and place of residence ($p = 0.33$) were not statistically significant predictors of learning outcomes.

The findings clearly demonstrate the effectiveness of the *Paramedics for Africa 3* training programme in improving theoretical knowledge in emergency medicine. At the same time, the persistence of knowledge gaps in key areas – especially trauma management, emergency procedures, and psychological first aid – underscores the need for additional support. Although participants exhibited significant learning gains, many would benefit from follow-up interventions to reinforce skills and promote knowledge retention. Practical workshops, simulation-based training, and periodic refresher sessions are recommended as the following steps to strengthen clinical competency and ensure the translation of acquired knowledge into effective practice during emergency response.

DISCUSSION

The results of this study underscore the persistent challenges facing emergency care systems in sub-Saharan Africa, particularly in Ghana, where limited infrastructure, shortages of medical supplies, and uneven distribution of personnel compromise prehospital care delivery [11]. Standardized emergency training programmes developed in high-income countries often fail to address the realities of low-resource environments, where electricity outages, lack of diagnostic equipment, and staff shortages are common. In these contexts, healthcare workers must often rely on physical examination and clinical intuition rather than technology, highlighting the need for context-specific, skill-oriented education. The *Paramedics for Africa 3* programme was designed with these conditions in mind, shifting the focus from advanced procedures to foundational clinical skills and real-life decision-making.

The findings demonstrated a significant increase in participants' knowledge following the training, with post-course test scores indicating that 52–64% of participants acquired trauma care competencies, compared with 30–39% before the intervention ($p < 0.001$). This outcome aligns with prior research, which shows that practical, simulation-based training is more effective in emergency education than lecture-only approaches [10, 12]. The use of mannequins, case-based learning, and skill stations helped build confidence in recognizing life-threatening conditions and applying appropriate interventions. Notably, the inclusion of modules on basic anatomy and physiology addressed a significant educational gap identified in previous research and in the authors' baseline assessment [13].

The training also prioritized triage and mass-casualty management – skills often overlooked in basic EMS training, yet essential in settings with long ambulance wait times and limited resources [14, 15]. Participants received 6 hours of dedicated instruction on MCI scenarios, triage protocols, and patient evacuation strategies. Given that accurate triage has been directly linked to improved survival in emergencies, the inclusion of these components was especially valuable [16].

Another critical aspect is the shortage and urban concentration of trained emergency personnel. Rural areas often rely on undertrained staff or traditional healers, while migration of professionals to wealthier countries exacerbates the staffing gap [17]. To mitigate this, long-term strategies, such as 'train-the-trainer' models, should be scaled up to enable knowledge dissemination through local instructors and enhance the sustainability of skills development [18].

Nurses represent a significant proportion of the healthcare workforce in sub-Saharan Africa and are frequently the first responders during emergencies. Despite this, many lack access to advanced emergency care training. A recent survey showed that nearly 89% of Ghanaian nurses desire more frequent simulation-based learning opportunities [19]. This demand highlights the need to integrate such training into national curricula and continuing education.

The general population also often lacks basic first-aid knowledge. Although more than 80% of Ghanaians report that they would assist in an emergency, fewer than half have adequate first-aid training [20]. In the current study, more than 50% of trainees lacked fundamental knowledge of anatomy, physiology, and trauma response at baseline. Following training, their scores improved significantly,

Table 2. Impact of the training on participants' knowledge

Item number	Lack of Knowledge Before Training		Improved Knowledge After Training		
	N	% of 268 Participants	N	% of participants lacking knowledge before training	p-value
1. Mark the name of the bone on the diagram (number 10)	138	51	54	39	<0.001
2. Mark the name of the bone on the diagram (number 18)	168	63	84	50	<0.001
3. It flows into the right atrium of the heart	167	62	95	57	<0.001
4. Which elements of blood transport oxygen?	158	59	82	52	<0.001
5. Which statements about the bronchi are true?	187	70	117	63	<0.001
6. Where do the respiratory and digestive paths cross?	120	45	64	53	<0.001
7. Which hormone increases blood glucose levels?	138	51	75	54	<0.001
8. What is the name of the part of the eye that expands and contracts with changes in light?	48	18	28	58	<0.001
9. Where does detoxification occur?	143	53	77	54	<0.001
10. Where is the spinal cord?	129	48	66	51	<0.001
11. Whose safety is most important during a rescue operation	179	67	99	55	<0.001
12. When administering oxygen from a cylinder, you cannot:	174	65	88	51	<0.001
13. HIV is transmitted by:	110	41	66	60	<0.001
14. How can infections spread?	169	63	94	56	<0.001
15. When should mental support be provided to an injured person?	192	72	124	65	<0.001
16. The cause of hypovolaemic shock is:	128	48	64	50	<0.001
17. What is the most serious early complication of electric shock?	146	54	84	58	<0.001
18. Causes of malaria	110	41	59	54	<0.001
19. Paracetamol overdose may occur:	132	49	83	63	<0.001
20. Spinal injuries may occur as a result of:	127	47	64	50	<0.001
21. According to the 'Rule of Nines', a burn of the entire right lower limb and the whole head constitutes:	162	60	98	60	<0.001
22. A casualty who does not respond to verbal or voice commands on the AVPU scale will receive:	154	57	95	62	<0.001
23. The slowing of the pulse is caused by:	171	64	98	57	<0.001
24. Anxiety, rapid breathing, faint pulse, pale, cold sweat on the face, these are the symptoms of:	157	59	98	62	<0.001
25. Cerebrospinal fluid leakage and/or bleeding from the ears in a trauma victim:	190	71	108	57	<0.001
26. The following symptoms indicate respiratory burns and inhalation poisoning:	171	64	97	57	<0.001
27. Common symptoms of a heart attack include:	159	59	96	60	<0.001
28. How long do we check the victim's breathing?	168	63	102	61	<0.001
29. A symptom of a brain injury is not:	163	61	101	62	<0.001
30. Symptoms of flail chest include:	175	65	102	58	<0.001
31. How often should chest compressions be performed in CPR?	180	67	120	67	<0.001
32. Symptoms of a sprain include:	123	46	66	54	<0.001
33. Body temperature:	83	31	47	57	<0.001
34. Bradycardia is:	165	62	94	57	<0.001
35. Where is the pulse checked?	159	59	81	51	<0.001
36. On which side should an unconscious pregnant woman be placed?	185	69	107	58	<0.001
37. The lack of breathing in an unconscious person is the basis for resuscitation using which protocol?	169	63	97	57	<0.001
38. What should be done for a drowning person after being removed from the water?	188	70	109	58	<0.001
39. When can CPR be stopped?	188	70	120	64	<0.001
40. What should be done for a trauma victim before conducting an examination?	181	68	94	52	<0.001
41. How should trauma victims be positioned if they are vomiting?	180	67	115	64	<0.001
42. When approaching an injured person, from which direction should the rescuer come?	177	66	108	61	<0.001
43. Which drug does NOT have anti-inflammatory properties?	185	69	102	55	<0.001
44. What should be done in the case of a high fever?	167		93	56	<0.001
45. In a mass casualty incident, a victim breathing 35 times per minute should be assigned which triage colour?	171	64	96	56	<0.001
46. What should be done when someone has an epileptic seizure?	164	61	92	56	<0.001
47. How should a foreign body in the abdomen of a patient be handled?	190	71	122	64	<0.001
48. How should bleeding from a head wound be managed?	197	74	98	50	<0.001
49. What is the most important step when providing aid to a victim of a traffic accident who has cerebrospinal fluid leaking from the ear?	189	71	102	54	<0.001
50. How should an open pneumothorax be treated?	191	71	119	62	<0.001

underscoring the importance of embedding anatomy-based modules in first-aid education.

Prehospital practices in Ghana are still dominated by 'load and go' strategies, which prioritize rapid transport over on-site patient stabilization. This approach can delay care and increase mortality in trauma cases. Our programme addressed these gaps by teaching wound care, fracture management, and scene safety techniques – skills that led to marked improvements in test scores and self-reported confidence. These results align with findings from *Advanced Trauma Life Support* (ATLS) training in Ghana, where knowledge of trauma protocols improved significantly following training [21].

Beyond trauma management, cardiopulmonary resuscitation (CPR) remains a cornerstone of emergency care. Yet, in Ghana, most laypeople and many health workers lack CPR skills, with fear of causing harm being a common barrier [22]. Our training included practical CPR instruction, resulting in measurable knowledge gains and reduced apprehension among participants. These findings support calls for widespread CPR education not only among medical staff but also in communities, where early intervention can be lifesaving [23].

In conclusion, the *Paramedics for Africa 3* programme proved to be a highly effective model for emergency care education in a low-resource setting. By combining theoretical instruction with hands-on simulation and tailoring the content to local needs, the programme helped bridge critical gaps in knowledge. Continued expansion of such programmes, including refresher courses and integration into formal healthcare training pathways, is essential for improving emergency preparedness and reducing preventable deaths in underserved regions [24, 25].

CONCLUSIONS

Organizations such as *Paramedics for Africa* play a crucial role in strengthening first-aid and emergency-care capacity, particularly in underserved settings. This study confirms that targeted, simulation-based training can significantly enhance knowledge and preparedness among both medical and non-medical personnel. However, a lasting impact depends on regular skill reinforcement and ongoing education, particularly in areas such as CPR, trauma care, patient assessment, and triage.

To ensure sustainability, future research should incorporate objective evaluations of practical skills, use longitudinal designs to track retention, and expand training to more diverse populations. Innovative tools—such as mobile apps, e-learning platforms, and virtual simulations—could further enhance accessibility and scalability. Collaborations with local health systems and communities will help align training with the cultural and infrastructural realities of these settings.

In conclusion, structured and context-sensitive training initiatives not only close critical knowledge gaps, but also lay the foundation for long-term improvements in emergency response. Continued investment in the development, implementation, and evaluation of their capabilities is essential to enhance the readiness and effectiveness of first responders, ultimately saving lives.

Funding: The research received no external funding.

Institutional review board statement. The study was conducted according to the Declaration of Helsinki and approved by the Bioethics Commission of the Nicolaus Copernicus University in Toruń at the Collegium Medicum in Bydgoszcz (Approval No. KBE 742/2016 13.12.2016).

Informed consent statement. Informed consent was obtained from all subjects involved in the study.

Data availability statement. The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of interest. The authors declare that they have no conflicts of interest.

REFERENCES

1. Yiadom M, McWade CM, Awoonor-Williams K, et al. Public Health Rationale for Investments in Emergency Medicine in Developing Countries—Ghana as a Case Study. J Emerg Med. 2018;55:537–543. https://doi.org/10.1016/j.jemermed.2018.07.021
2. Dartey AF, Dzansi G, Lotse CW, et al. Midwives' Experiences of Managing Clients with Eclampsia in a Low-Resource Setting: A Qualitative Descriptive Study. SAGE Open Nurs. 2022;8:23779608221094542. https://doi.org/10.1177/23779608221094542
3. Kumah A. The future of patient safety in Ghana: challenges and opportunities. Front Health Serv. 2025;5:1581468. https://doi.org/10.3389/frhs.2025.1581468
4. Asamani JA, Christmals CD, Reitsma GM. Modelling the supply and need for health professionals for primary health care in Ghana: Implications for health professions education and employment planning. PLoS One. 2021;16:e0257957. https://doi.org/10.1371/journal.pone.0257957
5. Gyedu A, Stewart B, Otupiri E, et al. First Aid Practices for Injured Children in Rural Ghana: A Cluster-Random Population-Based Survey. Prehosp Disaster Med. 2021;36:79–85. https://doi.org/10.1017/S1049023X20001430
6. Anto-Ocrah M, Maxwell N, Cushman J, et al. Public knowledge and attitudes towards bystander cardiopulmonary resuscitation (CPR) in Ghana, West Africa. Int J Emerg Med. 2020;13:29. https://doi.org/10.1186/s12245-020-00286-w
7. Akomeah AO, Sawe HR, Mfinanga JA, et al. Emergency medicine registrar training in Africa: overview of programmes, faculty and sustainability. Emerg Med J. 2020;37(5):300–305. https://doi.org/10.1136/emermed-2019-208668
8. Alhassan RK, Beyere CB, Nketiah-Amponsah E, et al. Perceived needs of health tutors in rural and urban health training institutions in Ghana: Implications for health sector staff internal migration control. PLoS One. 2017;12:e0185748. https://doi.org/10.1371/journal.pone.0185748
9. Traicoff D, Tchoualeu DD, Opare J, et al. Applying Adult Learning Best Practices to Design Immunization Training for Health Care Workers in Ghana. Glob Health Sci Pract. 2021;9:487–497. https://doi.org/10.9745/GHSP-D-21-00090
10. Flaherty KE, Zakariah AN, Vescio VA, et al. The state of emergency medical technician education in Ghana. Afr J Emerg Med. 2020;10:107–110. https://doi.org/10.1016/j.afjem.2020.01.009
11. Haruna U, Woods H, Kansanga M, et al. Enablers and barriers of community initiated health emergency transport systems in the Upper West Region of Ghana. Afr Geogr Rev. 2022;41(3):281–298. https://doi.org/10.1080/19376812.2021.1885458
12. Kironji AG, Hodkinson P, Stewart de Ramirez S, et al. Identifying barriers for out of hospital emergency care in low and low-middle income countries: a systematic review. BMC Health Serv Res. 2018;18:291. https://doi.org/10.1186/s12913-018-3091-0
13. Moabom M, Akayuure P, Anuwoje I, et al. Survival Analysis of the Sick and Injured in the Era of Pre-Hospital Care in the Upper East Region of Ghana. Authorea. 2023. https://doi.org/10.22541/au.168416298.82444821/v1

14. Arkoh AA, Coombs J, Talboys S. PAs in Ghana: A rich tradition with a hopeful future. JAAPA. 2025;38(4):e6-e9. https://doi.org/10.1097/01.JAA.0000000000000180
15. Afulani PA, Aborigo RA, Walker D, et al. Can an integrated obstetric emergency simulation training improve respectful maternity care? Results from a pilot study in Ghana. Birth. 2019;46:523–532. https://doi.org/10.1111/birt.12418
16. Tansley G, Bailey JG, Gu Y, et al. Efficacy of Surgical Simulation Training in a Low-Income Country. World J Surg. 2016;40:2643–2649. https://doi.org/10.1007/s00268-016-3573-3
17. Debrah S, Donkor P, Mock C, et al. Increasing the use of continuing professional development courses to strengthen trauma care in Ghana. Ghana Med J. 2020;54:197–200. https://doi.org/10.4314/gmj.v54i3.11
18. Adamtey R, Frimpong J, Dinye R. An Analysis of Emergency Healthcare Delivery in Ghana: Lessons from Ambulance and Emergency Services in Bibiani Anhwiaso Bekwai District. Ghana J Dev Stud. 2015;12(1–2):71–87. https://doi.org/10.4314/gjds.v12i1-2.5
19. AlShatarat M, Rayan A, Eshah NF, et al. Triage Knowledge and Practice and Associated Factors Among Emergency Department Nurses. SAGE Open Nurs. 2022;8:23779608221130588. https://doi.org/10.1177/23779608221130588
20. Japiong KB, Asiamah G, Owusu-Dabo E, et al. Availability of resources for emergency care at a second-level hospital in Ghana: A mixed methods assessment. Afr J Emerg Med. 2016;6:30–37. https://doi.org/10.1016/j.afjem.2015.06.006
21. Yakubu M, Jensen J. Developing Degree Programs in Emergency Management: Ghana's Experience. J Homel Secur Emerg Manag. 2019;16(2):1–12. https://doi.org/10.1515/jhsem-2018-0051
22. Konadu-Yeboah D, Yempabe T, Bo-ib Buunaaim AD, et al. Training Traditional Bonesetters in Basic Principles of Fracture Treatment: A Proof of Concept in Ghana. J Bone Joint Surg Am. 2023;105(24):1995–2001. https://doi.org/10.2106/JBJS.22.01304
23. Asiedu C, Mensah M, Erzuah IA, et al. Knowledge of triage and resuscitation among emergency nurses in Ghana's Central Region: a cross-sectional study. Discov Soc Sci Health. 2025;5:160. https://doi.org/10.1007/s44155-025-00316-z
24. Bam V, Diji A K A, Asante E, et al. Self-assessed competencies of nurses at an emergency department in Ghana. Afr J Emerg Med. 2020;10(1):8–12. https://doi.org/10.1016/j.afjem.2019.09.002
25. Dzakpasu D, Agyemang Opoku O, Owusu S, et al. Emergency Preparedness of Nurses and Midwives in Accra, Ghana. AJHS. 2023;2:339–352. https://doi.org/10.58631/ajhs.v2i8.64