



Challenge of virtual medical emergency education in conflict zone in low and middle-income countries: A protocol for systematic review and meta-analysis

Abbas Bazzal^{1,2}, Hadi Ftouni^{1,2,3}, Aya Kawssan^{1,2}, Bassel H Hoteit^{1,2}, Jobran Toami^{1,2}, Mahdi Akouch^{1,2}, Hiba Hamdar²

Correspondence: Hiba Hamdar, Medical Learning Skills Academy, Beirut, Lebanon. Email: Hamdarhiba95@gmail.com

Abstract

Introduction: Healthcare training in conflict-affected low- and middle-income countries is repeatedly disrupted by insecurity, displacement, and damaged infrastructure. Virtual education offers a practical route to sustain emergency care training when classrooms and clinical placements are curtailed, but the effectiveness of such programmes and the feasibility of delivery under conflict conditions remain uncertain. This protocol sets out methods to evaluate educational outcomes and implementation barriers for online emergency medical education in these settings.

Methods: This will be a systematic review and, where appropriate, meta-analysis registered prospectively with PROSPERO and aligned with PRISMA 2020. We will include randomised, quasi-experimental, observational, qualitative, and mixed-methods studies that evaluate virtual or online emergency education for healthcare professionals, trainees, students, or first responders in conflict-affected low- and middle-income countries. Primary outcomes will be knowledge and skill gain; secondary outcomes will include learner satisfaction and implementation barriers spanning technical, infrastructural, pedagogical, security, and cost domains. We will search PubMed, Embase, Scopus, and Web of Science for records from October 2022 to May 2025 with no language restrictions. Two reviewers will screen and extract data independently with third-party adjudication, contacting authors for missing information. Risk of bias will be assessed using RoB 2, the Newcastle–Ottawa Scale, CASP, and MMAT as appropriate, and certainty of evidence with GRADE. When at least three comparable studies with quantitative outcomes are available, we will conduct random-effects meta-analysis using standardised mean differences with 95% confidence intervals; otherwise a SWiM-guided narrative synthesis will be undertaken. Heterogeneity will be examined with I^2 alongside prespecified subgroup and sensitivity analyses.

Discussion: The review will clarify the educational impact of virtual emergency training in conflict settings and identify context-specific barriers, informing programme design, equitable access, and integration with resilient blended learning models.

Registration: This protocol had been prospectively registered with PROSPERO (ID: CRD420251083001)

Cite as: Hamdar, H., Al Bazzal, A., Ftouni, H., Kawssan, A., Hoteit, B. H., Toami, J., & Akouch, M. Challenge of virtual medical emergency education in conflict zone in low and middle-income countries: A protocol for systematic review and meta-analysis. *Impact Surgery*, 2(6), 205-210. <https://doi.org/10.62463/surgery.210>

Introduction

Access to professional emergency medical education was critical for providing healthcare personnel with life-saving skills, especially in low- and middle-income countries (LMICs), where trauma and acute illness were significantly prevalent. Major skills included

airway management, bleeding control, and Advanced Cardiovascular Life Support (ACLS)¹. However, giving this training in conflict zones was substantially more difficult because health systems were weakened, infrastructure gets disrupted, and healthcare practitioners suffer personal safety threats².

¹Faculty of Medical Sciences, Lebanese University, Hadat, Lebanon

²Medical Learning Skills Academy, Beirut, Lebanon

³MEDICA Research Investigation, Hadat, Lebanon



Table 1: Summary PICO criteria

Population	Healthcare professionals, medical students, emergency responders in LMIC conflict zones
Intervention	Virtual or online emergency medical education (e.g., trauma care, BLS/ALS, disaster response)
Comparison	In-person training
Outcomes	Challenges (technical, infrastructural, pedagogical), knowledge/skill gain, user satisfaction
Study design	(RCTs), quasi-experimental studies, observational studies (cohort, case control, cross-sectional), qualitative studies, and mixed-methods studies.

The introduction of virtual learning provides a potential lifeline in such situations. E-learning platforms, virtual simulations, and online teaching modules were widely used for emergency medical training. Research indicates that they may successfully teach skills such as pediatric resuscitation and trauma response even in resource-constrained settings^{3,4}. During the COVID-19 pandemic, virtual training technologies were useful in guaranteeing the continuation of clinical education despite worldwide constraints⁵. However, adopting virtual training in low- and middle-income war zones had many problems. The latter included insufficient internet connectivity, a lack of digital infrastructure, restricted electrical availability, and low technology knowledge among health staff⁶.

This review aims to critically examine the problems of delivering virtual emergency medical education in war zones in LMICs. The goal is to suggest long-term, scalable solutions that close the educational gap in the world's most disadvantaged areas by assessing current research and identifying context-specific challenges.

Methods

We aim to conduct a systematic review and meta analysis following PRISMA 2020 guidelines. Our main objectives were evaluating the effectiveness of virtual education specifically during conflict times, assessing the barriers related to technology, internet access and infrastructure and examining the outcomes in different war zones.

Inclusion criteria

This review will include primary healthcare professionals, medical students, emergency personnel in low middle income conflict zones. The intervention can be virtual or online emergency medical education. Our main outcomes will include the effectiveness of this method in terms of gained knowledge and skills, additionally to challenges including technical support, internet shortage

and more. We will include randomised controlled trials (RCTs), quasi-experimental studies, observational studies (cohort, case control, cross-sectional), qualitative studies, and mixed-methods studies. Qualitative and mixed-methods studies will be formally included, and their findings will be synthesized using thematic meta-synthesis. We will not had restrictions for languages. For studies published in other languages, we will utilise professional translation services.

Exclusion criteria

Studies outside low-middle income conflict zones will be excluded as well as studies that do not report virtual or online education, instead in person training. Moreover, studies that report poorly or irrelevant defined outcomes were excluded, additionally to editorials, commentaries, and protocols. Table 1 summarises our PICO criteria.

Search strategy

We will conduct a comprehensive search strategy using the following databases: PubMed, Scopus, Web of Science and Embase. We got the articles from October 2020 until May 2025. Our planned search string includes: ("emergency medicine" OR "emergency training" OR "disaster medicine" OR "trauma education") AND ("virtual education" OR "e-learning" OR "online learning" OR "distance education") AND ("conflict zones" OR "war zones" OR "fragile settings" OR "humanitarian crisis") AND ("low- and middle-income countries" OR "LMICs").

Example Search Strategy for PubMed

("Virtual Reality"[MeSH Terms] OR "Simulation Training"[MeSH Terms] OR "Education, Distance"[MeSH Terms] OR "Telemedicine"[MeSH Terms] OR "virtual reality"[tiab] OR "simulation-based"[tiab] OR "simulation training"[tiab] OR "e-learning"[tiab] OR "online learning"[tiab] OR "tele-education"[tiab] OR "telemedicine"[tiab]) AND ("Emergencies"[MeSH Terms] OR "Emergency Medicine"[MeSH Terms] OR "Disaster



Medicine"[MeSH Terms] OR "Wounds and Injuries"[MeSH Terms] OR "emergency care"[tiab] OR "disaster response"[tiab] OR "trauma care"[tiab] OR "emergency medical services"[tiab]) AND ("Armed Conflicts"[MeSH Terms] OR "Refugees"[MeSH Terms] OR "Humanitarian Crises"[MeSH Terms] OR "Developing Countries"[MeSH Terms] OR "conflict zones"[tiab] OR "war zones"[tiab] OR "post-conflict"[tiab] OR "humanitarian crisis"[tiab] OR "refugee camps"[tiab] OR "low-income countries"[tiab] OR "middle-income countries"[tiab] OR "LMICs"[tiab])

Study Selection

All identified records from the mentioned databases will be imported to Endnote. Two independent reviewers will screen the titles and abstracts against the eligibility criteria. A pilot screening of titles and abstracts will be conducted to ensure consistency and refine the screening process. Conflicts will be resolved by a third reviewer for final decision. Full-text articles of potentially eligible studies will be retrieved and independently screened by two reviewers. Disagreements at the full text screening stage will also be resolved by discussion or a third reviewer.

Data Extraction

Data will be extracted from included studies and stored in a Microsoft Excel document. Data will be extracted independently by two reviewers using this form, and discrepancies will be resolved through discussion or by involving a third reviewer. The following data will be extracted: Study identifiers: author(s), publication year, journal, country and conflict context, study design (e.g., RCT, cohort, cross-sectional, qualitative), population characteristics (e.g., students, physicians, paramedics), type and content of the virtual training (e.g., trauma care, disaster response), educational platform and delivery method (e.g., Zoom, Moodle, asynchronous modules), measured outcomes (e.g., knowledge gain, skills, satisfaction, engagement), and reported challenges (e.g., internet access, security concerns, pedagogical issues). Missing data will be handled by contacting the corresponding authors via email, with a waiting period of two weeks for a response. If no response was received, the missing data will be reported as such. Multiple reports of the same study will be managed by including only the most comprehensive or recent publication, while noting all related publications.

Risk of bias assessment

The risk of bias will be assessed by two independent reviewers. Conflicts and other discrepancies can be resolved by a third reviewer. For RCTs we will use RoB-2 tool, for observational studies we will use Newcastle–Ottawa Scale (NOS), Critical Appraisal Skills Programme (CASP) qualitative checklist will be used for qualitative studies while Mixed Methods Appraisal Tool (MMAT) will be use for mixed methods studies. Each domain of the relevant tool will be evaluated, and an overall risk of bias judgment will be assigned (e.g., low, moderate, or high risk). Overall judgments for each study will be derived from domain ratings by following the specific guidance provided within each tool. Disagreements at the domain level will first be resolved by discussion between the two reviewers. If a consensus cannot be reached, a third reviewer will arbitrate. The certainty of evidence for each outcome will be assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. This will involve evaluating the risk of bias, inconsistency, indirectness, imprecision, and publication bias, and then downgrading or upgrading the evidence quality accordingly.

Data Analysis

If three or more studies report similar quantitative outcomes (e.g., pre- and post-intervention knowledge scores), a meta-analysis will be conducted using a random-effects model to account for potential heterogeneity among studies. For quantitative outcomes, meta-analysis will be performed using a random-effects model with the DerSimonian–Laird estimator. Continuity corrections (e.g., adding 0.5 to all cells) will be applied for zero-cell counts in 2x2 tables. We will pool outcomes with at least three studies to ensure sufficient statistical power and meaningful interpretation of pooled estimated. This threshold was chosen to balance the need for robust estimated with the often limited number of studies in emerging fields or specific contexts. Standardized Mean Differences (SMDs) with 95% confidence intervals (CIs) will be calculated for continuous outcomes. For non-combinable quantitative data or qualitative data, a narrative synthesis will be conducted following the Synthesis Without Meta-analysis (SWiM) framework. This will involve systematically describing the characteristics and findings of included studies, identifying patterns, and exploring relationships between interventions and outcomes



Heterogeneity will be assessed using the I^2 statistic, with values above 50% indicating substantial heterogeneity. If there were sufficient studies (e.g., ≥ 10), meta-regression will be attempted to explore sources of heterogeneity. In cases where sufficient studies (≥ 10) were available, potential publication bias will be evaluated using funnel plots and Egger's regression test. We acknowledge that Egger's test was only valid with a minimum of 10 studies, and this limitation will be noted if fewer studies were available.

If sufficient data are available, subgroup analyses will be conducted based on Region-specific comparisons (e.g., Middle East vs. Sub-Saharan Africa), conflict intensity or duration, type of virtual platform (live, asynchronous, hybrid) and type of learner (student vs. physician vs. first responder).

Sensitivity analyses will be performed to assess the robustness of our findings. These will include, but were not limited to, excluding studies at high risk of bias, excluding studies with small sample sizes, and analyzing the impact of different data imputation methods for missing data.

Ethics and Dissemination

No ethical approval is required for this systematic review as it involves secondary analysis of publicly available published data and does not involve human subjects research. Our dissemination strategy will include submission of the completed systematic review to a peer-reviewed journal specializing in global health, medical education, or emergency medicine.

Discussion

Injuries remain the leading cause of surgical conditions globally and accounted for about 10% of deaths worldwide⁷. Although the burden of emergency conditions in low-income countries is estimated to be roughly three times that in high-income settings, utilisation of emergency services is only about 3% of the rate seen in high-income countries². Against this backdrop, conflict strains already fragile systems, highlighting the value of digital health for wider patient reach, faster emergency response, and better information management⁸. Shortages of well-

trained clinicians added to this pressure and reinforced the case for telemedicine and virtual medical education in resource-constrained settings⁹.

Protracted violence in Gaza disrupted infrastructure, damaged medical supply chains, and affected the psychological well-being of healthcare workers¹⁰. In response to workforce needs, a web-based Master's programme in burn care was delivered collaboratively to eleven professionals, with participants reporting favourable outcomes¹¹. At Al-Quds University in the West Bank, a distance-learning approach for clinical students achieved high satisfaction, with 95% of students reporting positive experiences¹². In Iraq, an online civilian course in Paediatric Advanced Life Support was completed by twelve physicians and certified by the American Heart Association, again with high satisfaction¹³. In Myanmar, during severe service disruption, an e-learning course covering trauma management, basic life support, psychological care, and paediatric emergencies also received strong evaluations¹⁴.

Despite these successes, implementation is likely to depend on reliable communications. Telemedicine required robust connectivity, yet in conflict zones internet infrastructure was frequently degraded or destroyed, limiting access to remote services and digital teaching¹⁵. Virtual education could therefore provide continuity when campuses or hospitals were inaccessible, but practical constraints in low- and middle-income countries during war were substantial¹⁶.

The wider context means that as conflict events rose from 2020 to 2023, health services were disrupted and skilled personnel left affected regions, intensifying local shortages¹⁷. Digital education offers one of the few scalable options to sustain training under such conditions. Cost considerations are not uniform, but some cohorts, such as Palestinian and Syrian learners, reported that distance education could be delivered at relatively low cost from the learner perspective¹⁸.

Technical limitations are likely to shape feasibility, with unreliable internet and limited infrastructure supporting the case for offering both online and offline modalities, with asynchronous access and downloadable materials



to bridge outages. Locally led approaches showed promise: in one Palestinian medical school, peer-led teaching trained students to deliver digital content to colleagues; in another initiative, a “revolving-door” model enabled students to train abroad and return to teach¹⁷. Even so, experience during the COVID-19 period illustrated persistent gaps: medical students in Gaza reported inadequate virtual learning owing to poor connectivity and the lack of practical in-hospital training opportunities¹⁹. During the current conflict, further barriers included unsafe travel, higher living costs, and lack of essential devices, with monthly programme running costs estimated at approximately \$300,000 in some settings²⁰.

Funding: this study did not receive any external funds

Conflict of interest: authors declare that they do not have any conflict of interest

GAIT statement for Generative AI use²¹: Generative AI was used to adjust the grammar of the manuscript and to edit it, however no AI was used in terms of data analysis, instead we would like to acknowledge our colleague efforts for the data analysis.

References

1. Lulic I, Mesquita C, Lulic D, Simões RL, Ferreira L, Koleda P, et al. Strengthening trauma resuscitation education and training in low-resource settings: a call for global inclusion. *Resusc Plus* [Internet]. 2025 Mar 20 [cited 2025 May 31];23:100935.
2. Kruk ME, Myers M, Varpilah ST, Dahn BT. What was a resilient health system? Lessons from Ebola. *Lancet*. 2015 May 9;385(9980):1910–2.
3. Della Corte F, La Mura F, Petrino R. E-learning as educational tool in emergency and disaster medicine teaching. *Minerva Anesthesiol*. 2005 May;71(5):181–95.
4. Kiragu AW, Dunlop SJ, Mwarumba N, Gidado S, Adesina A, Mwachiro M, et al. Pediatric trauma care in low resource settings: challenges, opportunities, and solutions. *Front Pediatr* [Internet]. 2018 Jun 4 [cited 2025 Jun 1];6:155.
5. Ahmady S, Kallestrup P, Sadoughi MM, Katibeh M, Kalantarion M, Amini M, et al. Distance learning strategies in medical education during COVID-19: a systematic review. *J Educ Health Promot*. 2021;10:421.
6. Agbeyangi A, Suleman H. Advances and challenges in low-resource-environment software systems: a survey. *Informatics* [Internet]. 2024 Dec [cited 2025 Jun 1];11(4):90.
7. Delaney PG, Eisner ZJ, Geduld H. The emergency burden in low and middle-income countries. *Surgery*. 2024 Aug;176(2):528–30.
8. Ahmed SK, Hussein S, Chandran D, Islam MR, Dhama K. The role of digital health in revolutionising healthcare delivery and improving health outcomes in conflict zones. *Digit Health*. 2023;9:20552076231218158. doi:10.1177/20552076231218158.
9. Nouhi M, Fayaz-Bakhsh A, Mohamadi E, Shafii M. Telemedicine and its potential impacts on reducing inequalities in access to health manpower. *Telemed J E Health*. 2012 Oct;18(8):648–53.
10. Jawad A, Mtairek MA, Awada Z, Kawssan A, Dghaili R, Soloh N, et al. Peri-operative management challenges in Gaza. *Impact Surgery*. 2024 Dec 1;1(6):214–9.
11. Theodorakopoulou E, Goutos I, Mason K, Ghanem AM, Myers S. London calling Gaza: the role of international collaborations in the globalisation of postgraduate burn care education. *Scars Burn Heal*. 2019;5:2059513119830519.
12. Penfold RS, Ali MA, Ali AM, Patel I, MacGregor T, Shankar S, et al. Evaluation of the first year of the OxPal Medlink: a web-based partnership designed to address specific challenges facing medical education in the occupied Palestinian territories. *JRSM Open*. 2014 Feb 1;5(2):2042533313517692.
13. Donaldson RI, Mulligan DA, Nugent K, Cabral M, Saleeby ER, Ansari W, et al. Using tele-education to train civilian physicians in an area of active conflict: certifying Iraqi physicians in Paediatric Advanced Life Support from the United States. *J Pediatr*. 2011 Sep;159(3):507–509.e1.
14. D’Apice C, Guasconi M. International partnerships in health education: adapting e-learning models for conflict-affected Myanmar. *Healthcare (Basel)*. 2025 Jan 31;13(3):285.
15. Haimi M. Telemedicine in war zones: prospects, barriers, and meeting the needs of special populations. *Front Med (Lausanne)*. 2024;11:1417025.
16. Effective e-learning for health professionals and students—barriers and their solutions. A systematic review of the literature—findings from the HeXL project. *Health Inf Libr J* [Internet]. 2005 [cited 2025 Jun 2].
17. El-Sbahi H, Lowe W, Morris C. How can we use distance education to teach medicine in conflict-affected countries? *Med Confl Surviv*. 2024 Oct;40(4):388–418.
18. Woodward A, Fyfe M, Handuleh J, Patel P, Godman B, Leather A, et al. Diffusion of e-health innovations in ‘post-conflict’ settings: a qualitative study on the personal experiences of health workers. *Hum Resour Health* [Internet]. 2014 Apr 23 [cited 2025 Jun 2];12:22. doi:10.1186/1478-4491-12-22.
19. Ismail A, Ismail A, Alazar A, Saman M, Abu-Elqomboz A, Sharaf FK. E-learning medical education in Gaza during COVID-19: students’ experiences and policy recommendations. *J Med Educ Curric Dev*. 2023 May 2;10:23821205231164228.



20. The New Humanitarian. 'It's the only hope': inside the effort to help Gaza university students continue their studies [Internet]. 2024 [cited 2025 Jun 2]. Available from: <https://www.thenewhumanitarian.org/news-feature/2024/09/26/inside-effort-help-gaza-university-students-continue-education-studies>

21. GAIT 2024 Collaborative Group. Generative artificial intelligence transparency in scientific writing: the GAIT 2024 guidance. *Impact Surg.* 2025;2:6–11. <https://doi.org/10.62463/surgery.134>