



MALAHAYATI INTERNATIONAL JOURNAL
OF NURSING AND HEALTH SCIENCE
ISSN 2620-9152 (Print)
ISSN 2621-4083 (Online)
DOI: 10.33024



ARTICLE INFORMATION

Received: March, 2, 2026

Revised: March, 11, 2026

Available online: March, 12, 2026

at : <https://e-jurnal.iphorr.com/index.php/minh>

Effectiveness of digital media for basic life support training among laypersons: A systematic review

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Abstract

Background: Basic Life Support (BLS) training among laypersons plays a crucial role in improving survival rates following out-of-hospital cardiac arrest. Early cardiopulmonary resuscitation (CPR) performed by bystanders can significantly increase the likelihood of survival. However, conventional face-to-face training is often limited by accessibility, time constraints, and resource availability. The rapid development of digital technology offers alternative approaches to delivering BLS education that may overcome these barriers.

Purpose: To examine the effectiveness of digital media in BLS training among laypersons, particularly in improving knowledge and practical skills related to CPR.

Method: This systematic review was conducted in accordance with the PRISMA guidelines. A comprehensive search was performed in Scopus, PubMed, ScienceDirect, CINAHL, Crossref, and Google Scholar for studies published between January 2020 and December 2025. Eligible studies evaluated digital media-based BLS training for laypersons and reported outcomes related to knowledge or skill performance. The methodological quality of included studies was assessed using the JBI Critical Appraisal Checklist. This review was registered in PROSPERO (CRD420251249898).

Results: Seven studies met the inclusion criteria. The findings consistently indicated that digital media, particularly virtual reality and video-based learning, were effective in enhancing participants' knowledge and practical BLS skills. Several studies also reported improved engagement and accessibility compared to conventional training methods. Nevertheless, variations in instructional design, content quality, and evaluation methods influenced the overall effectiveness of the interventions.

Conclusion: Digital media represents a promising approach to BLS training among laypersons. When appropriately designed, digital interventions can enhance learning outcomes, increase accessibility, and support independent practice. Future research should explore long-term skill retention and standardized outcome measures to strengthen the evidence base.

Keywords: Basic Life Support Training; Cardiopulmonary Resuscitation; Digital Media; Laypersons.

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) remains a major global public health challenge, and survival is highly dependent on the speed and quality of the first response before professional help arrives. In many events, the first rescuer is a layperson rather than a healthcare provider, making early bystander intervention crucial (Christian & Couper, 2020; Chavez, Huebinger, Chan, Gill, White, Mendez, Jarvis, Vithalani, Tannenbaum, Al-Araji, & Bobrow, 2022). Bystander cardiopulmonary resuscitation (CPR) has been consistently associated with improved outcomes in OHCA, underscoring the importance of expanding access to Basic Life Support (BLS) training for the general public (Birkun, Trunkwala, Gautam, Okoroanyanwu, & Oyewumi, 2020; Liou, Lin, Chien, Hung, Lin, Yang, Lai, Lin, Kuo, & Huang, 2021). However, participation in conventional face-to-face BLS training remains uneven due to barriers such as cost, limited time, geographic constraints, and restricted instructor availability, particularly among individuals without medical backgrounds (Birkun et al., 2020).

The need for more accessible training alternatives became more apparent during the COVID-19 pandemic, when restrictions on gatherings disrupted community-based instruction and exposed the fragility of traditional training models. This period was also associated with reduced bystander response and poorer OHCA outcomes in several settings (Lim, Reddy, Afroz, Billah, Shekar, & Subramaniam, 2020). At the same time, the pandemic accelerated the adoption of remote and technology-assisted learning across health education, creating momentum for digital approaches that can deliver CPR education while reducing physical contact and logistical barriers (Christian & Couper, 2020). As a result, digital media has increasingly been positioned as a practical strategy to broaden access to BLS education beyond conventional classroom delivery (Han, Lee, Jeong, Park, & Park, 2023; Schipper, Sloane, Shimelis, & Kim, 2025).

Digital media for BLS training now spans video-based instruction, smartphone applications, virtual reality (VR), augmented reality (AR), online modules, and other forms of technology-supported distance learning (Azionya, & Nhedzi, 2021). These formats offer flexibility, scalability, and the opportunity for

repeated self-paced practice. Importantly, many platforms include interactive elements such as step-by-step prompts, visual guidance, and performance feedback, which may strengthen both cognitive learning and psychomotor skill development. Emerging evidence suggests that well-designed non-face-to-face and digitally supported BLS training can produce learning outcomes comparable to conventional methods, particularly when instruction incorporates guidance and feedback (Lee, Hong, Lee, Shin, Song, Park, Choi, S., Lee, Pak, & Park, 2023; Sun, Wang, Wu, Wang, Liu, Wang, He, & Zheng, 2024). In addition, a multi-method study emphasized that remote BLS formats may improve feasibility and reach when tailored to lay learners' needs and local constraints (Han et al., 2023). More advanced approaches, including extended reality (XR) and VR simulation, have also been proposed to improve the accuracy of psychomotor performance through immersive practice environments (Alnagrat, Ismail, Idrus, & Alfaqi, 2022).

An increasing body of research supports the potential effectiveness of digital media for CPR education, although findings remain heterogeneous across technologies, populations, and evaluation methods. A systematic review focusing on adult laypersons reported that VR-based CPR training can enhance self-efficacy and practical skills, supporting its role as a promising modality in community settings (Alcázar Artero, Pardo Rios, Greif, Ocampo Cervantes, Gijón-Nogueron, Barcala-Furelos, Aranda-García, & Ramos Petersen, 2023). Similarly, a systematic review and meta-analysis found that VR and AR interventions were generally as effective as traditional training, while noting substantial heterogeneity in study designs and outcome measures (Sun et al., 2024). Other recent studies have reported positive results for AR smart-glass training, VR simulation, and broader technology-supported CPR education, particularly for learner engagement, skill rehearsal, and retention (Aranda-García, Otero-Agra, Fernández-Méndez, Herrera-Pedroviejo, Darné, Barcala-Furelos, & Rodríguez-Núñez, 2023; Castillo, Rodríguez-Higueras, Belmonte, Rodríguez, López, & Gallart, 2023; Schipper et al., 2025). Evidence from adolescent populations further indicates that technology-based CPR training can improve both knowledge and skill

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outcomes, especially when paired with instructor support or hands-on components (Lim, Liao, Wang, & Seah, 2022; Yulianto, Saryono, & Kamaluddin, 2024; Yulianto, Saryono, & Kamaluddin, 2024).

A more recent randomized trial published in 2025 suggested that VR-based BLS training may support comparable retention to traditional instruction over several months, even when short-term performance differences are observed, and may contribute to improvements in chest compression quality (Tannemann, Tsarenko, Herbstreit, Gestmann, Brenner, & Szalai, 2025). Taken together, these findings indicate that digital interventions are promising, yet their effectiveness likely depends on contextual and instructional factors such as platform design, feedback integration, supervision, and training duration. In line with broader emergency training literature, fully self-directed approaches may be less reliable for developing hands-on performance compared with guided or blended strategies, highlighting the importance of instructional structure (Baetzner, Wespi, Hill, Gyllencreutz, Sauter, Saveman, Mohr, Regal, Wrzus, & Frenkel, 2025).

Notably, although some existing studies include student samples, the central question for public health remains whether digital media can effectively improve BLS-related knowledge and practical CPR skills among laypersons in scalable community settings. Therefore, this systematic review aims to synthesize recent evidence (2020–2025) on digital media for BLS training among laypersons, with particular attention to effectiveness outcomes in knowledge, practical skill performance, and retention, and to clarify the strengths and limitations of current approaches to inform more accessible and scalable training strategies (Schipper et al., 2025; Doherty, Bray, Finn, & Cartledge, 2025).

RESEARCH METHOD

A systematic review examined the effectiveness of digital media in Basic Life Support (BLS) training among laypersons. The review was planned *a priori* (i.e., procedures were specified before screening began) to minimize bias, and reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline (Peters, Marnie, Tricco, Pollock, Munn, Alexander, McInerney, Godfrey, & Khalil, 2020; Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow,

Shamseer, Tetzlaff, Akl, Brennan, Chou, Glanville, Grimshaw, Hróbjartsson, Lalu, Li, Loder, Mayo-Wilson, McDonald, McGuinness, Stewart, Thomas, Tricco, Welch, Whiting, & Moher, 2021). The review question and eligibility criteria were defined using the PICO framework (*Population, Intervention, Comparator, Outcome*) to ensure alignment with the objective of evaluating digital-media-based BLS training in non-healthcare participants (Richardson, Wilson, Nishikawa, & Hayward, 1995).

A comprehensive search was conducted in Scopus, PubMed, ScienceDirect, CINAHL, Crossref, and Google Scholar for studies published from January 2020 to December 2025. The strategy combined controlled vocabulary (e.g., MeSH where available) and free-text terms related to digital learning and BLS, using Boolean operators (AND/OR). The core search string was: (“digital media” OR “virtual reality” OR “augmented reality” OR “video-based learning” OR “distance learning” OR “mobile application”) AND (“basic life support” OR “BLS” OR “cardiopulmonary resuscitation” OR “CPR”) AND (“laypersons” OR “non-healthcare”). Reference lists of relevant articles were also screened to identify additional eligible studies (Page et al., 2021).

Studies were eligible if they involved laypersons (non-healthcare participants) aged ≥18 years and evaluated any digital-media-based BLS training (e.g., video modules, mobile applications, VR/AR, distance/online learning, or simulator-assisted programs). Comparators included conventional non-digital training or usual practice; single-group pre-post studies were also eligible when effectiveness outcomes were reported. Primary outcomes were changes in BLS-related knowledge and practical cardiopulmonary resuscitation (CPR) performance. Eligible designs included randomized controlled trials, quasi-experimental studies, pilot studies, and research-and-development evaluations reporting measurable outcomes. Review articles and conference abstracts without accessible full text were excluded.

Two reviewers independently screened titles/abstracts and assessed full texts for inclusion, resolving disagreements through discussion until consensus. Data were extracted independently using a structured form guided by the Joanna Briggs Institute (JBI) approach, including author/ year/

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country, study design, participant characteristics, sample size, intervention type and duration, comparator, outcome measures, and key findings. Methodological quality was appraised using the appropriate JBI Critical Appraisal Checklist for each design, while randomized trials were additionally assessed using the Cochrane Risk of Bias 2 (RoB 2) tool to evaluate potential bias across domains such as randomization, missing outcome data, and outcome measurement (Igelström, Campbell, Craig, & Katikireddi, 2021; Sterne, Savović, Page, Elbers, Blencowe, Boutron, Cates, Cheng, Corbett, Eldridge, Emberson, Hernán, Hopewell, Hróbjartsson, Junqueira, Jüni, Kirkham, Lasserson, Li, McAleenan, Reeves, Shepperd, Shrier, Stewart, Tilling, White, Whiting, & Higgins, 2019).

Due to substantial heterogeneity in intervention formats and outcome measures, a meta-analysis was not performed. Findings were synthesized

narratively using a Synthesis Without Meta-analysis (SWiM) approach (i.e., structured narrative synthesis), grouping studies by intervention type, design, and outcome domain, and summarizing the direction and consistency of effects (Campbell, McKenzie, Sowden, Katikireddi, Brennan, Ellis, Hartmann-Boyce, Ryan, Shepperd, Thomas, Welch, & Thomson, 2020). Ethical approval was not required because this review used secondary data from published studies, and the protocol was prospectively registered in PROSPERO (CRD420251249898) (Page et al., 2021). In brief, the included evidence comprised seven studies (four experimental trials and three non-experimental evaluations such as pilot or research-and-development studies), covering digital interventions including virtual reality, distance learning formats, and simulator-based training; all assessed outcomes related to BLS knowledge and skill performance.

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RESEARCH RESULTS

The database search identified a total of 1.251 records published between 2020 and 2025 from six sources: Scopus (64), PubMed (73), ScienceDirect (121), CINAHL (210), Crossref (102), and Google Scholar (681). After duplicates were removed and studies were filtered by language and publication year, 230 records remained. From these, 65 articles were selected for title and abstract screening, while 28 articles progressed to full-text review. At the end of the selection process, 7 studies fulfilled the inclusion criteria and were included in this review. These studies focused on digital media interventions used in Basic Life Support (BLS) training.

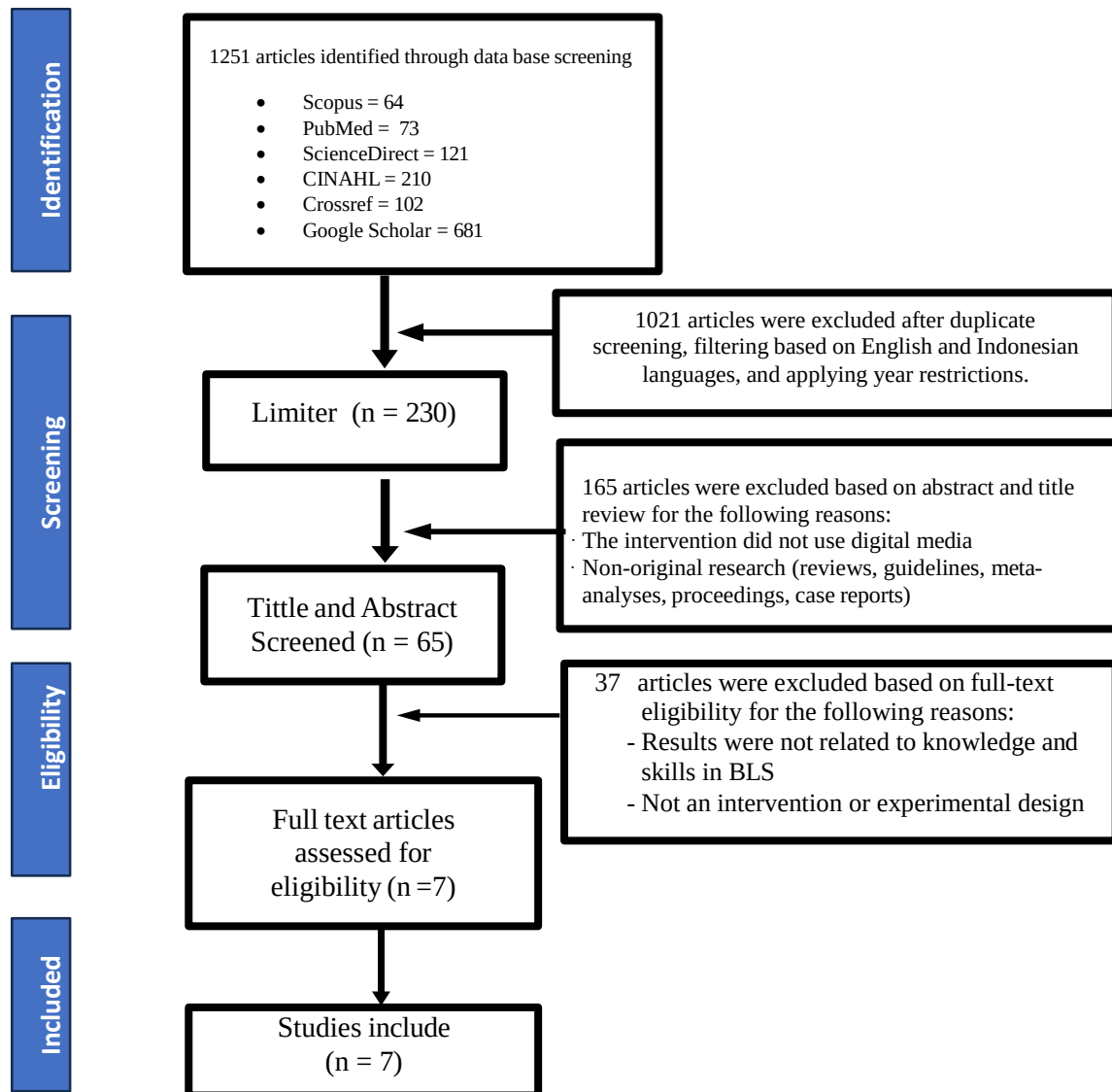


Figure PRISMA Flow Diagram

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Table 1. Summary of Included Studies (Digital Media for BLS Training Among Laypersons)

(Author, Year) (Country)	Study Design (Human)	Main Intervention	Comparator	JB Score (9)	Validity of Assessment Tools	Key Findings (Knowledge/Skills)
(Rahmatia et al., 2025) (Indonesia)	Experimental trial	VR simulation for BLS– AED training	Traditional face-to- face training	8/9	Assessment (validity NR)	sheet Knowledge and skills improved; overall outcomes broadly similar to traditional training; retention decreased over time in both groups.
(Nur et al., 2023) (Indonesia)	Quasi-experimental (one-group pre– post)	Distance-learning BLS training (e.g., Zoom/WhatsApp + periodic refresher)	None	8/9	Assessment (validity NR)	sheet Significant improvement in knowledge and skills (reported $p<0.001$); pass rate high; skills declined at ~6 months, suggesting retention challenge.
(Castillo et al., 2023) (Spain)	Experimental trial	VR simulation for BLS– AED training	Traditional face-to- face training	9/9	Assessment (validity NR)	sheet Learning outcomes comparable to conventional training; retention decreased over time; traditional training showed better defibrillation performance in some measures.
(Kiegaldie & Shaw, 2023) (Australia)	Mixed-methods quasi-experimental	Immersive VR simulation modules	Traditional simulation-based education (SBE)	9/9	Assessment (validity NR)	sheet Similar learning outcomes overall; VR perceived feasible and potentially cost-effective; supported higher engagement/critical thinking (context-dependent).
(Shatpattananunt et al., 2023) (Thailand)	Two-group pre–post (R&D evaluation)	VR-based BLS program (MFU BLiS VR)	Traditional training	9/9	Assessment (validity NR)	sheet Better performance and satisfaction in VR group; shorter no-flow time reported; promising for self-directed practice with structured content.

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(Author, Year) (Country)	Study Design (Human)	Main Intervention	Comparator	JB Score (9)	Validity of Assessment Tools	Key Findings (Knowledge/Skills)
(Aranda-García et al., 2023) (Spain)	Pilot study (pre-post)	Smart-glasses assisted BLS training (tele/video guidance)	None (assisted vs unassisted post-training comparison)	6/9	Assessment sheet (validity NR)	Feasible delivery of BLS training using smart glasses; assisted vs unassisted performance generally comparable; promising for remote or hard-to-reach settings.
(Lee et al., 2022) (South Korea)	Development & usability study	XR-based BLS simulator (VR + manikin integration)	None	6/9	Expert feedback/usability (validity NR)	System rated useful and easy to use; high positive expert feedback; potential to address limitations of conventional training (needs effectiveness trials).

Table 2. Methodological Quality Appraisal Using JBI (9-Item Checklist)

(Author, Year) (Country)	JB Assessment Tool	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	% Yes	Interpretation
(Rahmatia et al., 2025) (Indonesia)	Quasi-Experimental Checklist	✓	✓	✓	X	✓	✓	✓	✓	✓	89%	High quality
(Nur et al., 2023) (Indonesia)	Quasi-Experimental Checklist	✓	✓	✓	X	✓	✓	✓	✓	✓	89%	High quality
(Castillo et al., 2023) (Spain)	Quasi-Experimental Checklist	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	High quality
(Kiegaldie & Shaw, 2023) (Australia)	Quasi-Experimental Checklist	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	High quality
(Shatpattananunt et al., 2023) (Thailand)	Quasi-Experimental Checklist	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	High quality
(Aranda-García et al., 2023) (Spain)	Quasi-Experimental Checklist	✓	?	✓	X	✓	✓	✓	✓	?	67%	High quality
(Lee et al., 2022) (South Korea)	Quasi-Experimental Checklist	✓	?	✓	X	✓	✓	✓	✓	?	67%	High quality

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Table 3. Risk of bias assessment using Cochrane RoB 2 (randomized trials)

(Author, Year) (Country)	D1	D2	D3	D4	D5	D6	D7	Overall Risk of Bias	Interpretation
(Rahmatia et al., 2025) (Indonesia)	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate Risk	No randomization, potential baseline differences
(Nur et al., 2023) (Indonesia)	Moderate	Moderate	Low	Low	Moderate	Low	Low	Moderate Risk	Quasi-experimental, no control, 6-month follow-up, potential attrition
(Castillo et al., 2023) (Spain)	Low	Low	Low	Low	Moderate	Low	Low	Low Risk	6-month retention, attrition possible
(Kiegaldie & Shaw, 2023) (Australia)	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate Risk	Quasi, potential confounding
(Shatpattananunt et al., 2023) (Thailand)	Low	Low	Low	Low	Low	Low	Low	Low Risk	Clear methods
(Aranda-García et al., 2023) (Spain)	Serious	Serious	Low	Moderate	Low	Low	Low	Serious Risk	Pilot, no control, confounding from experience
(Lee et al., 2022) (South Korea)	Serious	Not Clear	Low	Moderate	Not Clear	Low	Low	Serious Risk	Pilot, no control, confounding from experience

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Table 4.. Risk of bias assessment using Cochrane RoB 2 (randomized trials)

(Author, Year) (Country)	Type of Digital Media	Study Model	Effect on Knowledge and Skills	Effectiveness Level
(Rahmatia et al., 2025) (Indonesia)	Video-Based Education	Pre-post test design.	Significant increase in knowledge scores (pre: 63.3%, post: 83.3%); improved understanding of BLS procedures among adolescents.	High ($p < 0.001$; effective for knowledge enhancement).
(Nur et al., 2023) (Indonesia)	Distance-Learning (online videos, social media group)	Quasi pre-experimental post.	Knowledge retention increased significantly (pre: $Z = -6.904$, $p < 0.001$); skills decreased after 6 months but remained above baseline.	Moderate (proven alternative during pandemic, but retention fades over time).
(Castillo et al., 2023) (Spain)	Virtual Reality (VR) Simulation	Randomized controlled trial with 6-month retention assessment.	Improved BLS-AED skills initially; defibrillation results decreased over time but VR group showed better retention in some metrics compared to traditional.	Moderate (similar to traditional; better long-term retention in VR).
(Kiegaldie & Shaw, 2023) (Australia)	Virtual Reality (VR) Simulation	Mixed methods quasi-experimental pre-post with clinical placement follow-up.	Significant initial improvements in knowledge ($p < 0.01$) and skills; not maintained post-placement; fostered critical thinking.	High (cost-effective and scalable; 95% active participation).
(Shatpattananunt et al., 2023) (Thailand)	Virtual Reality (VR) Simulation	Two-group pre-post test design.	Shorter no-flow time ($Z = -5.02$, $p < 0.001$); higher knowledge ($Z = -3.39$, $p < 0.01$) and skills ($Z = -7.26$, $p < 0.001$).	High (effective for reducing no-flow time and improving outcomes).
(Aranda-García et al., 2023) (Spain)	Augmented Reality (AR) Smart with Glasses	Pilot study with assisted and unassisted assessments.	Good BLS protocol adherence; compression rate improved ($p = 0.001$) but depth inadequate; faster performance times post-training.	Moderate (valid alternative for remote learning; needs feedback improvements).
(Lee et al., 2022) (South Korea)	Extended Reality (XR) Simulation	Development and expert usability survey.	High usability (100% agreement on ease of use); effective self-directed learning of BLS steps.	High (useful for immersive, repeatable training without instructors).

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DISCUSSION

This systematic review indicates that digital media can serve as an effective complement and in some contexts, a practical alternative to conventional Basic Life Support (BLS) training for improving short-term knowledge and selected practical skills among lay or non-healthcare learners. Across seven included studies, digital approaches consistently supported gains in cognitive outcomes and often improved performance indicators relevant to cardiopulmonary resuscitation (CPR), although the strength and durability of effects varied depending on the type of media, instructional design, and study rigor (Rahmatia, Aprilianti, & Basri, 2025).

A clear pattern across studies is that digital delivery can strengthen knowledge acquisition and immediate preparedness, particularly when interventions are structured and accessible for independent learning. Video-based education and platform-supported distance learning demonstrated improvements in post-training knowledge and observable skills, supporting the idea that digital formats can reduce barriers related to time, location, and instructor availability (Rahmatia et al., 2025). However, several studies also highlight that retention is not automatic: skills and knowledge tend to decline over follow-up periods unless supported by reinforcement, indicating the need for periodic refreshers as part of program design rather than an optional add-on (Castillo et al., 2023).

When comparing modalities, immersive technologies such as virtual reality (VR) and extended reality (XR) appear especially promising for psychomotor and workflow outcomes that depend on repeated rehearsal and engagement. VR/XR interventions were frequently associated with improvements in practical performance such as efficiency during resuscitation sequences and better execution of key steps suggesting that high-immersion learning may be particularly useful for developing CPR performance behaviors (Shatpattananunt, Petpichetchian, Pinsuwan, Chaloempong, Waraphok, & Wongwatkit, 2023). In parallel, augmented reality (AR) using smart glasses showed potential for remote guidance and training delivery in geographically underserved settings, although limitations in haptic feedback imply that AR-only approaches may benefit from being paired with hands-on components or devices that support tactile

learning (Aranda-García et al., 2023). Overall, these comparisons suggest that modality matters, and “digital media” should not be treated as a single intervention category; effectiveness depends on whether the technology provides guidance, feedback, and practice opportunities aligned with the skill being trained (Nur, Prasamya, Ikhwindi, Santoso, & Utomo, 2023).

From a practical perspective, these findings support integrating digital media into BLS education for community members, students, and lay volunteers, particularly in contexts where conventional training is constrained by logistics, costs, or instructor shortages. Scalable formats such as videos and remote learning platforms may be most useful for expanding baseline knowledge rapidly, while VR/XR-based training may add value when the educational goal includes improving psychomotor performance and maintaining engagement during skill rehearsal (Kiegaldie, & Shaw, 2023). Additionally, digital tools can be deployed as preparatory modules before face-to-face sessions or as refresher interventions after initial training, which directly addresses the recurring challenge of retention decline reported across multiple studies (Castillo et al., 2023).

The strength of conclusions is limited by heterogeneity in study designs, populations, and outcome measures, which also explains why meta-analysis was not appropriate. Methodological quality varied across the evidence base, with quasi-experimental studies generally showing stronger internal validity than small pilot or development-focused studies, where limited sample sizes and lack of control groups increase susceptibility to confounding and restrict generalizability (Aranda-García et al., 2023). Usability-oriented studies contribute important feasibility insights, but they do not substitute for well-powered effectiveness trials, particularly when the goal is to inform large-scale public training policy (Lee, Choi, Jheon, Jo, Im, & Il, 2022). Future research should prioritize adequately powered randomized trials, standardized CPR performance outcomes, and longer follow-up periods to better estimate sustained effectiveness and identify which combinations of digital and hands-on components optimize real-world competency (Pallavicini, Pepe, Clerici, & Mantovani, 2022).

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CONCLUSION

Digital media can effectively support BLS training for laypersons by improving short-term knowledge and selected CPR skills and by reducing barriers to training access. Given variability in intervention design and outcome measurement, future research should prioritize standardized skill metrics and longer follow-up to determine durable retention and identify the most effective digital or blended training models.

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DOI: <https://doi.org/10.33024/minh.v8i12.2748>

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DOI: <https://doi.org/10.33024/minh.v8i12.2748>