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Original Article

A Comparative Study of Video-Based and Face-to-Face Cardiopulmonary Resuscitation Training among Emergency Medical Services Students

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ABSTRACT

Background: Cardiopulmonary arrest remains a major cause of mortality worldwide and is a critical concern in both developing and developed countries. Effective Cardiopulmonary Resuscitation (CPR) training is essential for improving survival outcomes. This study aimed to compare the effectiveness of Video-Based Training (VBT) and traditional Face-to-Face Training (FFT) in enhancing CPR knowledge and practical performance among undergraduate Emergency Medical Services (EMS) students.

Methods: This quasi-experimental study included 86 EMS students enrolled in a mandatory CPR course at Qom University of Medical Sciences, Qom, Iran, from September 2023 to January 2024. Participants were recruited through convenience sampling and randomly assigned to either the VBT group or the FFT group using block randomization, with 43 students completing the study in each group. Both groups received identical educational content aligned with the American Heart Association (AHA) 2020 Guidelines, delivered through different modalities. Knowledge and practical skills were assessed using a validated, researcher-developed examination and checklist via the Direct Observation of Practical Skills (DOPS) as an approach to the assessment. The reliability of the instruments was confirmed through a test–retest procedure with correlation coefficient of 0.85, and assessments were conducted before and two weeks after the intervention. Data analysis was conducted in SPSS V.26 using Chi-square and t-tests, with a significance level of P<0.05.

Results: The mean scores of pre-test did not differ significantly between the VBT (6.34±2.54) and FFT (6.41±2.17) groups (P=0.892), confirming baseline equivalence. However, post-test scores were significantly higher in the VBT group (74.51±8.19) compared to FFT group (64.74±9.94; P>0.001). Further analysis revealed no significant associations between post-test scores and demographic variables, including age (P=0.624), grade point average (P=0.930), or gender (P=0.085).

Conclusion: The results indicate that VBT is an effective educational approach for teaching CPR, leading to significant improvements in both theoretical knowledge and practical performance among EMS students. Given its scalability, consistency, and learner-centered design, video-based instruction can serve as a viable alternative or complement to traditional face-to-face CPR education, especially in resource-limited or large-group settings.

Keywords: Video-Based, Face-to-Face, Cardiopulmonary Resuscitation, Knowledge, Practical Performance, Distance, Education

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Introduction

Cardiopulmonary arrest remains a leading cause of mortality worldwide, with an estimated global incidence of 55–95 cases per 100,000 population annually, placing immense pressure on healthcare systems (1, 2). In Iran, approximately 1,000 cases are reported each year (3), underscoring the urgent need for effective resuscitation training at both national and institutional levels. Despite high mortality, timely and high-quality Cardiopulmonary Resuscitation (CPR) significantly enhance both survival chances and neurological recovery (4, 5). To sustain this life-saving impact, continuous CPR training for healthcare professionals is indispensable; with evidence showing, that periodical retraining enhances skill retention and job satisfaction (6).

However, despite its proven effectiveness, conventional CPR Face-to-Face Training (FFT) presents considerable challenges to broader adoption. It demands substantial financial, logistical, and instructional resources (7, 8), limiting scalability, especially in resource-constrained or rural settings. Furthermore, passive teaching methods such as lectures often fail to engage learners or promote long-term retention (9), highlighting the need for more dynamic and accessible educational approaches.

Video-Based Training (VBT) emerges as a promising solution to these challenges. By offering flexibility, multimedia integration, self-paced modules, and repeatable content, VBT supports deeper comprehension and skill mastery. Empirical evidence reinforces its superiority, showing that nursing students who trained via VBT achieved assessment scores 20% higher, reported 30% greater confidence, retained 15% more knowledge after three months, and expressed higher satisfaction (85% compared with 60% in traditional instruction) (10, 11).

Building on this evidence, CPR training videos provide clear, sequential demonstrations of essential skills such as chest compressions, rescue breathing, and scenario-based decision-making (12). International standards also support this movement toward digital learning. Both the European Resuscitation Council (13) and the American Heart Association (AHA) (14) recognize online and remote CPR instruction as legitimate and scalable educational approaches.

Given the direct correlation between CPR proficiency and patient survival, systematic evaluation of innovative training methods among future healthcare providers is not just beneficial—it is essential (13).

Emergency Medical Services (EMS) students and nurses, as frontline responders in cardiac arrest scenarios, bear particular responsibility for CPR competence (14, 15). Yet, despite global advocacy for VBT, a critical knowledge gap persists in its application within local academic settings—particularly at the Paramedical School of Qom University of Medical Sciences, Qom, Iran, where no comparative studies have evaluated video-based versus traditional CPR training.

This study directly addressed this gap by conducting a comparative evaluation of VBT versus FFT on CPR knowledge acquisition and procedural proficiency among EMS students. By generating context-specific evidence, this research aimed to inform scalable, technology-enhanced training models that can strengthen resuscitation education and, ultimately, improve patient outcomes in Iran and beyond.

Methods

Study Design and Setting

This was a two-arm, pretest-posttest interventional study with one intervention group (VBT) and one control group (FFT). The study was conducted among undergraduate EMS students enrolled in the mandatory CPR training course at the Paramedical School of Qom University of Medical Sciences, Iran, from September 2023 to January 2024.

Participants and Sampling

Based on a previously reviewed study (16), the post-test willingness scores on the Video Satisfaction Index (VSI) and Video Relevance Satisfaction Index (VRSI) were reported as 4.07±0.94 and 4.60±0.68, respectively. Using these parameters, and assuming a 5% margin of error and 80% statistical power, the required sample size was calculated to be 78 participants (39 per group). Considering a 10% expected attrition rate, the final sample size was adjusted to 90 participants.

$$n = \frac{(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2(\delta_1^2 - \delta_2^2)}{(\mu_1 - \mu_2)^2}$$

Participants were selected using a convenience sampling method. After completing the pre-test, they were randomly assigned to either the intervention group (VBT) or the control group (FFT) through block randomization with equal block sizes to ensure balanced group allocation. The randomization sequence was generated in SPSS software (version 26) and implemented by a researcher not involved in the intervention delivery. To prevent information contamination between groups, training sessions were conducted simultaneously in separate locations, each supervised by an independent researcher.

Participants were eligible for inclusion if they were enrolled in the Emergency Medicine program at the Paramedical School of Qom University of Medical Sciences, had no prior formal CPR training or participation in similar courses, and provided written informed consent. Exclusion criteria comprised voluntary withdrawal due to lack of motivation, two or more unexcused absences from scheduled sessions, or more than 20% incomplete responses on assessment tools.

Teaching Interventions

The instructional interventions were developed based on adult learning and experiential learning principles, emphasizing self-directed and practice-oriented education. The objective was to improve participants' knowledge and practical skills in CPR according to the AHA Guidelines, 2020 (14).

The educational content was identical for both groups and included four modules: Introduction to CPR, CPR for Special Populations, Familiarization with CPR Equipment and Devices, and Overview of Standard CPR Protocols and Procedures. Instruction in both groups was provided by three certified CPR trainers, each with a minimum of five years of professional experience in EMS and teaching. All instructors attended an orientation session to ensure consistency in learning objectives, content delivery, and assessment methods. All materials were derived from peer-reviewed sources and validated by CPR experts for accuracy and alignment with the latest guidelines.

Intervention Group (VBT)

Participants in the intervention group received a video-based CPR training program designed using a micro-learning approach. Instructional videos, each lasting 5–7 minutes, demonstrated correct CPR techniques using mannequins or live instructors. These videos were delivered via a social media platform, allowing learners to access the materials at their convenience and participate in online question-and-answer discussions. The intervention lasted four weeks, with 10 videos per module released weekly.

A certified instructor supervised the program, provided feedback, and responded to participants' questions. Consistency was maintained using a delivery checklist, and engagement was monitored via confirmation of video access and participation in discussions. Although the program was not individually customized, clarifications were offered when necessary. Knowledge and skills were assessed through tests conducted before and after the intervention.

Control Group (FFT)

The control group received conventional, in-person CPR instruction delivered in a classroom setting equipped with mannequins and audiovisual resources. To maintain consistency across groups, the same curriculum and instructors were used. The training program consisted of two one-hour sessions per module each week for four weeks, combining brief theoretical explanations with guided practical exercises.

Participants were encouraged to seek clarification and were provided with real-time feedback during hands-on activities. Adherence to the training protocol was maintained through standardized instructional procedures and session monitoring. Throughout the program, attendance, engagement, and performance were continuously documented. Knowledge and skill acquisition were evaluated using identical pre- and post-assessments, along with a structured observational checklist, and learners received immediate corrective feedback to strengthen proper CPR techniques. Table 1 summarizes the instructional features of both the intervention and control groups.

Tools/Instruments

The study utilized a set of structured assessment tools to evaluate participants' learning outcomes. ***Knowledge Assessment:*** A theoretical knowledge test was employed to measure students' understanding of CPR concepts based on the AHA 2020 Guidelines. The content of this assessment covered fundamental topics, including basic knowledge, patient assessment, chest compressions, ventilation, and the use of an Automated External Defibrillator (AED). The test consisted of 10 multiple-choice questions (0.5 points each) and 10 descriptive questions (2 points each), yielding a total score of 25 points and providing a comprehensive evaluation of participants' cognitive knowledge of CPR. This material was later converted into a multimedia format under the supervision of a specialist from the emergency CPR team.

Skill Assessment: A practical assessment test was conducted using the Direct Observation of Practical Skills (DOPS) (17), which included five domains: chest compression depth, chest compression rate and consistency, full chest recoil, correct hand position and body alignment, and use of manikin feedback indicators. Each domain was scored out of 15 points, for a total possible score of 75. The DOPS structure replicated authentic clinical conditions, allowing for a direct and comprehensive appraisal of practical competencies.

Validity and Reliability - To ensure validity, the examination questions were reviewed by three experts in e-learning and eight in EMS. The Content Validity Ratio (CVR) and Content Validity Index (CVI) were 0.9 and 0.84, respectively. Reliability was confirmed through a test-retest procedure among 86 students over a two-month interval, yielding a correlation coefficient of 0.85.

Data Collection

A pre-test was administered to both groups to assess baseline knowledge and skills. Two weeks after completion of the training period, a post-test was conducted to measure learning outcomes. Participants in the intervention group received the CPR instructional content through short educational videos, while the control group received the same content through conventional in-person instruction. Pre- and post-test data were collected using the same assessment tools for both groups from September 2023 to January 2024.

Table 1: Comparison of intervention and control group teaching characteristics

Component	VBT (Intervention)	FFT (Control)
Mode of delivery	Asynchronous videos via a social media platform	Face-to-face classroom sessions
Format	5–7 minutes micro-learning videos	Two 1-hour sessions per week
Duration	4 weeks	4 weeks
Instructor role	Demonstrator and online facilitator	Lecturer and practical instructor
Interaction type	Asynchronous question-and-answer discussions	Real-time discussion and feedback
Learning approach	Self-paced micro-learning	Guided practice and immediate feedback
Assessment	Pre/post knowledge tests, discussion participation	Pre/post knowledge tests, practical skill evaluation

VBT: Video-Based Training; FFT: Face-to-Face

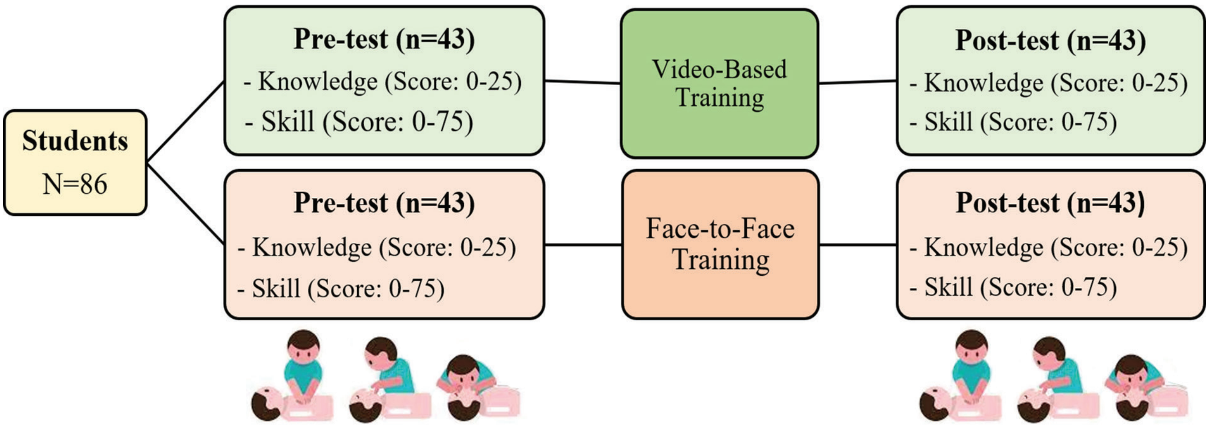

Figure 1: Schematic view of research design

The schematic view of the research design is presented in Figure 1.

Data Analysis

Data analysis was performed using SPSS software (version 26). Quantitative variables were reported as means with their corresponding standard deviations, while qualitative variables were described using frequencies and percentages. To compare demographic characteristics between groups, the Chi-square test was applied for categorical data, and either the independent t-test or the Mann–Whitney U test was used for continuous data, depending on the normality of distribution. Differences in pre- and post-test scores between the VBT and FFT groups were examined using dependent t-tests or Wilcoxon Signed-Rank Test. Statistical significance was defined

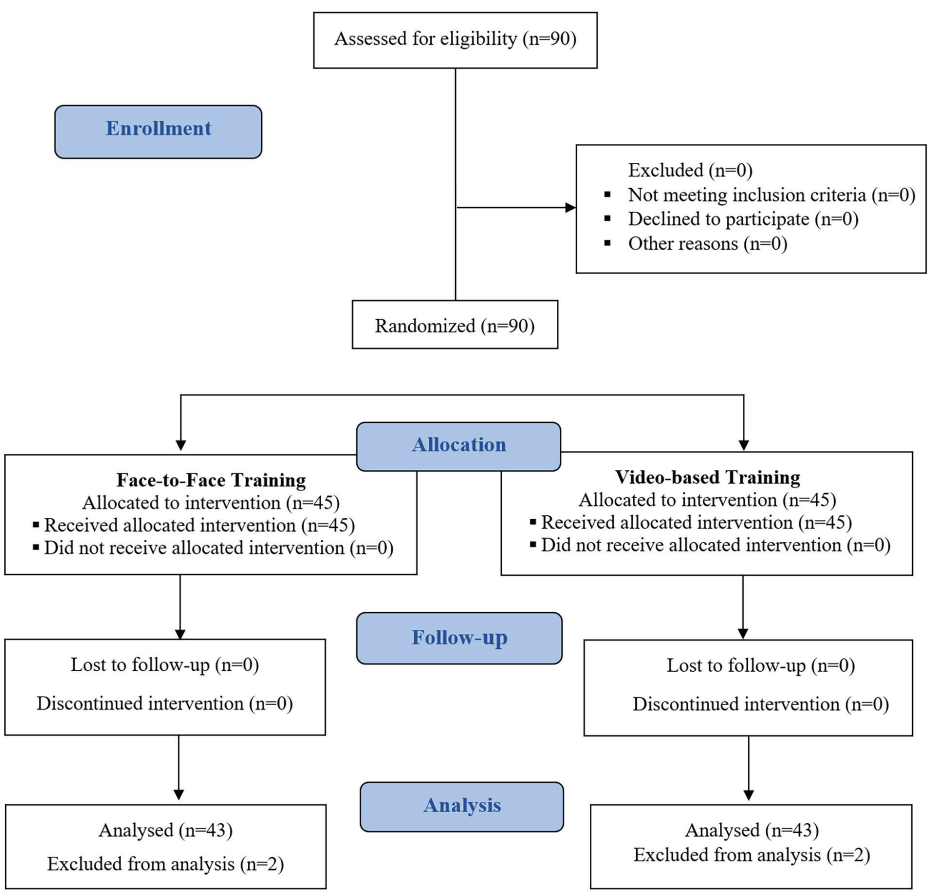

Figure 2: Flow diagram of the participant recruitment process

as a P-value less than 0.05. In addition to significance testing, effect sizes (Cohen's d) were calculated to quantify the magnitude of differences between groups.

Ethics – All participants provided written informed consent, and their participation was entirely voluntary, with the option to withdraw at any time. Ethical approval was granted by the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran.

Results

A total of 90 EMS students who met the inclusion criteria were enrolled in the study. They were then randomly assigned to one of two groups: the VBT group (n=45) or FFT group (n=45). Out of the 90 participants, 86 completed both the intervention and the follow-up assessment, as four individuals missed either the pre-test or post-test phase. The flow of participant recruitment is shown in Figure 2.

The statistical analysis revealed no significant differences in gender distribution (P=0.458), age distribution (P=0.998), or mean Grade Point Average (GPA) between the two study groups (P=0.211). The participants' demographic information is summarized in Table 2.

Prior to the intervention, the relationship between participants' demographic characteristics and baseline CPR knowledge was evaluated. Statistical analysis revealed no significant association between age and pre-test scores (P=0.624) or between GPA and pre-test scores (P=0.930). Although female participants had slightly higher mean pre-test scores than males (7.75 vs. 6.24), this difference was not statistically significant (P=0.085). These findings show that demographic factors had no effect on the initial CPR knowledge, confirming the comparability of the two groups at baseline.

Table 3 presents the pre- and post-test comparisons of CPR knowledge and skill scores between the control and intervention groups. The table also reports effect sizes (Cohen's d), which were calculated for the post-test differences between the intervention and control groups, thereby indicating the practical significance of the observed improvements.

The results indicate that while both groups improved significantly from the pre-test to the post-test, the intervention group experienced a notably larger increase. Within-group analyses revealed modest gains in the control group (p-values ranging from 0.04 to 0.05), consistent with the effect of routine training. In contrast, the intervention group achieved much stronger gains across all areas (P=0.01–0.02), highlighting the enhanced impact of feedback-based instruction.

Between-group comparisons at baseline (pre-test) confirmed that the two groups were statistically equivalent (all P>0.80), ensuring comparability. Post-test comparisons, however, revealed significant differences favoring the intervention group across knowledge and skill domains (all P<0.05). The corresponding effect sizes (Cohen's d) further emphasize the practical importance of these findings: knowledge gains reflected medium to large effects (d=0.65–0.75), while skill improvements ranged from large to very large (d=0.60–1.04). When knowledge and skills were combined into an overall score, the effect size was very large (d=1.00), highlighting the strong overall influence of the intervention.

Table 2: Demographic characteristics of the participants

Variable		Group		P-value
		FFT group	VBT group	
Gender, n (%)	Male	40 (46.5)	38 (44.2)	0.458
	Female	3 (3.5)	5 (5.8)	
Age, Mean±SD		20.62±0.9	20.62±1.02	0.998
GPA, Mean±SD		16.68±1.17	16.38±1.05	0.211

GPA: Grade Point Average; VBT: Video-Based Training; FFT: Face-to-Face

Table 3: Comparison of pre- and post-test knowledge and skill scores between control and intervention groups with effect sizes

Variable	Control Pre (Mean±SD)	Control Post (Mean±SD)	Within-Group P-value (Control)	Intervention Pre (Mean±SD)	Intervention Post (Mean±SD)	Within-Group P-value (Intervention)	Between-Group P-value (Pre-test)	Between-Group P-value (Post-test)	Cohen's d (Post-test)
Knowledge (Multiple Choice)	3.90±0.80	4.10±0.70	0.040	3.85±0.80	4.55±0.55	0.015	0.81	0.008	0.75
Knowledge (Descriptive)	14.70±2.80	15.30±2.60	0.045	14.60±2.90	16.40±2.20	0.015	0.88	0.010	0.65
Total Knowledge Score	18.60±3.30	19.60±3.00	0.042	18.50±3.40	21.00±2.60	0.010	0.90	0.007	0.72
Skill-Chest Compression Depth	11.10±2.10	11.60±2.00	0.041	11.00±2.20	13.00±1.80	0.010	0.93	<0.001	0.74
Skill-Compression Rate & Consistency	10.90±2.20	11.40±2.10	0.046	10.80±2.20	12.80±2.00	0.020	0.89	<0.001	0.60
Skill-Full Chest Recoil	11.90±2.00	12.30±1.90	0.049	11.80±2.00	13.40±1.70	0.020	0.91	0.003	0.61
Skill-Hand Position & Alignment	11.40±2.30	11.80±2.20	0.043	11.30±2.30	13.00±1.90	0.020	0.92	0.003	0.63
Skill-Use of Manikin Feedback	12.60±2.10	13.00±2.00	0.042	12.50±2.20	14.30±1.80	0.020	0.93	0.003	0.63
Total Skill Score	58.20±6.50	60.00±6.30	0.040	58.00±6.60	66.30±5.10	<0.001	0.94	<0.001	1.04
Total Score (Knowledge + Skill)	76.80±8.00	79.20±7.80	0.041	76.50±8.10	87.00±7.00	0.010	0.95	<0.001	1.00

Discussion

This quasi-experimental study provides compelling evidence on the comparative efficacy of VBT versus FFT in enhancing CPR knowledge and practical skills among undergraduate EMS students. The key findings revealed that while both modalities yielded improvements from baseline, VBT produced significantly superior post-test outcomes, particularly in multiple-choice knowledge, practical skills, and case report analysis, demonstrating that well-designed video instruction can effectively convey complex clinical procedures. The effect sizes were medium to large for knowledge outcomes and large to very large for skill development, highlighting the intervention's real-world impact. Accordingly, VBT shows strong potential as a robust, learner-centered approach for delivering complex, life-saving procedural education, aligning with the growing emphasis on technology-integrated medical training.

These results align with the observations of Todd and colleagues (18), who demonstrated that concise instructional videos can significantly enhance procedural accuracy and knowledge acquisition among medical trainees. These outcomes suggest that VBT not only supports cognitive understanding but also facilitates the transfer of learning to applied clinical tasks. Paglino and colleagues (19) similarly reported that video-based CPR training is effective for large, diverse learner populations, reinforcing the idea that standardized audiovisual demonstrations can help achieve widespread competency.

VBT training offers several features that may contribute to these outcomes. It allows learners to study at their own pace, pause or replay content, and review challenging concepts multiple times, which is particularly useful for mastering psychomotor skills like CPR (20). This aligns with multimedia learning theory, where integrated visual-auditory cues optimize cognitive load and retention (21). Unlike FFT's reliance on real-time feedback (16), the platform fostered engagement through an asynchronous "Question and Answer" feature. This approach mirrors key blended learning principles, effectively bridging the gap between virtual and traditional instruction.

In contrast to FFT's reliance on real-time feedback, VBT's repeatable demonstrations ensured guideline fidelity (AHA 2020), reducing protocol-adherence errors commonly seen in live trainings. Evidence also shows that VBT performs comparably to more immersive tools such as Virtual Reality (VR), yet avoids the hardware limitations that restrict VR use in low-resource settings—making VBT particularly suitable for paramedical programs facing mannequin shortages and geographic dispersion (22).

When comparing these findings with other studies, both parallel and non-parallel results support the value of VBT learning. Kuchaki and colleagues (16) found that both virtual and face-to-face CPR training improved knowledge and performance, highlighting the effectiveness of blended approaches. Tang and colleagues (23) reported that although VR and video self-instruction were effective, highly immersive VR did not outperform VBT, suggesting that simpler, widely accessible media like video can achieve comparable outcomes in clinical education. These findings collectively indicate that VBT is particularly suitable for CPR education, as it enables repeated practice, visual demonstration of precise techniques, and reinforcement of procedural protocols while maintaining flexibility and accessibility.

From a competency perspective, VBT supports both cognitive and psychomotor learning. Learners can visually analyze correct techniques, internalize procedural sequences, and mentally rehearse actions prior to hands-on practice, which enhances the efficiency of subsequent practical sessions. This study's results—specifically the gains in practical and case-based performance—highlight that VBT is not limited to theoretical instruction but can contribute meaningfully to the acquisition of clinically relevant decision-making and procedural skills. Such outcomes are particularly important in CPR training, where protocol adherence, rapid assessment, and technical precision determine patient survival (21, 24).

Although VBT performs well, FFT still provides key benefits, especially the real-time feedback from instructors and instant correction during practical sessions. Therefore, rather than viewing VBT and FFT as competing modalities, the current findings support a blended-learning approach that combines the scalability and consistency of VBT with the interactive, corrective strengths of FFT.

This study found no significant association between participants' age and their pre-test or post-test scores or GPA. These findings align with previous research indicating that age does not substantially influence performance in CPR training or smartphone-based learning. Overall, age appears to play a minimal role in acquiring CPR-related skills, with both younger and older learners benefiting similarly from technology-enhanced instruction. This suggests that CPR learning outcomes are shaped more by instructional design, practice opportunities, and feedback quality than by chronological age (24).

Limitations and Suggestions

This study had several limitations that should be considered when interpreting the results. First, the relatively small sample size may restrict the generalizability of the findings to the broader population of EMS students. A larger and more diverse sample would provide stronger evidence for the effectiveness of each training method. Second, the short follow-up period limited the ability to evaluate the long-term retention of CPR skills after the intervention. Future studies with extended follow-up and objective performance assessments are recommended to determine the sustainability of learning outcomes over time.

Conclusion

Considering the increasing expenses linked to cardiopulmonary failure and cardiac arrest—as well as the complexity of managing these conditions—there is a clear demand for up-to-date and precise training approaches. The results of the study strongly indicate that training plays a crucial role in improving participants' CPR abilities and overall performance. Notably, both VBT and traditional FFT have proven effective in elevating the proficiency and awareness of support staff. However, given the time constraints inherent in practical and FFT sessions, as well as logistical challenges such as the availability of mannequins, the adoption of VBT emerges as a prudent recommendation. This educational approach offers a viable solution and can be seamlessly integrated into the training curricula of emergency response teams, thereby maximizing efficiency and accessibility.

Abbreviations

CPR: Cardiopulmonary Resuscitation
DOPS: Direct Observation of Practical Skills
FFT: Face-to-Face Training
EMS: Emergency Medical Services
VBT: Video-Based Training
VR: Virtual Reality

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Authors' Contribution

AR was responsible for the conceptualization, study design, and data collection. ZN conducted data analysis and supervised the project. ZK contributed in statistical issues and improving the data collection. All authors reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors have reported no conflicts of interest related to this study. Nahid Zarifsanaiey, in her role as Editor-in-

Chief, did not take part in the peer review or decision-making for this manuscript. Similarly, Zahra Karimian, as an Editorial Board member, was not involved in any aspect of the manuscript's review. The peer review process was conducted by a non-author chairperson without their awareness.

Ethical Considerations

This study was conducted in full compliance with ethical standards and received approval from the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran (Approval Code: IR.SUMS.REC.1402.229). In alignment with ethical research practices, informed consent was obtained from all participants prior to their involvement in the study. Participants were fully informed about the nature of the research, the potential risks, and their right to withdraw at any time without consequence. Furthermore, all personal data collected during the study was kept confidential and anonymized to protect participant privacy.

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Availability of Data and Materials

All data generated or analyzed during the present study are available from the corresponding author upon reasonable request.

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