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Comparing learning outcomes in cardiopulmonary resuscitation (CPR) basic life support training using self-training video with learning feedback vs. traditional onsite training in a running population

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Abstract

Background: Sudden cardiac arrest (SCA) can occur during running events and immediate and effective cardiopulmonay resuscitation (CPR) significantly improves survival. Training race participants in basic life support (BLS) could potentially increase survival chances during these events. Online learning may improve access to BLS training by reducing instructor, travel and organizational costs. While online video training alone may not fully replicate in-person learning, this study explores a refined online training model with online platform feedback. The aim was to compare CPR performance, knowledge, and confidence scores in traditional onsite training vs. self-training video with learning feedback as an alternative method for teaching BLS.

Methods: Runners were invited into the study and voluntarily participated in either 1) traditional BLS training or 2) online self-training videos with learning feedback. CPR training dummies were sent to public parks and running groups for the VDO group to use. Both groups were assessed for CPR performance by certified BLS instructors, and self-assessments for knowledge and confidence scores in BLS were collected through a questionnaire before and after the training.

Result: Of the 738 included runners, 161 participants were in the VDO group, and 577 were in the onsite training group. BLS competency was achieved by 97.5% of the video group and 99.8% of the face-to-face groups (p value = 0.25). Knowledge and confidence scores increased statistically significantly in both groups. Although improvements were observed, the increase in knowledge scores in the VDO group was associated with an odds ratio of 0.5 (95% CI: 0.34, 0.74, p-value of 0.001), and the increase in confidence for assisting unconscious patients was with an odds ratio of 0.33 (95% CI: 0.22, 0.5, p-value of <0.001), compared with the F2F group.

Conclusion: Self-training videos with learning feedback achieved competent BLS skills in runners and improved knowledge and confidence in performing basic life support, but to a lesser extent than onsite training. Such a method could potentially be used to increase BLS training in runners.

Clinical trial number: not applicable.

Introduction

The escalating popularity of running events has been accompanied by a parallel rise in sudden cardiac arrest (SCA) incidence among participants. Each year, competitive races continue to attract more runners, and with this increase, the incidence of SCA has been reported at approximately 0.54–0.60 cases per 100,000 runners (1, 2). Research indicates hypertrophic cardiomyopathy and coronary artery disease as the most common causes of death in these cases (1, 2).

Prompt and effective bystander chest compression significantly improves survival rates from cardiac arrest (3–6), with early out-of-hospital cardiopulmonary resuscitation (CPR) linked to higher 30-day survival (5, 7). Consequently, equipping race participants with basic life support (BLS) skills and

exceptionally proficient chest compression techniques could enhance survival rates for out-of-hospital cardiac arrest.

The ongoing evolution of educational methodologies has led to a re-evaluation of traditional face-to-face instruction and assessment. Online learning offers advantages by overcoming geographical barriers, limited teaching spaces, and instructor shortages, while also reducing educational costs (8, 9). However, current literature suggests that online video-based learning systems cannot fully replicate traditional in-person training for BLS (8–10).

Despite this, researchers hypothesize that an online learning system integrating self-directed video lessons, video-recorded CPR performance submission, and subsequent expert feedback with opportunities for re-recording may serve as an effective alternative or complement to conventional face-to-face BLS training. This study aims to evaluate the efficacy of this novel online approach compared to traditional onsite learning. Therefore, the objective of this study was to compare CPR performance, knowledge, and confidence scores in traditional onsite training versus self-training video with learning feedback as an alternative method for teaching BLS.

Methods

Study designs and setting

This study employed an ambidirectional, questionnaire-based design using data from participants who voluntarily joined the “1669 CPR virtual run” and “1669CPR xPark Run” projects in Thailand between October 2023 to August 2024. Inclusion criteria were age of 18 years or older with no underlying health conditions, such as heart disease, asthma, or psychiatric disorders, no disabilities or impairments, that would hinder participation in basic CPR training. Participants who were unable to submit the required number of videos as specified by the researcher were excluded from the study.

Both initiatives were local projects in Thailand designed to strengthen knowledge, skills, confidence, and attitude toward CPR among individuals, particularly runners, who may be called upon to assist during cardiac arrest events in running events. The goal was to improve the chances of survival for those who collapse during the race by enhancing the CPR capabilities of the fellow participants.

Runners could participate in the BLS training under the ‘1669 CPR virtual run’ and ‘1669CPR xPark Run Thailand’ projects, by registering through the THAIRUN webpage (a virtual run platform) or the Park Run Thailand network and provided their consent, then entered their personal information required for registration for the running event on thairun.com or via the online form for the ‘1669CPR xPark Run Thailand’ project. Finally, participants could select between two types of BLS trainings which were traditional face-to-face training or self-training videos and online learning feedback.

The Traditional CPR training group received standard on-site BLS training at a certified training center and direct feedback by certifed instructor, using Thai Resuscitation Council checklists. The self-training

and feedback group used BLS self-learning video clips via online video system. The video content followed the standards of the American Heart Association (AHA) and the Thai Resuscitation Council. These videos have been reviewed and verified for accuracy by experts, including cardiologists and emergency medicine specialists. After watching 2 clips (i.e., BLS step and automated external defibrillator (AED) use) participants used a CPR mannequin and mini-AED training to practice. The mannequins and mini-AED used in the study were locally made and wereable to provide real-time sound feedback when appropriate compression depth was performed. These mannequins were distributed around Thailand to provincial sports centers, some public parks and around the Park Run Thailand network. The participants then submitted a video demonstrating basic CPR skills and AED use on the CPR mannequin for evaluation by the BLS instructors. The self-training videos were provided at https://www.youtube.com/watch?v=ZgEqVTzQJ-k (Steps for BLS) and https://youtu.be/mnRQfzxH9go?si=rtBuqEl042Gd8v9T (Steps for using an AED).

The survey instrument evaluated participants' knowledge, attitudes, and confidence. The knowledge component was translated from a validated Basic Life Support (BLS) assessment aligned with American Heart Association (AHA) guidelines (11), while the attitude and confidence scales were derived from prior research (12, 13). (supplementary file)

Variables and measurement

Participants who consented to join the study after reading the study information through the registration process entered their personal details, including general Information (i.e., age, gender, occupation, education level, height and weight), CPR Experience (i.e., CPR training and performing real CPR). Confidence levels toward assisting unconscious individuals in public places and knowledge of BLS were measured at the time of registration and after completing training, using a questionnaire, modified from Midani et al. 2019(14). The confidence level was measured in 4 dimensions, including, assessing unconscious patients, using AEDs, performing CPR, and assisting unconscious patients and the level was rated as score 1 to 5 which represented strongly disagree to strongly agree. Whereas, knowledge of BLS was assessed by 5 multiple-choice questions. Each question was worth 1 point, covering topics such as the sequence of CPR steps, the emergency contact number, the location of chest compressions, the assessment of an unconscious patient, the ratio of breaths to chest compressions, and the compression rate.

After training was completed, CPR performance was assessed by experienced certified BLS instructors, including doctors, nurses, and paramedics. For traditional CPR training group, the BLS instructor team assessed participants at the training center. The assessment included incident reporting, responsiveness assessment, and quality of chest compressions. Participants passed the skill test when they achieved a compression rate of 100–120 bpm and a depth at 5–6 cm in more than 95% of total chest compressions. In addition, participants received immediate feedback at the training center.

For self-training and feedback group, certified BLS instructors conducted the evaluation. Participants submitted a video file demonstrating their basic CPR skills and AED use for assessment, and subsequently the certified BLS instructors assessed the CPR performance, using the same check list as traditional CPR training group. After the first evaluation, the assessor provided scores and gave feedback to the participant on CC techniques, specifically addressing instances where they were performed incorrectly or resulted in a score below 95%. Participants had the opportunity to practice and record a second video demonstrating their basic CPR skills after receiving feedback from the assessor. The assessment was conducted again based on this second submission.

Before study initiation, all assessors reviewed training videos to understand the scoring system and test the scoring standards. There were videos provided to assess the accuracy and reliability of the evaluation process.

Sample size estimation

The sample size was estimated based on comparing two population means in a non-inferiority study. In 2020, Chien et al. demonstrated the mean CPR quality scores after onsite BLS training versus e-learning were 34.44 and 34.88, respectively(15, 16). The margin was set as 1.125, while ratio between onsite/online groups was 1. Type I and Type II error were 0.05 and 0.2, respectively. The estimated sample size was 318 participants/groups. Additional 10% dropout rate was added. Therefore, 350 participants/groups, i.e., total 700 participants, were required for the study.

Statistical Analysis

Categorical data was described as number and its percentage whereas continuous data was described as mean and standard deviation (SD). The Chi-square test was applied for comparing 2 categorical data. Unpaired t test was used to compare 2 continuous data. Crude odds ratio (OR) was estimated by univariate logistic regression to determine association of improvement of score and 2 leaning techniques. To deal with confounding variables, multivariate logistic analysis was applied by adjusting for age, gender, levels of education and CPR experiences. Statistical significance was achieved when P value less than < 0.05. All statistical analyses were performed using STATA statistical software version 17.0.

Results

Out of 750 participants who voluntarily joined the 1669 CPR Run and PARKRUN projects, 12 participants were excluded for not submitting a second video after feedback. A total of 738 participants were ultimately enrolled in the study. Of these, 161 participants were in the self-training video with learning feedback group, whereas 577 participants were in the traditional onsite training group.

Table 1
participants' baseline characteristics between the Self-training and feedback group and the traditional onsite training group

Characteristics	Self-training and feedback (n = 161)	Traditional CPR training (n = 577)	P value
Age (years), mean (SD)	52.17 (11.49)	45.1 (12.49)	< 0.001
Gender, n (%)			
Male	47 (29.2)	202 (35)	0.168
Female	114 (70.8)	375 (65)	
Height (cms), mean (SD)	159.7 (7.02)	164.76 (8.32)	< 0.001
Weight (kgs), mean (SD)	65.33 (6.5)	62.89 (12.73)	0.019
BMI (kg/m2), mean (SD)	25.78 (3.54)	23.05 (3.59)	< 0.001
Level of education, n (%)			
Middle school	15 (9.3)	135 (23.4)	< 0.001
High school	60 (37.3)	285 (49.4)	
University	86 (53.4)	157 (27.2)	
CPR experience, n (%)			
training and practical	6 (3.7)	76 (13.2)	< 0.001
training but no practical	85 (52.8)	194 (33.6)	
no training and no practical	70 (43.5)	307 (53.2)	

Characteristics of participants were described in Table 1. Participants in the online group had a higher average age (52.17 ± 11.49 years old) compared to those in the traditional CPR training group (45.1 ± 12.49 years old), with a p-value of < 0.001. Their average height was lower (159.7 ± 7.02 cm) compared to the Traditional CPR training group (164.76 ± 8.32 cm), also with a p-value of < 0.001. There was no significant difference in gender between the two groups. However, the online group had a higher level of education, with the following: middle school (15 participants, 9.3%), high school (60 participants, 37.3%), and university (86 participants, 53.4%), with a p-value of < 0.001.

Regarding CPR training experience, 76 participants (13.2%) in the Traditional CPR training group had both training and practical experience with CPR, significantly more than the online group, where only 6 participants (3.7%) had such experience (p < 0.001). Conversely, among those who had training but no practical experience, the online group had a higher proportion, with 85 participants (52.8%) compared to 194 participants (33.6%) in the onsite group, with a p-value of < 0.001.

Table 2

the improvement in knowledge and confidence scores after completing Self-training and feedback group versus traditional onsite training group.

Dimensions	Phases	Self-training and feedback		Traditional CPR training	
		(n = 161)		(n = 577)	
		Means (SD)	95% CI	Means (SD)	95% CI
Knowledge score	Before	3.00 (0.89)	(2.86, 3.13)	2.90 (1.31)	(2.79, 3.01)
	After	3.53 (0.83)	(3.39, 3.65)	3.88 (0.84)	(3.81, 3.95)
Confidence scores	Before	3.26 (0.91)	(3.11, 3.40)	2.41 (1.07)	(2.31, 2.49)
	After	4.20 (0.70)	(4.08, 4.30)	3.54 (1.11)	(3.45, 3.63)
Using AED	Before	3.20 (0.91)	(3.06, 3.34)	2.59 (1.03)	(2.50, 2.67)
	After	4.22 (0.69)	(4.11, 4.32)	3.57 (1.12)	(3.47, 3.65)
Performing CPR	Before	3.20 (0.97)	(3.05, 3.35)	2.56 (1.07)	(2.47, 2.65)
	After	4.17 (0.75)	(4.05, 4.28)	3.60 (1.12)	(3.51, 3.69)
Assisting unconscious patients	Before	3.81 (1.07)	(3.64, 3.97)	3.51 (1.12)	(3.42, 3.60)
	After	4.41 (0.63)	(4.31, 4.50)	3.47 (1.14)	(3.30, 3.62)

Test scores showed a statistically significant increase in both groups across all areas: knowledge, confidence in assessing unconscious patients, using AED, performing CPR, and assisting unconscious patients, see Table 2.

Table 3
shows the odds ratios for the increase in knowledge and confidence scores, comparing Self-training and feedback group to traditional onsite training.

Dimensions	Crude			Adjusted		
	OR	95% CI	P	OR	95% CI	P
Knowlegde score	0.44	(0.31, 0.62)	< 0.001	0.50	(0.34, 0.74)	0.001
Confidence scores						
Assessing unconscious patients	1.07	(0.75, 1.52)	0.733	0.81	(0.54, 1.21)	0.298
Using AED	1.57	(1.09, 2.25)	0.015	1.35	(0.90, 2.03)	0.160
Performing CPR	1.03	(0.72, 1.48)	0.880	0.90	(0.61, 1.35)	0.602
Assisting unconscious patients	0.36	(0.25, 0.51)	< 0.001	0.33	(0.22, 0.50)	< 0.001

Table 3 shows the ORs for the increase in knowledge and confidence scores after training, comparing between self-training and feedback group versus traditional onsite group. After adjustment the confounders, the increase in knowledge score had an odds ratio of 0.50 (95% CI: 0.34, 0.74) with a p-value of 0.001, and the increase in confidence for assisting unconscious patients had an odds ratio of 0.33 (95% CI: 0.22, 0.50), with a p-value of < 0.001, both indicating a significantly larger amount of improvement in the onsite training group. However, there was no statistically significant difference between the online and onsite training groups in confidence scores for assessing unconscious patients, using AEDs, and performing CPR.

Table 4
Result of BLS skills evaluation

Dimensions		Self-training and feedback	Traditional CPR training	P value
		(n = 161)	(n = 577)	
Adequate depth	No	4 (2.5)	1 (0.2)	0.009
	Yes	157 (97.5)	576 (99.8)	
Adequate rate	No	3 (1.9)	0	0.01
	Yes	158 (98.1)	577 (100)	
Overall competency	No	1 (0.6)	5 (0.9)	0.255
	questionable	18 (11.2)	34 (5.9)	
	Competent	15 (9.3)	67 (11.6)	
	Good	42 (26.1)	178 (30.9)	
	Very good	61 (37.9)	210 (36.5)	
	Outstanding	24 (14.9)	82 (14.2)	

Table 4 shows the number of participants who passed the BLS skills assessment. In the self-training video with learning feedback group, 4 participants (2.5%) in the online group did not meet adequate compression depth, compared to one participant in the onsite group (P = 0.009). There was 3 participants (1.9%) in the online group did not meet adequate compression rate, while all participants in the onsite group met this standard (P = 0.01). However, overall competency, as assessed across both groups, did not significantly differ between the online and onsite training groups.

Discussion

We conducted the first study which compared the effectiveness of implementing an online self-training project with learning feedback versus traditional onsite training in improving CPR-related knowledge, confidence, and performance among a large number of lay runners. The findings indicate that while both methods led to statistically significant improvements across all measured dimensions, traditional onsite training was more effective in enhancing knowledge acquisition and adherence to CPR technical standards.

Our result indicated that both educational strategies significantly enhanced participant's knowledge and skills. Notably, no statistically significant differences in confidence gain, specifically regarding assessing unconscious patients, using AEDs, or perfoming CPR, were observed between the two training modalities. This finding aligns with previous studies reporting that video-based and online training can

achieve outcomes comparable to traditional face to face methods in enhancing learner confidence and skill retention (9, 17, 18).

However, the traditional onsite group demonstrated significantly greater gains in knowledge scores, with adjusted OR revealing that the onsite group was twice as likely to achieve knowledge improvement, compared to the online group. This finding aligns with existing literature that supports the superiority of instructor-led, face to face training for psychomotor skills like CPR(18). Nevertheless, it is crucial to consider the imbalance baseline of the 2 training groups. The traditional onsite group had substantially greater proportion of prior CPR training and practical experience compared to the online group (13.2% versus 3.7%). This likely led to the superior post-training outcomes observed in the onsite group.

Interestingly, despite having a higher baseline level of education, the online group exhibited smaller gains in knowledge and achieving the targeted compresison depth and rate standards. This suggests that while online formats can convey theoretical content effectively, they may be at an disadvantage in certain aspects of learning compared to traditional onsite training. Online formats may require a higher level of learner discipline and attention to retain all the information, and they also lack the possibility of immediately being able to ask questions, and receiving feedback, on confusing parts of the content, as well as real-time physical adjustments for technical proficiency by an instructor, which would be available with onsite training. (17, 19, 20).

For clinical and policy implication, our findings demonstrated that digital BLS platforms effectively enhance the knowledge and skills of lay runners, driven by the flexibility, self-pacing, and enhanced comfort offered by video-based learning. By mitigating geographic and logistical barriers, digital platforms facilitated the rapid, wide spread expansion of CPR/AED education. Scaling these digital initiatives is particularly vital for community networks and mass participation athletic events, such as marathons, where immediate bystander intervention is critical to improving survival rate following sudden cardiac arrest. For research implication, while this study established a novel framework for implementing online BLS training within the running community, further technological and pedagogical innovations are required, including further developing and validating the online skill-feedback system, optimizing the digital learning content and platforms for initial and refreshment training, and conducting longitudinal studies to determine the long-term retention of BLS knowledge and skills.

Limitations

This study has some limitations. First, the non-randomized design potentially introduced selection bias, although the findings still demonstrated a non clinical-inferiority trend between the two modalities. Second, confidence outcomes were self-reported and subject to response bias, which was migtigated by incorperating objective performance assessments by certified BLS instructors. Third, long-term retention was not evaluated, as assessments were done immediately after the intervention. To address these gaps, further study should include randomized controlled designs to determine the efficacy of integraing

digital BLS training platform, combined initial and refresh training with online feedback system and alongside objective assessments of skill retention.

Conclusion

In summary, while both training methods led to meaningful improvements, traditional onsite training was superior in enhancing CPR knowledge and technical performance. Online training remains a viable and accessible method, particularly when paired with feedback and supplemental hands-on practice. A hybrid approach may offer the best balance of accessibility and effectiveness for large-scale CPR education.

Declarations

Ethical approval and consent to participate: This study received ethical approval from the Human Research Ethics Committee, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, granted on September 07, 2023 (IRB COA. MURA2023/632). The Institutional Review Boards in Mahidol University are in full compliance with the International Guidelines for Human Research Protection, including the Declaration of Helsinki, The Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP). All personal identification was removed and replaced with study IDs.

Consent to participate declaration: For the prospective phase of the study, each participant provided written informed consent, aligning with the ethical principles governing research involving human subjects.

Data availability: The data generated during this study are included in this published article.

Competing interest: The authors declare that they have no conflicts of interests.

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Author's contributions: Ch T is principal investigator, and Pa C is co-principal investigator. Ph P is corresponding author. Po A is essentially intellectual contributor (EIC) and co- corresponding author. Ch T, Ta K, Ra S, Po A, Ph C, Ph P and Pa C made a considerable contribution to the study, including the conception and design of the study, or acquisition of data, or analysis and interpretation of data, and drafting the article or revising it critically for important intellectual content. Ch T and Po A performed data analysis. Ch T, Ta K, Ra S, Po A, Ph C, Ph P and Pa C interpreted the results. All authors participated in drafting, revising, and critically reviewing the manuscript. All authors approved the final version of manuscript to be published.

Use of AI: For this study, the authors used Grammarly to refine and modify the language. The authors reviewed and edited the content as required and took full responsibility for the manuscript's content.

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