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Research on the Effectiveness of Teacher-Led Cardiopulmonary Resuscitation (CPR) Training for Middle School Students Using Standardized Videos under the Train-the-Trainer Model

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Abstract: *Objective:* To explore the effectiveness of teacher-led CPR training for middle school students using standardized videos under the Train-the-Trainer model and verify its non-inferiority. *Methods:* A total of 400 students from 10 second-grade classes at a middle school in Deyang City were selected from December 2024 to December 2025 and randomly assigned to an experimental group and a control group, with 200 students in each group. The experimental group was taught by teachers who had undergone standardized training using standardized videos, while the control group was taught by medical personnel using the same videos and courseware. The scores of emergency medical theory knowledge, the pass rate of CPR practical skills, and the ratings on the training attitude scale were compared between the two groups after training and three months after training. *Results:* After training, the theoretical knowledge scores and the pass rate of practical skills in the experimental group were compared with those in the control group ($P > 0.05$). The 95% confidence intervals of the scores between the two groups were entirely within the non-inferiority margin. During the three-month follow-up after training, the skill retention in the experimental group was comparable to that in the control group. Both groups of students had high ratings on the training attitude scale. *Conclusion:* Under the Train-the-Trainer model, the effectiveness of teacher-led CPR training for middle school students using standardized videos is not inferior to that of medical personnel-led training. This model can effectively alleviate the shortage of emergency training teachers in schools and is worthy of promotion and application.

Keywords: Train-the-trainer model; Standardized video; Middle school student; Cardiopulmonary resuscitation; Training effectiveness; Non-inferiority

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1. Introduction

Cardiac arrest is one of the leading causes of death among urban and rural residents in China, with approximately 544,000 out-of-hospital cardiac arrests occurring annually and a survival rate of only 1% to

5%. If bystanders perform cardiopulmonary resuscitation (CPR) promptly at the scene, the survival rate of patients can be increased by 2 to 3 times. However, less than 1% of the public in China has received CPR training, a proportion significantly lower than that in developed countries [1]. Adolescents, who constitute 28.4% of China's total population, possess strong learning abilities and are receptive to first aid skills, making them a key target group for first aid training [1]. Developed countries have incorporated CPR education into the mandatory curriculum for primary and secondary school students. In China, however, school-based first aid training is still in its infancy, facing challenges such as a shortage of qualified instructors and inconsistent training standards. The "Train the Trainer" (TTT) model, which involves medical professionals providing standardized training to in-school teachers who then deliver instruction to students, can alleviate instructor shortages [2]. Nevertheless, questions arise regarding whether non-medically trained professional teachers have mastered the appropriate first aid knowledge and whether their teaching processes are standardized. Standardized video-based instruction ensures consistency in teaching content and reduces constraints on instructors [3]. The TTT model, through a three-tier transmission from "medical professionals to teachers to students," effectively expands the reach of training. Teachers, as permanent school staff, have stable teaching audiences and ample instructional time, enabling the establishment of regular retraining mechanisms. This study integrates the TTT model with standardized video-based instruction, using medical professional-led instruction as a control to verify the non-inferiority of teacher-led instruction. The aim is to provide evidence-based support for constructing a replicable and scalable school-based first aid training model.

2. Materials and methods

2.1. General information

Four hundred students from ten classes in the eighth grade of a middle school in Deyang City were selected as the study subjects from December 2024 to December 2025. Using cluster randomization, the ten classes were divided into five experimental groups and five control groups, with one experimental and one control class compared at a time, totaling two classes. Details are shown in **Table 1**.

Inclusion criteria: (1) Students currently enrolled in the eighth grade of a middle school in Deyang City; (2) Aged 13 years or older with normal cognitive abilities; (3) Voluntary participation in the study with informed consent signed by legal guardians; (4) No physical disabilities affecting CPR performance.

Exclusion criteria: (1) Severe cardiopulmonary diseases or physical disabilities preventing the completion of simulated manikin operations; (2) Cognitive impairments or mental illnesses that hinder understanding of training content and cooperation with assessments; (3) Allergies to the materials of the simulated manikin.

Table 1. Comparison of baseline data between the two groups [n (%), mean ± SD]

Indicator	Experimental Group (n = 200)	Control Group (n = 200)	t/χ^2 value	*P* value
Age (years)	14.12 ± 0.45	14.08 ± 0.42	0.917	0.360
Gender: Male, n (%)	98 (49.00)	101 (50.50)	0.090	0.764
Gender: Female, n (%)	102 (51.00)	99 (49.50)	0.090	0.764
Previous first aid knowledge baseline score	52.34 ± 8.12	53.01 ± 7.98	0.832	0.406

2.2. Methods

The experimental group consisted of five instructors who had completed an 8-hour standardized Basic Life Support training certified by the American Heart Association and passed the assessment. These instructors delivered lectures using developed standard videos and courseware, playing the videos while simultaneously explaining key knowledge points and providing feedback and corrections during students' practical sessions. Medical personnel did not participate in direct teaching interactions but only supervised the process off-site.

The control group was taught by American Heart Association instructors with more than five years of experience in cardiopulmonary resuscitation (CPR) training. They used the same standard videos and courseware as the experimental group and followed the same training procedures and duration.

Both groups received training on the same content: the importance of out-of-hospital cardiac arrest first aid, the principles and procedures of CPR, and the indications and operation methods of automated external defibrillators (AEDs). The total training time was 2 hours, including theoretical instruction, operational demonstrations, and practical exercises. Students in each group were divided into eight subgroups, with each subgroup provided with one CPR training manikin and one AED training device to ensure that all participants conducted at least five simulated CPR + AED operations.

2.3. Observation indicators

(1) First aid theoretical knowledge score: A theoretical knowledge test was conducted immediately after the training, with a full score of 100 points.

(2) CPR practical skill pass rate: Practical assessments were conducted immediately after the training and three months post-training. The scoring sheet was developed based on American Heart Association standards, with a full score of 100 points, and a score of 80 or above considered passing [4].

(3) Training attitude scale score: A self-made "CPR/AED Training Attitude Scale" was used, covering four dimensions: learning interest, operational confidence, willingness to provide first aid, and teaching satisfaction, with a full score of 100 points [5].

(4) Non-inferiority judgment: Whether the 95% confidence interval of the difference in practical skill pass rates between groups after training was entirely within the preset non-inferiority margin.

2.4. Statistical analysis

SPSS 26.0 statistical software was used to process the study data. Continuous variables were expressed as mean + standard deviation (SD) and analyzed using *t*-tests; categorical variables were expressed as (*n*, %) frequencies and percentages and analyzed using c^2 tests. A *P*-value < 0.05 indicated a statistically significant difference.

3. Results

3.1. Comparison of theoretical knowledge scores after training between the two groups

After training, the experimental group scored 86.54 ± 6.23 points in first aid theoretical knowledge, while the control group scored 87.12 ± 5.98 points. The comparison between the two groups showed $P < 0.05$ ($t = 0.942$, $P = 0.347$).

3.2. Comparison of practical skill pass rates after training and three months post-training

Between the two groups, the practical skill pass rate in the experimental group was higher than that in the control group after training, as shown in **Table 2**.

Table 2. Comparison of practical skill pass rates between the two groups [*n* (%)]

Time Point	Experimental Group (n = 200)	Control Group (n = 200)	Difference (%)	95% Confidence Interval	Non-Inferiority Conclusion
After training	185 (92.50)	189 (94.50)	-2.00	-5.23 to 1.23	Non-inferior
3 months later	172 (86.00)	176 (88.00)	-2.00	-6.12 to 2.12	Non-inferior

3.3. Comparison of scores on the training attitude scale between the two groups

Both groups of students scored relatively high on the overall training attitude scale, as detailed in **Table 3**.

Table 3. Scores on the training attitude scale for the two groups (mean ± SD, points)

Dimension	Experimental Group (n = 200)	Control Group (n = 200)	*t* value	*P* value
Learning Interest	22.56 ± 1.23	22.78 ± 1.18	1.812	0.071
Confidence in Operation	21.98 ± 1.56	22.12 ± 1.48	0.913	0.362
Willingness for First Aid	23.45 ± 1.34	23.56 ± 1.29	0.827	0.409
Satisfaction with Teaching	23.24 ± 1.12	23.25 ± 1.18	0.089	0.465
Total Score	91.23 ± 5.12	92.08 ± 4.89	1.673	0.095

3.4. Feedback on teaching experience from teachers

All five teachers involved in delivering the lessons completed the teaching experience feedback questionnaire. All teachers believed that the standard videos significantly aided teaching by effectively reducing lesson preparation difficulty; 80% of teachers indicated that after training, they were fully capable of completing cardiopulmonary resuscitation (CPR) teaching tasks. The overall satisfaction rating of teachers with the training model was 94.20 ± 3.15 points.

4. Discussion

The golden window for resuscitation after cardiac arrest is four minutes, and over 500,000 people die annually in China. Pre-hospital CPR can effectively improve the success rate of resuscitation, but currently, the CPR training rate among the Chinese public is less than 1%, far behind the levels in developed countries. Students are one of the most suitable groups to receive CPR training, making CPR education in schools the most effective method for cultivating citizens' first aid capabilities [6]. However, a shortage of qualified instructors has become a critical factor hindering the promotion of first aid education in schools. The "train-the-trainer" model can expand the training effect through a three-tier transmission from "medical personnel-teachers-students," but non-professional teachers may have uncertainties regarding the depth of medical knowledge and the standardization of teaching. Standard video instruction can unify content, standardize processes, and reduce quality fluctuations caused by differences in instructors' backgrounds [7]. This study combined the train-the-trainer model with standard video instruction, using medical personnel teaching as a

reference to evaluate the non-inferiority of teachers' teaching effectiveness, providing empirical evidence for the scientific validity of this training model. The study showed that after training, there was no significant difference in the scores of emergency theory knowledge between the experimental group and the control group. Both groups used the same standard videos and courseware, ensuring high consistency in teaching content. Teachers in the experimental group participated in an 8-hour basic life support standardized training session before teaching and obtained certification, mastering the theoretical essence and key technical points of CPR, enabling them to correctly understand the teaching content in the videos and answer students' questions. During the teaching process, teachers used the courseware in conjunction with the videos, allowing students to learn alongside the videos, compensating for potential gaps in knowledge depth among teachers without a medical background.

The similar theoretical exam scores of students in both groups indicate that the dominant role of standard videos in knowledge transmission is sufficient to diminish differences in instructors' professional backgrounds. Regarding the pass rate of practical skills, after training, both the experimental and control groups had pass rates exceeding 90%, with the 95% confidence interval for the difference in pass rates between the two groups entirely within the predefined non-inferiority margin, proving that teachers' teaching effectiveness is not inferior to that of medical personnel. The learning of operational skills relies on correct demonstration of movements and timely error correction guidance. The standard actions for chest compressions (location, depth, frequency) and artificial respiration demonstrated by professionals in the standard videos are more standardized and reproducible than those demonstrated by any instructor on-site; teachers provide feedback and corrections to students during practice according to video standards, ensuring that each student receives the same quality of guidance [8].

Additionally, teachers are the teaching staff students interact with most frequently, possessing a stronger affinity and classroom management skills, enabling them to better motivate student participation and enthusiasm for practice. The follow-up pass rates for both groups three months after training decreased to varying degrees, but the decrease in the experimental group was the same as that in the control group, indicating that the skill retention rates of students trained by both methods are similar, and both require periodic reinforcement training to consolidate [9]. The training attitude scale results showed that both groups of students had high levels of interest in learning, confidence in performing operations, and willingness to provide first aid, with no significant differences between the two groups. In terms of teaching satisfaction, the control group was slightly higher than the experimental group, likely due to students' recognition of the authority of professional medical personnel.

However, the overall score difference was not significant, indicating that teachers can also enhance student motivation and willingness to provide first aid when teaching based on standard videos. The vividness, intuitiveness, and case-based approach of the standard videos attract students' attention and reduce the monotony of skill learning. Teachers reported that the videos significantly reduced their lesson preparation workload, standardized and made the teaching process reproducible, and increased their confidence in participating in first aid teaching. This study confirms the feasibility and effectiveness of combining the train-the-trainer model with standard videos in conducting school first aid training. Teachers who have completed short-term standardized training can independently conduct student first aid lessons. This model is no longer limited by the number of medical personnel serving as first aid instructors, providing a replicable template for broader implementation of school CPR teaching [10]. However, this study has some

limitations. It was conducted in only one school, lacking representativeness; it did not further analyze differences in teaching effectiveness among individual teachers; and the three-month follow-up period was insufficient to understand long-term skill retention rates. Further research is needed to address these issues.

5. Conclusion

In conclusion, under the train-the-trainer model, teachers conducting CPR training for middle school students based on standard videos achieve teaching effectiveness that is non-inferior to that of professional medical personnel. This model can effectively alleviate the shortage of first aid training instructors in schools, featuring standardization, replicability, and ease of promotion, making it a preferred option for school first aid education.

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Disclosure statement

The authors declare no conflict of interest.

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