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ORIGINAL ARTICLE

Evaluation of the efficiency of different methods of teaching cardiopulmonary resuscitation for children and adolescents: an integrative review

Evaluation of the efficiency of the different methods of teaching cardiopulmonary resuscitation to children and adolescents: integrative review

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KEYWORDS

Cardiopulmonary resuscitation
Heart arrest
Teaching

ABSTRACT

Objective: To evaluate the efficiency of different teaching methods of Basic Life Support for lay students from 12 years of age.
Methods: A search was carried out for articles on the MEDLINE/PubMed and Lilacs/BVS platforms between December 2021 and January 2022 to answer the guiding question, "How effective are the different teaching methods of cardiopulmonary resuscitation for children and adolescents?". Articles published in English and Portuguese in the last five years were included.
Results: Seven articles addressed teaching methods: self-regulated learning, training of teachers followed by students, peer education, online teaching associated with practical self-training, distance learning, digital training added to practice, and application use through a tablet with subsequent evaluation. In all studies, there was a comparison between intervention and conventional training. Generally, all teaching methods contributed to developing the ability to act in trauma situations, but strategies that involved the presence of instructors in training showed better short- and long-term results.
Conclusion: this study verified the findings in the literature regarding the effectiveness of different BLS teaching methods for children and adolescents. Among all approaches, better performance was observed in methods that had the presence of instructors, who offered feedback to students and reduced distractions. However, digital, self-regulated, and peer teaching also proved viable. Therefore, the choice of method should be based on the target audience's reality.

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PALAVRAS-CHAVE

Ensino
Parada cardíaca
Reanimação cardiopulmonar

RESUMO

Objetivo: Avaliar a eficiência dos diferentes métodos de ensino de Suporte Básico de Vida (SBV) para estudantes leigos a partir dos 12 anos de idade.
Métodos: Realizou-se busca por artigos nas plataformas MEDLINE/PubMed e Lilacs/BVS, entre dezembro de 2021 e janeiro de 2022, para responder à questão norteadora "Qual a efetividade dos diferentes métodos de ensino de ressuscitação cardiopulmonar para crianças e adolescentes?". Incluíram-se artigos publicados nos últimos cinco anos, nos idiomas inglês e português.
Resultados: Sete artigos abordaram os métodos de ensino: aprendizagem autorregulada, treinamento dos professores seguido dos estudantes, educação em pares; ensino *online* associado ao autotreinamento prático, ensino à distância, treinamento digital somado à prática, e uso de aplicativo por meio de um *tablet* com posterior avaliação. Em todos os estudos houve comparação da intervenção com o treinamento convencional. De forma geral, todos os métodos de ensino contribuíram para desenvolver a habilidade de agir em situações de trauma, mas as estratégias que envolviam a presença de instrutores nos treinamentos mostraram melhores resultados, a curto e longo prazo.
Conclusão: O presente estudo verificou os achados na literatura a respeito da eficácia de diferentes métodos de ensino de SBV para crianças e adolescentes. Dentre todas as abordagens observou-se melhor desempenho nos métodos que contaram com a presença de instrutores, os quais ofertaram *feedback* aos alunos e diminuíram as distrações. Porém, o ensino digital, o autorregulado e o aos pares também se mostraram viáveis. Logo, a escolha do método deve se pautar na realidade do público-alvo.

INTRODUCTION

Cardiovascular diseases, the main determinants of cardiopulmonary arrest (CPA), lead the causes of death in the world. In Brazil, it is estimated around 200,000 CPA per year, half of which occur outside the hospital environment[1]. The main rhythms that trigger CPA are ventricular fibrillation (VF) and pulseless ventricular tachycardia (PVT), which account for 80% of cases, both with good ability to reverse with defibrillation. It is known that for each minute that elapses from the onset of a sudden arrhythmic event without defibrillation, survival rates decrease by 7% to 10%. When performed promptly, within 3 to 5 min of the onset of CPA, defibrillation confers a survival rate of 50 to 70%[2-4].

Among out-of-hospital cardiopulmonary arrests (OHCPA), 86% occur in the victim's own homes. Furthermore, 50% of these are attended by children and adolescents without any adults around. Due to the prevalence of OHCPA, lay people, based on their previous knowledge or guided by emergency medical service attendants, play a crucial role in the early assistance to victims through Cardiopulmonary Resuscitation (CPR) and the use of an automatic external defibrillator (AED), which, when combined, show survival rates of 85%. However, despite recent advances, less than 40% of adults receive lay-initiated CPR, and less than 12% have an AED applied before emergency medical care (EMS) arrives[2-5]. Thus, the training of the lay public, especially initiated during the school period, rises as an effective proposal, given that it allows rapid application of CPR, corroborating with increased survival in OHCPA.

In 2015, the World Health Organization (WHO) supported the Kids Save Lives initiative, encouraging first-aid training for schoolchildren worldwide. This recommendation suggests teaching CPR to students over 12 years of age, aiming to create a generation that multiplies this knowledge, which would increase significantly in the long term the number of people who know how to help in a CPA[6-8]. Therefore, this study aims to select articles in the literature referring to the different methods of teaching basic life support (BLS) for children and adolescents in schools, to evaluate their efficiency in training this public. For this, an integrative literature review was developed.

METHODS

This is an integrative review that analyzed data in the literature regarding CPR teaching for children and adolescents. The guiding question was prepared according to the PICO strategy (Population, Intervention, Comparison, and Outcome), with the following structure considered: P - children and adolescents; I - CPR training in schools; C - untrained children; O - level of knowledge and ability to act in trauma situations[10]. Thus, the question was structured: What is the effectiveness of the different methods of teaching cardiopulmonary resuscitation for children and adolescents?

Search for evidence

The electronic search of the articles was carried out independently in the *Biblioteca Virtual da Saúde* (BVS) and Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed) databases, independently, by the three researchers, between Dec 2021 and Jan 2022.

The descriptors "cardiopulmonary resuscitation" and "teaching" were selected from the controlled list of vocabularies Medical Subject Headings (MeSH), in addition to the keyword "school". The terms were combined using the Boolean operator "AND". In the BVS/Lilacs database, the respective terms in Portuguese were used (*reanimação cardiopulmonar, ensino, escola*). Initially, the publication date and study design restrictions were not added.

Inclusion and exclusion criteria

Randomized clinical trials that compared different CPR teaching techniques aimed at children from 12 years of age, published in the last 5 years, were included. Articles that dealt with secondary themes and did not compare teaching techniques were excluded. The outcome knowledge and ability to act in trauma situations were defined as the primary outcome to demonstrate whether the teaching method was effective. Additionally, duplicate articles, or articles not in Portuguese or English were excluded.

Data extraction and analysis

Studies were selected and reviewed by three independent reviewers. Initially, the titles and abstracts were read to verify whether they were under the inclusion criteria. Then, the selected articles were read in full and organized in an electronic spreadsheet.

The data were organized into two tables. The first one comprised the authors' names, year of study publication, journal, and country of origin. The second consisted of author, teaching method, sample, and results.

RESULTS

Initially, 405 records were found in the VHL and 4,739 in PubMed. With the application of filters (articles published in the last five years, in English and Portuguese, and type of study), 38 articles were found in BVS and 184 in PubMed. From this, after reading the titles and, eventually, the abstracts, those that dealt with secondary themes to the proposal were excluded, leaving 19 articles from the BVS and 12 from PubMed. After removing the duplicates, 26 articles were obtained for eligibility assessment, with 7 articles excluded and 19 read in full. Finally, 12 articles that did not fit the proposed theme or did not compare different teaching approaches were excluded, resulting in 7 being included in the review. Figure 1 identifies the selection and exclusion flowchart of the analyzed studies.

The included articles are shown in Table 1, with author/year, journal, and country of origin. All studies evaluated were randomized controlled clinical trials, 2 conducted in Germany, 2 in Belgium, and one in Turkey, South Korea, and Switzerland, each.

As for the different strategies employed in teaching BLS to children and adolescents, 4 studies used a digital tool in training, and 3 used the conventional method. In addition, 2 initially trained the previously lay instructors and subsequently taught the children by them, while in the others, the training was directed directly at the children.

The BLS teaching methods consisted of self-regulated learning, teacher training and subsequent training for students, peer education, online *teaching* associated with practical self-training, distance learning (DL), training with an application or digital video added to the practice, and the use of an application through a tablet. The results found for each method used are shown in Table 2.

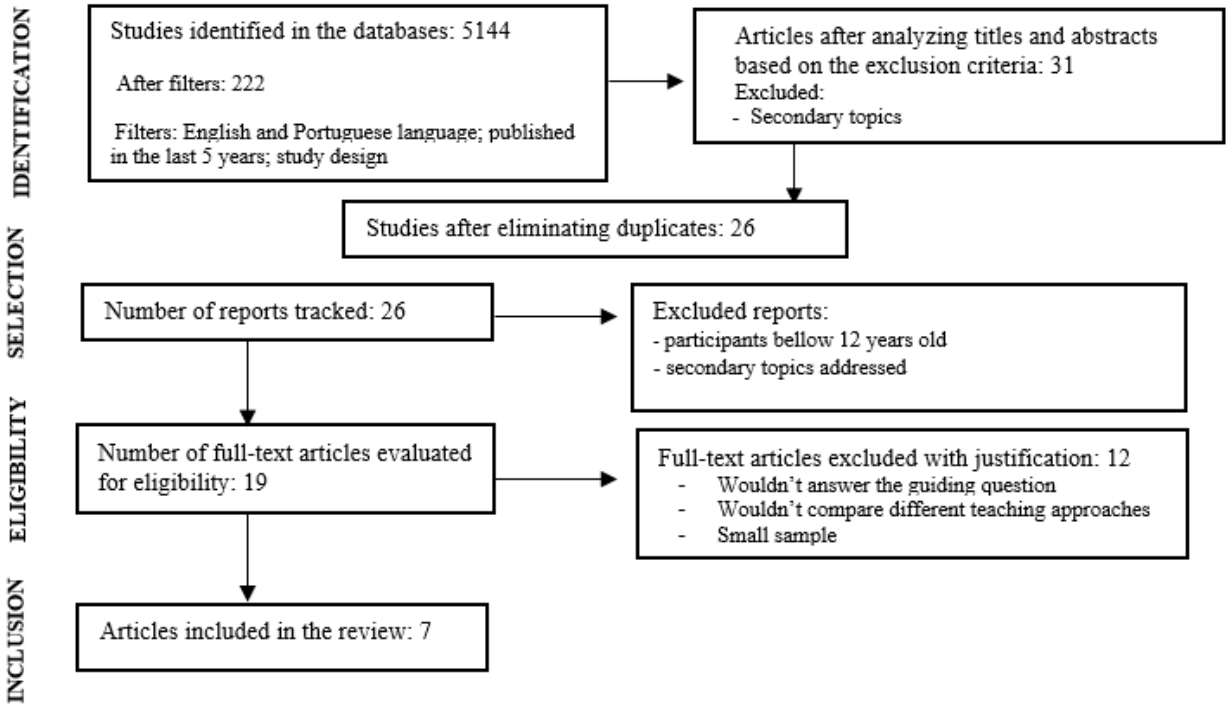

Figure 1 — Study selection flowchart.

Table 1 — General information on the studies included in the integrative review.

Author\ year	Journal	Country of origin
Süss-Havemann C. et al. (2020) [12]	BMC Public Health	Germany
Iserbyt P, Madou T (2021) [13]	Acta Cardiologica	Belgium
Kesici S et al. (2021) [14]	Prehospital and Disaster Medicine	Turkey
Napp A et al. (2020) [15]	Resuscitation	Germany
Han S et al. (2021) [16]	Plos One	South Korea
Nord A et al. (2017) [17]	BMJ Open	Switzerland
Doucet L et al. (2018) [18]	Acta Clinica Belgica	Belgium

Table 2 — Summary of samples and results found in each teaching method.

Author	Teaching method	Sample	Results
Süss-Havemann C. et al.[12]	self-regulated learning	600 seventh and eighth-grade students.	It was noted that the self-regulated learning method is effective, given that there was no statistical difference between the conventional and alternative method groups concerning support in case of cardiac arrest (p = 0.135). It was also possible to observe that male students had higher performance in the self-regulated method and greater retention of skills in the long term.
Iserbyt P, Madou T[13]	Training of teachers and subsequent training of students by teachers.	6 physical education teachers and 235 students from two schools	Better results were found in the group that received instruction using the specialized method (p = 0.032). Still, it was analyzed that there were better results of chest compressions and ventilation after the second class compared to the first.
Kesici S et al.[14]	peer education	156 14-year-old students.	A success rate of 90.2% was obtained in the control group and 93.4% in the intervention group, with no statistically significant difference between the groups, attesting to the method's effectiveness.
Napp A et al.[15]	Online teaching associated with practical self-training in the training of instructors	401 high school students between 12 and 14 years old, 407 high school students between 16 and 20 years old, and 74 instructors.	It was observed that online education, associated with practical self-training in BLS, is efficient in preparing trainers to work in schools since the average grades of students trained by instructors in the intervention group were only 0.14 (95% CI: 0.27 - 0.56) points below those of the students trained by the control group, with no statistical difference between the groups.
Han S et al.[16]	Distance Learning (DL)	62 high school students, median age 17.	It was attested that DL guided by instructors has similar efficiency to conventional education (CE). There was a statistically significant improvement only in the average depth of compressions (before 47 mm [IQR: 39 – 54 mm] vs. after 49 mm [IQR: 45 – 54 mm], p < 0.001), and the EAD group showed even more improvement in the depth of compressions than the EC group (p = 0.015).
Nord A et al.[17]	Training with an application or digital video disc associated with practice; Post training feedback; Reflective questions.	587 students aged 13 years.	It was observed that the group that performed a practical test followed by post-training feedback performed better when compared to conventional teaching (88% vs. 73%; p = 0.002). However, there was no statistically significant difference after 6 months between this intervention and the one that included reflective questions, a group that stood out only in terms of confidence in applying CPR in real situations.
Doucet L et al.[18]	Application on a tablet.	165 students from 15 to 17 years old.	No significant difference in overall effectiveness (p = 0.34) was observed between the traditional method and self-instruction using the StartnHart app. However, the group that received conventional training with an instructor performed better and showed a significant difference when compared to the control group in checking the airway (p = 0.018), asking for the AED (p < 0.01), and administering the shock (p = 0.002).

Self-regulated learning consisted of dividing students into a control group, which performed a practical stage with demonstration, deconstruction, compression, and execution of learning, and an intervention group, subdivided into small groups of 8 to 12 students, with medical students and middle school students conducting the teachings and the children assuming the role of instructor, executor, or BLS evaluator, evaluating the performance of the others through training cards. Regarding the primary outcomes, it was noted that there was no significant difference between the groups to act in CPA (mean difference to act in CPA: 0.11 points, 95% CI: − 0.26 to 0.04, p = 0.135), even though male students in the control group had better results[12].

In the strategy of training teachers and their subsequent training of students, professionals were divided into a common content knowledge group and a specialized knowledge group. The teachers were trained by a trained professional in BLS. The common knowledge group was trained in pairs and on mannequins so that one practiced and the other reviewed the performance, and, finally, performed a test until they presented 100% of use. Similarly, in the specialist knowledge group, teachers alternated the roles of performer, helper, and peer teacher on a dummy, thus creating a microteaching environment, being trained to learn BLS and correcting common errors related to compression and ventilation, and instructed to evaluate the performance of others according to the role for which he was responsible. One week later, the teachers taught BLS classes to two classes, and the data were analyzed. In the first class, no significant difference was found between the teachings of the common knowledge group and the specialized knowledge group (p = 0.56). As for the second class, the BLS performance was higher in the specialized knowledge group compared to the other group (p = 0.032)[13].

Peer education made use of the initial training of a group of students by specialists, and later these students became instructors of other students. To this end, two groups were formed. The first group received training in BLS from emergency physicians or intensivists and then took a practical exam to attest to their learning, followed by training to become instructors in BLS. Thus, these students trained eight students in the second group, who also became instructors. Pre- and post-training questionnaires were applied in addition to a practical exam. As a result, a success rate of 90.2% was observed in the first group and 93.4% in the second group, with no statistically significant difference between the groups. Regarding the pre- and post-training questionnaires, there was a statistically significant improvement (p < 0.05) in 7 of the 12 evaluated questions. The worst performance observed was regarding the correct time to call the emergency service. There was no improvement in any group (58.6% and 58% in groups A and B after training, respectively). Most students knew the correct number (98.7% and 100% in groups A and B, respectively) but were confused about the right time to make the call or forgot to make it. As for the questions about compressions, there was a significant improvement in the rhythm of chest compressions (p < 0.001 and p = 0.003 in groups A and B, respectively) and location of correct hand positioning (p = 0.004 and p = 0.006 in groups A and B, respectively). Even so, the level of success was not satisfactory in the post-training test (about 60% in both groups), which can be explained by the fact that only one training session was applied[14].

Online teaching associated with practical self-training for training instructors was based on their division into control and intervention groups. The first received face-to-face training from experienced CPR educators, with theoretical and practical teaching and simulation scenarios. The second trained through a website that addressed theoretical and practical knowledge, in addition to performing practical self-training guided by a checklist and relying on feedback from their pairs. Subsequently, these instructors offered training to the children and adolescents, and the observed pass rates were comparable between the intervention and control groups. Therefore, the group the instructor belonged to did not influence the student's chance of passing the test[15].

The CPR DL methodology allocated high school students into the EAD and conventional teaching (CT) groups. The CT group participated in a face-to-face class with theoretical and practical content guided by an instructor. In the DL group, the students were sent to a room containing two tablets, a dummy with a feedback device, and an AED. The first included a theoretical training guide, and the second allowed access to a videoconference with an instructor for the part of the practice. To assess learning before and after training, the instructor presented a CPA simulation in which the rhythm and depth of compressions, proportion of correct compressions, ratio of compressions with proper depth, and complete chest recoil between compressions were evaluated. A statistically significant improvement was observed only in the average depth of compressions (before 47 mm [IQR: 39 – 54 mm] vs. after 49 mm [IQR: 45 – 54 mm], p < 0.001), with the group DL showing even more improvement in the depth of compressions than the CT group (p = 0.015). Thus, it was attested that distance education guided by instructors is efficient for training in CPR and presented results similar to conventional teaching[16].

The method that used training with an application or digital video disc associated with practice, with two additional interventions (post-training feedback and reflective questions) divided the students into 3 groups: CPR training only (O), CPR training with practical skill tests including feedback (T), CPR training with reflection, and practical skill tests including feedback (TR). The first group received conventional training, carried out by trained teachers, based on a mobile application or a digital video disc, with a practical test carried out to verify responsiveness, breathing, and call for help, in addition to CPR, which should include at least 5 cycles, each consisting of 30 compressions and 2 ventilations. The second group received the same training and subsequent feedback on the points observed by the instructor. The third group received training, feedback, and an additional

intervention with reflection, which consisted of discussing 3 reflective questions in pairs for 15 min and then presenting the conclusions to the class, namely: "(1) Imagine yourself in a situation where you see a person suffering a cardiac arrest. Reflect on what factors influence if you intervened in a real situation? Remember that your actions can be the difference between life and death; (2) You are alone when a person suffers cardiac arrest. According to the guidelines, you must first call 911 and then start CPR; why this request? (3) Place your hands in the correct compression position on yourself. Reflect on the position of compression. Why should the palm of the hand be placed in the center of the victim's chest? Soon after the training was received and after 6 months, a questionnaire was applied about what was taught and the willingness to act in the case of OHCPA to assess confidence in using this knowledge in real situations. Yet another practical test was performed by all intervention groups. The group that received the practical skills test and feedback (T) performed better compared with the group that received only the conventional training (O) in terms of scores (T 56%, O 50%, $p < 0.001$). Furthermore, group T was more willing to help cases of CPA after training than group O (88% vs. 73%; $p = 0.002$)[17].

The approach that used an application on a *tablet* separated the students into a control group, which received conventional training, and an intervention group, which used the StartnHart application, which consists of self-instruction by video and an evaluation section, through a scenario of CPR section waiting for the AED to arrive. There was no significant difference between groups for checking responsiveness, calling emergency services, location and depth of compressions, and compressions/ventilations ratio. However, the group that received conventional training with an instructor performed better and showed a significant difference compared with the control group in checking the airway ($p = 0.018$), asking for the DL ($p > 0.01$), and administering the shock ($p = 0.002$)[18].

DISCUSSION

This review sought to analyze the efficiency of different CPR teaching methods for children and adolescents, comparing the various techniques used to demonstrate their effectiveness. It is worth noting that the Kids Save Lives initiative, supported by the WHO, encourages the introduction of up to two hours of teaching CPR per year for children, especially those over 12 years old, given that individuals younger than this age do not have, on average, the physical conditions to perform a good CPR, which often results in later discouragement[8]. Furthermore, the American Heart Association (AHA) believes that, by teaching, these subjects will also be able to teach their family members. With that, there will be an increase in the rates of survivors[20]. Another point to be considered is the evidence that CPR training is less likely to occur in adulthood, especially voluntarily. Therefore, by making teaching this topic mandatory in schools, there are greater chances of spreading this knowledge throughout the population, regardless of socioeconomic status and location[19].

Many students are interested in learning CPR techniques, even if this knowledge is not always offered. A survey carried out in China, with 1,093 students, states that about 72% of them desired to learn and share knowledge with others. After training, more than 90% showed good theoretical performance and CPR skills[21]. Similarly, a study in Germany with 424 students between 14 and 18 years of age confirmed that, after 90-minute classes on the subject, there was greater self-confidence and ability to perform resuscitation[22].

Regarding the different teaching methods for CPR, it is noted that there are several ways to teach this subject and present good results. The most evident and much-discussed model is the traditional method, in which an instructor gives an expository class to the public and then promotes practical training. However, a survey found that only 6 of 1,207 smartphone applications studied were effective since most were unrelated to teaching BLS to school-aged children[23]. In this sense, the search must be oriented. Furthermore, another training strategy involves applying video classes with subsequent practice on mannequins. On this subject, a study carried out in Costa Rica demonstrated, through a questionnaire before and after classes, a significant improvement after the intervention and greater comfort on the part of the children in performing CPR on someone who suffered cardiac arrest[24].

Concerning the use of digital technologies as an alternative for teaching CPR aimed at children and young people in schools, Doucet et al.[18] observed that the group taught about BLS through an application on a tablet showed greater distraction and lack of interest than the group that had a face-to-face instructor, also ensuring greater performance in airway control, ability to ask the DL, and shock administration by students of the conventional method. However, there was no statistical difference in the progress between the two groups. In this sense, Han et al.[16] ratified that, when dividing two groups, one with DL of CPR and the other with the conventional method, the DL presenting support equipment, such as two tablets (one with access to the video and the other to an instructor) and mannequins with feedback devices and AED, you can have a performance similar to the conventional method and even superior (as in improving the depth of compressions).

However, some studies have presented data on remote teaching aimed at teachers based on self-training. Napp et al.[15] sought to demonstrate whether online teaching with this method was effective in training instructors. The results showed that the intervention group, trained through a website about heart attack and BLS, did not obtain significantly different scores from the conventional group in the assessed items, making self-regulated practical training efficient to prepare trainers to transmit the knowledge in schools. Therefore, it is demonstrated that online tools can be effective, particularly when teachers have access to this method.

In addition, the self-regulated learning method is also generally shown to be a valuable alternative for teaching CPR. Suss-Havemann et al.[12], even not having found data that confirm the greater effectiveness of

self-regulated learning, guarantees that it is an effective method for laypeople, such as teachers. Furthermore, as highlighted, male students who use this method have, on average, a more excellent retention of skills in the long term than the others.

Similarly, studies that presented training in pairs were also efficient. Kesici et al.[14] confirm that this model can qualify more trainers since instructors who their peers trained were as efficient as those taught by specialists. Still, in this perspective, Iserbyt and Madou[13] discuss that training in pairs to encourage the evaluation of the errors of their companions is very useful, given that they make educators capable of identifying and correcting students' mistakes.

In addition, it is worth noting that some studies have presented data that guarantee an improvement if more than one class is given. Kesici et al. and Iserbyt and Madou[13-14] ensure that only one session does not have the same effect on increasing students' knowledge about CPR, with a significant improvement in applying more than one class on the subject.

Finally, it is emphasized that the studies included in this article demonstrate limitations in methodological quality since the instruments used to assess knowledge are not standardized, making it difficult to compare different teaching methods. Furthermore, in addition to the non-standardization of the methods of the articles included, this review is limited to spatial coverage since it includes only six countries, most of which are European. Therefore, further studies are needed to assess the effectiveness of teaching CPR to children in other parts of the world, particularly in Brazil.

CONCLUSION

The most efficient teaching methods for children and teenagers include instructors, who are responsible for providing feedback to students and correcting participants' distractions. Methods involving remote teaching and self-learning through apps or digital forms have also proven valid; however, they are associated with more significant inattention among participants, so further studies are needed to assess their applicability according to socioeconomic conditions. In addition, peer training proved to be valid for training new instructors without needing specialists, facilitating the dissemination of BLS knowledge.

Therefore, it was observed that, as well as the traditional method, new technologies are equally efficient in teaching CPR to children and adolescents. It is important to emphasize that most students indicated they would intervene in a CPA situation regardless of the intervention applied. The choice of methodology should be based, therefore, on the most appropriate reality for the target audience and on the number of resources available, emphasizing that through it, there will be the creation of a confident generation capable of helping a case of CPA anywhere in for it to occur.

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