

Teaching cardiopulmonary resuscitation to young people: what are the benefits and methodologies used?

O ensino de ressuscitação cardiopulmonar para jovens: quais os benefícios e as metodologias empregadas?

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ABSTRACT

Cardiovascular diseases are the main cause of mortality in the world, and cardiorespiratory arrest (CRP) represents about 320 thousand deaths per year in Brazil. It is estimated that half of the CRP occur outside the hospital, and among these cases, 80% are seen exclusively by laypeople. It is believed that the time between CRP and the onset of cardiopulmonary resuscitation (CPR) is the most critical factor, since every minute there is a reduction of up to 10% in the victim's chances of survival. From this, it appears that the training of laypeople to perform CPR is of utmost importance, especially the young population, who are able to perform the maneuvers and are a source of information dissemination. Some countries have already adopted the mandatory insertion of CPR training in the school curriculum. In Brazil, there are still no classes aimed at developing the skills of basic life support (BLS). In view of this, it is of utmost importance to analyze the interventions carried out in other countries to understand which teaching strategies are being used. Thus, the objective of the present study was to carry out a bibliographic review about the methodologies and results achieved in processes of training high school students on BLS. For this, a bibliographic review was carried out on the PubMed platform and 10 articles were included. Studies have shown that teaching CPR to high school students is effective, especially those who address more than one teaching methodology and make long-term interventions.

Keywords: Cardiopulmonary Resuscitation; Extra-Hospital Cardiac Arrest; Health Education; Adolescent.

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RESUMO

Doenças cardiovasculares constituem a principal causa de mortalidade no mundo, sendo que a parada cardiorrespiratória (PCR) representa cerca de 320 mil mortes por ano no Brasil. Estima-se que metade das PCRs ocorram em ambiente extra-hospitalar, sendo 80% presenciados exclusivamente por pessoas leigas. Sabe-se que o tempo entre a PCR e o início da ressuscitação cardiopulmonar (RCP) é um fator crítico, visto que a cada minuto há uma redução em até 10% das chances de sobrevivência da vítima. A partir disso, constata-se que é de suma importância a capacitação de leigos para realizarem RCP, especialmente, a população jovem, que além de estar apta a realizar as manobras, representa uma importante fonte de disseminação de informação. Alguns países já adotam como obrigatório o treinamento de RCP no currículo escolar. No Brasil, contudo, ainda não existem aulas voltadas para o desenvolvimento das habilidades do suporte básico de vida (SBV). Diante disso, faz-se necessária a análise das intervenções realizadas em outros países para entender quais estratégias de ensino vêm sendo utilizadas. Dessa forma, o objetivo do presente estudo foi realizar uma revisão bibliográfica acerca das metodologias e resultados alcançados em processos de capacitação de alunos do ensino médio sobre SBV. Para isso, realizou-se uma revisão narrativa, na base de dados PubMed, resultando ao total 10 artigos, de acordo com os critérios empregados. Tais estudos demonstram que o ensino da RCP para alunos do ensino médio parece apresentar boa resposta, especialmente quando as intervenções são de longo prazo e abordam mais de uma metodologia de ensino.

Palavras-chave: Reanimação Cardiopulmonar; Parada Cardíaca Extra-Hospitalar; Educação em Saúde; Adolescente.

INTRODUCTION

Cardiovascular diseases represent the leading cause of death in the world, with 17.9 million people affected annually¹. In Brazil, it is estimated that about 320,000 deaths per year are due to cardiorespiratory arrest (CRP), half in hospital environments, and the other half in non-hospital locations, such as residences, shopping malls, airports, stadiums, and other locations^{2,3}. It is estimated that in 80% of the cases, extra-hospital CRP is witnessed only by laypeople, and in only 15%, there is someone who recognizes cardiopulmonary resuscitation (CPR) techniques. Morais et al. (2014)⁴ also points out that, without prior training, only the guidance of first responders through telephone does not seem to be able to assist in the execution of the techniques. Furthermore, it is worth mentioning that 86% of extra-hospital cases occur in the victim's own home, and in 50% cases are assisted only by adolescents or children, without an adult nearby⁵.

It is assumed that the most critical factor for the patient with CRP is the time between the beginning of the stop to the beginning of CPR, and every minute the victim's chances of survival are decreased by up to 10%^{4,6}. From this perspective, considering the time of arrival of the emergency service, which, for example, in Belo Horizonte, capital of Minas Gerais, can go from 1 to 45 minutes (average of 10.3

minutes), it is important to train people to act in the face of this interfacing^{4,6}. Furthermore, studies show that those who had CRP witnessed by someone trained in basic life support (BLS) were up to three times more likely to survive^{4,7}.

In the United States of America (USA), PCR is responsible for more than 395,000 extra-hospital cases per year, being considered the third leading cause of death in the country^{8,9}. In most communities, CPR before the arrival of the emergency service is considered low, reaching, on average, 15% to 30% of cases^{10,11}. Scientific evidence suggests that, in a context of extra-hospital CRP, it is of paramount importance that CPR be applied by laypeople, enabling an increase in the victim's chances of survival. Furthermore, studies indicate that the chances of lay individuals performing this techniques in the face of a CRP are higher when they undergo some training^{12,13}. The guidelines of the American Heart Association (AHA) emphasize the need for BLS training for the general public and its inclusion as mandatory in the school curriculum⁷.

Based on this, it is extremely important to teach CPR to laypeople, especially among young people, since they act significantly as multipliers of information for the population, besides being inserted in a school environment, whose place represents a facilitator in the learning process^{4,12,13}. Thus, the aim of this study was to conduct a bibliographic review

about the methodologies and results achieved in training processes of high school students (MS) on BLS.

METHODS

The study is a narrative review of the literature, carried out in the PubMed database. The descriptors used for the research were: “cardiopulmonary resuscitation” OR “resuscitation training” OR “basic life support” AND “teaching” AND “high school”. The searches were carried out in January 2021. Included in this study were: articles published from 2016 in English, Portuguese or Spanish; experimental or near-experimental works and articles containing the above-mentioned words or terms in the title. Those published prior to 2016, review articles, those that did not contain in the title the words “teaching” or “training” AND “cardiopulmonary resuscitation” or “resuscitation training” AND “high school students” or “school(s)” and those whose main objective did not refer to evaluating the training of students. Moreover, to cover the existing literature, an active search was performed in the bibliographic references of the articles originally included.

RESULTS

The literature studied resulted primarily in 108 studies, and 64 articles were excluded because they were published before 2016. From the analysis of the title of 44 articles, 38 articles were excluded because they did not contain in the title the words “teaching” or “training” AND “cardiopulmonary resuscitation” or “resuscitation training” AND “high school students” or “school(s)”. After reading the abstract of the six remaining studies, three were excluded, one for being a review article, one whose objective was to analyze the effectiveness of the teacher’s teaching and one in which the school’s conditions were evaluated to receive the training. Thus, three articles were read in full and composed this study. Through the active search performed in the references of these three articles, 7 studies were included, totaling 10 articles. Figure 1 shows the strategy used in the selection of the articles included in the review.

Among the 10 articles included in this review, one was published in 2020, one in 2019, two in 2016, one in 2015, three in 2014, one in 2012 and one in 2008. The studies analyzed took place in Spain (n=4), Germany (n=1), Brazil (n=1), South Korea (n=1), Denmark (n=1), USA (n=1), and Japan (n=1). The total number of subjects approached in the studies ranged from 87 to 6,352 participants. Table 1 summarizes the main aspects of each study included in this review.

DISCUSSION

In most of the states of the USA, it is mandatory to include the SBV in the school curriculum⁶. Some European countries corroborate the same reasoning by implementing, in the academic grid of MS students, the training of CPR and the use of the automatic external defibrillator (AED)^{15,16}. In Europe, compulsory CPR training was initiated by Denmark and currently covers more countries such as Spain and the United Kingdom¹⁷. However, the publications show a divergence between the teaching of techniques on this continent, given that in Germany, 80% of the population is trained in CPR, while in the United Kingdom this figure

represents only 5%¹⁷. Thus, it is observed that there is a vast diversity of training and its results between different countries and within their own territories¹⁷.

Several studies have elucidated that the CPR training employed in schools is economical and reduces the risks of improper technique performed and the incorrect use of the¹⁸⁻²⁰. The “Kids Save Lives” document reports the mandatory training in school age BLS in five European countries, and the expert’s view of creating legislation on this content is vital for its implementation. This work demonstrates the benefits of teaching the SBV both for society and for the social, motivational, inclusive and emotional formation of students^{13,21}.

It is believed that older students are better able to receive training, and that they perform better in BLS than those of fundamental school ages^{14,22}. In particular, compression techniques are better performed by MS adolescents when compared to younger students, since the depth of chest compression is related to the age and weight of the young person^{15,22}. According to the mannequin test, the 70% value in CPR quality is generally considered the cutoff point for an acceptable score, and several studies have judged that quality in children is suboptimal, also emphasizing the influence of strength and anthropometric characteristics in these results²³. It is worth mentioning that MS adolescents seem to be able to perform compressions in the same efficacy as adults^{15,22}. From this perspective, these students become a more effective audience for the teaching of BLS, since studies indicate that the knowledge acquired in this age group can last even after six months, in addition to the fact that the long-term benefit is a generation of trained adults in the future¹⁶.

Likewise, these students provide key information for their network of family and friends, such as the need to call an emergency service¹⁴.

In addition to the physical aspects, MS students are also the best target audience of school age, from the psychic-emotional point of view. This age group has adequate maturity, intellect and dexterity to develop the skills necessary for BLS²². Studies show that, after training, students feel with a greater degree of confidence to deal with the situation, regardless of the performance of the CPR maneuver¹⁵. From this perspective, training also serves as guidance for students to interpret an emergency situation and at least ask for specialized help in a timely manner¹⁵.

Thus, when analyzing the statistical data and the public that witnesses CRP episodes, one perceives the need to teach and train this population. In short, MS students make up a good target group since: (1) their training will eventually lead to an entire generation of trained adults, being a long-term benefit¹⁶; (2) the knowledge and skills of the students are well maintained to prolong the duration of teaching¹⁶; (3) young adults should be able to perform the basic procedures until the arrival of specialized help, since most CRP occur in private homes¹⁴. Therefore, young people trained to act in these situations can probably increase the victim’s life chances and survival.

Accordingly, with effective training, young people will be able to perform CPR, a fact evidenced in Norway, where training was conducted in selected schools that resulted in a number of 50,000 young people between 16 and 19 years old, culminating in a 60 to 73% increase in CPR²⁴. Thus, with the trained population, there is a decrease in the time for

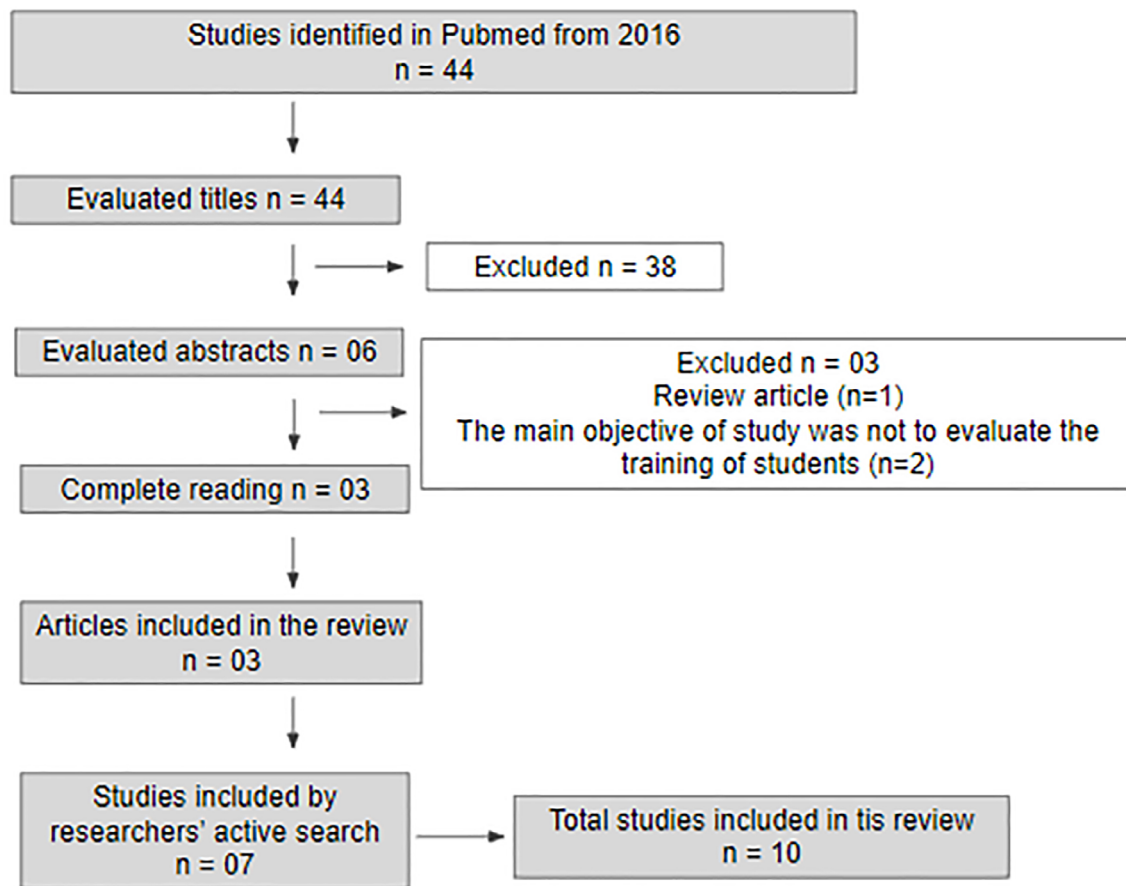


Figure 1. Strategy for selecting articles.

the application of the first shock by the defibrillator, which, in addition to the correct performance of the techniques, the survival of patients on CRP can be increased³.

BASIC LIFE SUPPORT TEACHING METHODOLOGIES IN SCHOOLS

There are several methodologies training methodologies for young people in schools, being more frequent the traditional theoretical-practical or only theoretical training, mainly due to the ease of implementation and the use of few resources¹². Several studies have shown positive results in this type of training, such as in studies conducted in Spain, “Anxos” in Galicia and “PROCES” in Catalonia^{25,26}. The study by Ballesteros et al. (2020)²⁷ compared the effectiveness of theoretical-practical training in relation to only theoretical training in schools in Spain, and demonstrated that, although both methodologies increased students’ knowledge about CPR, the theoretical-practical intervention achieved a greater increase in the score of the questionnaire applied for evaluation. Also, it is worth mentioning that, after two months of training, both groups presented an equivalent fall in the score of the questionnaires.

Most trainings address the following skills: recognition of CRP, seeking for help or local emergency, positioning of hands for cardiac massage, placement of the AED electrode, and effectiveness of ventilation and compressions²¹. In the study by Otero-Agra et al. (2019)²⁸, “Little Anne” manikins connected to the “QCPR Instructor App” smartphone application were used to verify the effectiveness of the

compression techniques, showing the quality of CPR, as a percentage; compression time, in percentage; total number of compressions; correct depth, in percentage; correct rate, in percentage; and mean rate, compressions per minute. Thus, a value of 70% for the quality variable of \geq CPR was considered as a quality standard for effective compressions²⁸.

The duration of CPR teaching methodologies varies, and interventions with an extension of 50 minutes to one hour are more frequent^{21,28}. It is worth mentioning that those studies that had a practical-theoretical methodology provided a longer time to training practical skills to the detriment of theoretical content²⁸.

Vetter et al. (2016)²¹ proved that students who received theoretical and practical training and then exposed themselves to the Olympics on CPR had a retention of the necessary psychomotor skills, when compared to students who received the same training, but without participation in the Olympics, whose skills were considered good²¹. It is known that competitive games have good results in the retention of psychomotor skills, since students like alternative teaching methods²⁹.

The randomized study of Otero-Agra et al. (2019)²⁸ compared four methods of teaching CPR in schools: (1) gamification method - mandatory curriculum, which scored in the field of physical education, and had visual feedback and contained team Olympics at the end; (2) training with evaluation - mandatory curricular activity, which scored in the field of physical education, and had visual feedback; (3) complementary training with visual

Table 1. Characteristics of the included studies in this review.

Article (Authors and years)	Country	Population (n)	Age group/Average age (\approx)	Intervention	Findings
Choi et al. (2015) ⁷	South Korea	187 students	15 to 16 years	The students were divided into a control group (they received intervention by school nurses) and the PAL group (they received intervention by students trained in BLS). A pre-intervention questionnaire was applied, followed by a theoretical-practical class and a questionnaire after 3 months of the intervention.	The control and PAL groups were not significantly different in their willingness to perform CPR or in their retention of knowledge of how to perform the SBV.
Vetter et al. (2016) ²¹	United States	412 students	\approx 15.9 years	In each institution, there was a control class and a study class. Both completed pre- and post-CPR tests and the use of ASD to assess cognitive knowledge and psychomotor skills.	There was retention of psychomotor skills scores in the study class (88%) versus the control class (79%) ($p < 0.001$).
Hori et al. (2016) ²²	Japan	6.352 students	10 to 16 years	Participants divided into three groups by age group: (1) 10 to 11 years ($n=392$); (2) 12 to 13 years ($n=1,798$); (3) 15 to 16 years ($n=4,162$). All were submitted to a single CPR training intervention lasting three hours. The course was evaluated by a questionnaire completed by the participants.	Students between 10 and 11 years of age answered all questions more positively. These students enjoyed CPR training more and were more confident in their ability to perform CPR than students in other age groups.
Ballesteros et al. (2020) ²⁷	Spain	326 students	\approx 15.6 years	The students were divided into 2 groups; one took the theoretical-practical course on CPR and the other only a theoretical course of CPR. Three knowledge questionnaires were conducted on CPR: the 1st, prior to the course; the 2nd, after the course; and the 3rd, two months after the completion of the course.	The mean score of the 1 st questionnaire was 5.1 points; In the 2 nd questionnaire, in the theoretical-practical group 8.2 points compared to the theoretical group with 7.7 points; and in the 3 rd questionnaire, there was a fall of 1 point in both groups.
Otero-Agra et al. (2019) ²⁸	Spain	489 students	12 to 16 years	The students were divided into 4 groups: gamification method, training with visual feedback, training with evaluation and traditional training. All received theoretical and practical training, but with different teaching methodologies. The practical test was applied one week after training.	The gamification method group presented better or equivalent results to the other groups. The gamification method had a significantly higher proportion of correct compressions (93.4%) compared to traditional training (71.9%). There was no difference between gamification method groups and training with visual feedback.
Aaberg et al. (2014) ¹⁴	Denmark	651 students	\approx 17.5 years	A 45-minute theoretical-practical training session. Students completed an initial questionnaire before the training session and another after a week.	The response rate in the follow-up questionnaire was 61%. There was an improvement in the correct answers in the multiple-choice test in relation to the pre-test ($p < 0.001$). The proportion of students who feel well prepared to perform BLS increased from 30% to 90% ($p < 0.001$).

Meissner et al. (2012) ¹⁵	Germany	132 students	≅14.6 years	There was a two-hour training that provided theoretical grounding on sudden cardiac death and a practical CPR tutorial. Participants completed a self-assessment of their pre- and post-training confidence. Four months later, the participants' knowledge retention rate was evaluated.	Before training, 29.5% of the students performed chest compressions correctly compared to 99.2% after training. In the follow-up, 99% of the students still performed the correct chest compressions. The overall improvement, assessed by the BLS performance score, was also statistically significant (median of 4 and 10 before and after training, respectively, $p<0.05$). After training, 99.2% stated that they felt confident to perform CPR, compared with 26.9% ($p<0.05$) before training.
Fernandes et al. (2014) ¹⁶	Brazil	87 students	Private school students ≅16.8 years Public school students ≅16.5 years	Theoretical and practical training was conducted on CPR and use of AED. A knowledge questionnaire was applied before the course, immediately after and six months after.	There was generally a significant increase in knowledge after training, with satisfactory late retention of learning among students. After training, correct answers were increased above 100% in relation to baseline knowledge ($p<0.001$). After six months, there was still a statistically significant increase in relation to baseline knowledge.
Abelairas-Gómez et al. (2014) ²³	Spain	721 students	10 to 15 years	Groups were conducted with 5 participants. Each group received theoretical classes lasting one hour, taught by an instructor and practical class with compression training for two consecutive minutes.	All participants were able to perform quality CPR. Younger children performed CPR outside the recommended range. Older children underwent CPR at the upper limit of the recommended interval. When the results of the first minute of compressions were compared with those of the second minute, it was observed that the performance decreased significantly over time.
Miró et al. (2008) ²⁶	Spain	1.501 students	14 to 16 years	<i>PROCES</i> was conducted in public and private schools. The training has 6 sessions of 45 minutes each, three dedicated to theoretical classes and three dedicated to practical classes. In addition, there is a seventh session dedicated to the review. A test was applied before and after the program was administered, in addition to a third test one year later.	58.1% of the participants obtained satisfactory learning immediately after the completion of the <i>PROCES</i> and 41.6% still maintained one year after the end of the program.

Caption: Table prepared by the author. *PROCES*: Cardiopulmonary Resuscitation Program Oriented to High School Centers; PAL: Peer-assisted learning; BLS: Basic life support; CPR: Cardiopulmonary resuscitation; AED: Automatic external defibrillator.

feedback - non-mandatory activity, without interference in school subjects and with visual feedback; (4) traditional training - non-mandatory activity, without interference in school subjects and without visual feedback²⁸. In this study, mandatory methodologies presented better results than non-mandatory ones. Furthermore, the three methodologies that used visual feedback showed better results, to the detriment of the traditional way²⁸. The gamification methodology, with Olympics at the end, presented the best results, with a

higher quality of CPR, and should therefore be considered as a method of teaching CPR for young people²⁸.

Studies indicate better quality results when visual feedback is added to the training, along with the teacher's instructions³⁰. Due to this evidence, it is interesting to use this strategy as a complementary method in CPR training whenever possible¹².

Therefore, considering the different teaching methodologies on CPR, one should take into account the target audience and the availability of the space of schools to perform the

training, being applied, whenever possible, practical training, and can also use strategies for knowledge retention, such as the Olympics and the use of visual feedback^{12,13,28}.

AUTHOR'S CONTRIBUTION

Júlia Coutinho Cordeiro: data collection, database development, manuscript writing.

Marcela Oliveira de Deus: data collection, database development, manuscript writing.

Sandy Sousa Pinheiro: data collection, database development, manuscript writing.

Lidiane Aparecida Pereira de Sousa: guidance, data analysis, writing and final review of the manuscript.

Maria Cecília Souto Lúcio de Oliveira: guidance, data analysis, writing and final review of the manuscript.

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CONCLUSION

In view of the present literary review, it can be inferred that the training for MS students can lead to a better performance of CPR techniques, in the face of CRP situations. It is also observed that theoretical-practical and applied classes as a team can be better for learning and for the retention of information about CPR. However, it is important to highlight that there are still few studies evaluating the retention of information in the long-term, but there are indications of the need to apply CPR training more frequently during the long-term school grid. This need is justified in order to improve student performance and provide better aggregation and retention of knowledge, as well as better security when performing CPR. It is believed that, thus, there may be positive impacts on the survival rate for victims in critical situations, if the population knows how to perform first aid before the arrival of the specialized service. It is also noted that the Brazilian current legislation does not ensure training in schools, making projects like these, demonstrated in this literary review, establish themselves as a *sine qua non* condition for the training of our population in the face of PCR.

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