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Impact and effectiveness assessment of children training in basic life support: a systematic review

Avaliação do impacto e efetividade do treinamento de crianças em suporte básico de vida: uma revisão sistemática

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ABSTRACT: Early and effective cardiopulmonary resuscitation (CPR) performed by spectators is an important predictor of survival in victims of cardiac arrest outside hospitals. In this sense, WHO has recommended CPR training in schools since 12 years. This study aims to evaluate the effectiveness of training of children in basic life support. For this, a systematic literature review was performed in the MedLine indexing base, with a search phrase constructed with the words "Cardiopulmonary Resuscitation", "Education" and "Child" and their variations obtained from MeSH. Inclusion criteria were studies published for up to five years with CPR training approach for children in school environment. Review studies with no description of training methods and incomplete results were excluded. 13 suitable for the methods of this study were selected. In all there was a theoretical and practical training followed by the application of an evaluative questionnaire. The results demonstrate the ineffectiveness of compressions of younger children attributed to low weight, height and BMI, and a greater interest of younger children in relation to older children and adults. CPR training for children before the age of 12 is effective. Despite ineffective CPR, the knowledge gained promotes the solidification of techniques in the future.

Keywords: Cardiopulmonary resuscitation; Training; Emergencies; Child.

RESUMO: A reanimação cardiopulmonar (RCP) precoce e eficaz realizada por espectadores é um preditor importante da sobrevida em vítimas de parada cardiorrespiratória fora de hospitais. Nesse sentido, a OMS preconiza o treinamento em RCP em escolas desde 12 anos. Este estudo objetiva avaliar a efetividade do treinamento de crianças em suporte básico de vida. Para isso, foi realizada uma revisão sistemática da literatura na base indexadora MedLine, com frase de pesquisa construída com as palavras "Cardiopulmonary Resuscitation" "Education" e "Child" e suas variações obtidas no MeSH. Foram critérios de inclusão estudos publicados em até cinco anos com abordagem do treinamento de RCP para crianças em ambiente escolar. Foram excluídos estudos de revisão sem descrição dos métodos de treinamento e com resultados incompletos. Foram selecionados 13 adequados aos métodos deste estudo. Em todos houve um treinamento teórico e prático seguidos da aplicação de um questionário avaliativo. Os resultados demonstram a inefetividade das compressões de crianças menores atribuída ao baixo peso, altura e IMC, e um maior interesse de crianças menores em relação às maiores e adultos. Treinamentos de RCP para crianças antes mesmo dos 12 anos são efetivos. Apesar da RCP ineficaz, o conhecimento adquirido propicia a solidificação das técnicas no futuro.

Descritores: Reanimação cardiopulmonar; Capacitação; Emergências; Criança.

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INTRODUCTION

Cardiopulmonary arrest is an important public health problem, being one of the leading causes of death worldwide[1]. Even with significant scientific advances in the treatment of victims of this event, early and effective cardiopulmonary resuscitation (CPR) performed by bystanders, lay or otherwise, present in the cardiopulmonary arrest scene, proves to be the most important predictor in long run survival and quality of life in patients affected by this event outside the hospital environment[1-2].

Despite the realization of the importance and effectiveness of spectator-initiated CPR and many efforts to spread the technique teaching, it is estimated that about one-third to one-half of the patients with cardiopulmonary arrest outside the hospital are not yet approached with CPR by the viewers[3]. The CPR rates held by the viewers vary widely between different locations and countries around the world, ranging from 0 to 100%. In European and North American countries rates are < 20%[4].

Faced with the significant need to train the population and make them able to offer effective CPR when the spectators are present on the scene, the recommendation that CPR trainings be conducted for children in the school environment is increasingly strong. The school environment choice for these trainings is based on the fact that the students are in a phase of great motivation, in which they learn faster and retain skills more easily.[1] In addition, the positive reaction of children to the acquisition of new knowledge may promote the spread of this training to their families and friends.[5]

In this sense, in 2015, the World Health Organization (WHO) issued the recommendation "Kids Save Lives", which recommends CPR training with 2 hours of annual workload for children in school environment, from the 12 years old[6]. Studies indicate that before this age training may be ineffective, since the ability to reach an adequate depth of chest compression depends on the age and the body weight[4].

In this context, the aim of this study is to evaluate the impact and effectiveness of training children in basic life support.

METHODS

This is a systematic literature review, consisting indexed publications in the MedLine Database (an online Medical Literature Analysis and Retrieval System). This search was performed from July to August 2019, using the keywords "Cardiopulmonary Resuscitation", "Education" and "Child" and their variations obtained through the MesH tool resulting in the research phrase [(CPR OR "Cardio-Pulmonary Resuscitation" OR "Cardio Pulmonary Resuscitation" OR "Code Blue" or "Mouth-to-Mouth Resuscitation" OR "Mouth to Mouth Resuscitation" OR "Mouth-to-Mouth Resuscitations" OR "Basic Cardiac Life Support") AND ([Workshops OR Workshop OR "Training Programs" OR "Training Program" OR "Educational Activities" OR "Educational Activity" OR "Literacy Programs" OR "Literacy Program") AND (Child OR "Preschool Child")].

For the refinement of the research, the following inclusion criteria were defined: studies published from January 2014 to August 2019, which addressed the basic life support training of children in a school environment. Exclusion criteria were: review studies, studies that did not describe the methods employed in training and which did not present complete results. The full text of the articles was obtained online. The initial search presented a total of 764 articles and after applying the inclusion criteria of the publication period between January 2014 and August 2019, 75 articles remained. The remaining articles were saved and analyzed through their abstracts, selected according to the other inclusion criteria, leaving 18 articles. After reading in full the remaining 18 articles, 5 articles that did not detail the methods used in the training were excluded, reaching the final number of 13 articles selected for this study.

RESULTS

Thirteen studies were selected directly related to the topic. Of these, it was observed that most of them were published in the 2017-2018 biennium, totaling of 8 publications, followed by 2016 with a total of 3 publications and 1 in each of the remaining years of the period delimited by this study.

From the selected studies, 9 presented exclusively the results from the applied training for school-age children and 4, in addition to this analysis, compared the effectiveness of training realized with young and older children or adults.

In the Chart 2 illustrates the articles titles, participants age range, number of participants, objectives and results.

All selected articles have theoretical and practical training and all studies have applied a questionnaire or an assessment to verify the retention of knowledge after training. Among the topics covered in training, all studies covered the teaching of the technique of chest compressions in case of cardiac arrest. Furthermore, as shown in Table 1, some studies have highlighted in their wording the approach to emergency services trigger guidance and the use of the Automatic External Defibrillator (AED).

Studies evaluating the effectiveness of CPR maneuvers performed by children generally indicated that the effectiveness of depth and frequency of compressions,

and especially of ventilation, are directly related to the child's weight, height, BMI and age, presenting better effectiveness rates in older children[1,5,7,8,9,10]. The study by Mpotos et al.[5] was the only study that showed a difference between the gender of the children, and girls had lower performance regarding the effectiveness of chest compression, being associated with the lower weight of this group.

Studies covering ADE training showed that older children had a better understanding of the training content in relation to ADE[3,9,10,11]. Among younger children, only the outline of the technique was apprehended[3], although they were more interested in training[9]. The most common mistake regarding the use of the AED was the change in order of execution, followed by the change of paddles[11].

Regarding the effectiveness of training when assessed through knowledge apprehension, among the studies comparing younger and older children, most had better results among older children[8,9,10]. Notably, the study by Kua et al.[9] in which the adequate rate of responses to the evaluation questionnaire went from initial 4.2% to 68.9% after training. When compared the groups separately, the younger children showed a significant difference between the pretest and the questionnaires applied immediately after training and after 4 months, showing satisfactory apprehension of the content[8]. Comparing the apprehension rates of knowledge between children and adults, the result was significantly more satisfactory in children, demonstrating greater ease of teaching to this group[1].

However, despite the significant difficulty of younger children in performing an effective CPR maneuver, learning is not unmotivated because of their disability[4]. The interest shown by them outweighs the physical difficulties, being observed a higher level of satisfaction and a more favorable response to the training of the children (10-11 years old)[8]. Post-training attitudinal changes suggest that elementary school children are able to learn the general outline of CPR, AED use, and the adoption of a positive attitude toward CPR, and training in this age group is plausible to provide the correct understanding of technique when older[3].

Chart 1 – Approach list used in SBV training in studies

Researches	Journal / Publishing country	Theoretical and pratical training	Emergency service triggering	Chest compressions and ventilation	AED usage
Huang et al.[1]	Prehospital and Disaster Medicine. Estados Unidos	–		–	
Li et al.[2]	Medicine. Estados Unidos	–	–	–	–
Kitamura et al.[3]	Pediatrics International. Austrália	–		–	–
Weidenauer et al.[4]	PloS One. Estados Unidos	–		–	
Mpotos et al.[5]	Resuscitation. Irlanda	–		–	
Bánfai et al.[7]	Orvosi Hetilap. Hungria	–		–	
Bánfai et al.[8]	Emergency Medicine Journal. Inglaterra	–		–	–
Kua et al.[9]	Singapore Medical Journal. Singapura	–		–	–
Petris et al.[10]	Internal and Emergency Medicine. Itália	–	–	–	–
Jorge-Soto et al.[11]	Resuscitation. Irlanda	–		–	–
Baldi et al.[12]	Resuscitation. Irlanda.	–	–	–	
Hori et. al.[13]	The Keio jouRnal of Medicine. Japão	–		–	
Stroobants et al.[14]	Resuscitation. Irlanda	–		–	

SOURCE: Own research

Chart 2 – Details of the articles analyzed according to age and number of participants, objective and result

Researches	Age group	Number of children in the study	Objective	Result
He et al.[1]	6 a 12	360	Identify the best age for students to receive CPR training	Adequate depth of compression was achieved in participants> 12 years, the correct hand position rate in groups> 6 years and complete release rates are similar across all age groups. In addition, students <12 years old may be potential candidates for chest compression, considering the importance and urgency of CPR training. School-age education has been shown to be the best way to provide CPR skills by being relatively easier and more effective than educating adults.
Li et al.[2]	9 a 16	1093	Evaluate the CPR training in children while in school age in China and the impact of neighborhood socioeconomic on participant's status.	This study revealed that elementary and high school children had little prior knowledge of CPR, especially those from poorer neighborhoods. However, performance was similar among participants from neighborhoods with different socioeconomic levels, scoring after performing spectator CPR proficiency training (0 to 100 points scale), 97.75% of students scored> 77 and 82% scored> 90 points.
Kitamura et al.[3]	10 a 12	1899	Compare primary school student's attitudes toward CRP and knowledge before and after the training.	Only assessed attitude toward CPR and knowledge, not evaluating CPR performance. Post-training attitude changes suggest that elementary school children can learn the general outline of CPR, AED use, and have a positive attitude toward CPR. Continuous training from high school would lead to a correct understanding of CPR application..
Weidenauer et al.[4]	8 a 13	349	Investigate the motivation of school children after receiving CPR training and also evaluate their performance in CPR after training.	Although the rigidity of the dummy affected CPR performance, it does not appear to affect children's motivation or interest. Depth, fraction of fully released and deep compressions were better in the soft dummies group compared to the standard dummies group. However, the average compression ratio and the fraction of compressions at an appropriate rate were significantly higher in the standard group of dummies.
Mpotos et al.[5]	12 a 18	265	Obtain information on the variability of compression depth in different age groups in relation to physical characteristics and minimum levels of compression excellence for training.	About 25% of the level of excellence in percentage compressions was achieved by boys 12-14 years (55 kg) and girls 14-16 years (58 kg). Girls achieved only a level of excellence of 60% at 16-18 years. At the same time, 16-18 year olds (71 kg) nearly achieved a level of excellence of 90%.
Bánfai et al.[7]	7 a 14	164	To evaluate CPR skills of elementary school children of different ages and their effectiveness (chest compressions, ventilation).	43.9% of the children pressed their chest deep enough, 72% held their hands properly 25.6% compressed the chest at the correct frequency. However, only 12.8% were able to effectively ventilate. These factors showed a significant association with age, height and body weight, but were not influenced by gender. Children who have previously participated in first aid training have significantly higher rates of correct hand positioning during chest compressions. However, other factors were not related to the fact of previous first aid.
Bánfai et al.[8]	7 a 14	582	To evaluate the effects of a three-day first-aid course on knowledge and skills before, immediately after and 4 months after training for all primary school age groups.	7-year-olds performed worse than older children, but their scores increased in a significant manner immediately after and 4 months after training compared with the pretest. In practical CPR skills, a significant correlation was found between chest compression depth and children's age, weight, height and BMI, but these factors did not influence knowledge and cognitive abilities.
Kua et al.[9]	11 a 17	1196	Measure, evaluate and report any immediate gain in knowledge and attitude changes experienced by students participating in the training.	The hit rate in the pre-training questionnaires corresponded to 4.2%, rising to 68.9% of students who correctly answered all questions about knowledge testing in post-training research, with the best result concentrated in older students. It was observed that although our students gained general knowledge and were more willing to perform CPR and AED to help others after the training, there was a persistent harm the victim.

Continue

Chart 2 – Details of the articles analyzed according to age and number of participants, objective and result *Continuation*

Researches	Age group	Number of children in the study	Objective	Result
Petris et al.[10]	9 a 19	327	Conduct a first investigation into how drawing (as a nonverbal communication method) can serve as a way of retaining information about CPR steps, identifying how children perceive the actors involved in this process, and what are the main messages promoted by this type of CPR training.	No statistically significant difference was identified between children who had previous experience in emergency and those without experience in the stages of resuscitation, withdrawal of steps or characteristics of CPR. The only statistically significant difference between younger and older students was demonstrated in the cases of steps 7 (performing 30 chest compressive cycles) and 8 (two rescue breaths) and AED
Jorge-Soto et al.[11]	6 a 16	1295	To evaluate the ability of school-age children to use the AED without any prior training or feedback during performance.	19.9% of participants simulated a safe and effective discharge in less than 3 minutes, with significant improvement from the 6-year-old group (8.7%) to the 16-year-old group (33.3%). The most common mistake made by defibrillating participants was the change in order of execution, followed by changing paddles. No significant differences were found between younger groups (6-10 years) and between older groups (12-16 years).
Baldi et al.[12]	11 a 13	170	Assess whether children's knowledge of the sequence of SBV is so good one year after a shorter and cheaper SBV course.	Questionnaire with three questions: 1) Recognition of a person in cardiac arrest; 2) Importance of early activation of the emergency system 3) Correct Compression-Ventilation Ratio. The results compared with the adults they was no significant difference in the first and second question regarding children, but there was a statistically significant difference in the answers to the third question, with better results among adults.
Hori et. al.[13]	10 a 16	6352	Compare satisfaction and willingness to perform CPR of students who attended primary and secondary schools who participated the same training at their schools.	Elementary students (10-11 years) responded more favorably to SBV training than elementary and high school students 12-13 and 15-16 years.
Stroobants et al.[14]	11 a 13	874	To investigate the impact on the attitude of performing CPR among spectators and to support school-age children to become BLS teachers of their relatives and friends.	There was a positive change in family attitude towards CPR in the case of training by a child compared to high school students. Children are physically and emotionally able to perform BLS, and their access to relatives and friends with the skills they have learned in school is considerable.

SOURCE: Own research

CONCLUSION

The physical limitations inherent in underweight, height, BMI and age of younger children imply ineffectiveness of adequate CPR technique, as well as compromise the complete understanding and apprehension of relevant data such as compression-ventilation rates and appropriate use of AED.

However, the studies also show that there is a relevant advantage with regard to the interest shown by younger children in learning, which validates the importance of training even before the recommended age range of 12 years, since physical disability does not discourages maneuvering and continuing training from early childhood will provide greater absorption of technical knowledge when they reach an older age, providing a concrete basis for future training opportunities, in addition to the spread of skills acquired to family members.

With regard to CPR training for children in general, the benefits are irrefutable when compared to training offered to adults, which is a recommendation extremely relevant from the WHO – "Kids Save Lives".

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REFERENCES

1. He DX, Huang KS, Yang YI, et al. What is the optimal age for students to receive cardiopulmonary resuscitation training? Prehosp Disaster Med. 2018;33(4):394-8. doi: https://doi.org/10.1017/S1049023X1800047X.
2. Li H, Shen X, Xu X, et al. Bystander cardiopulmonary resuscitation training in primary and secondary school children in China and the impact of neighborhood socioeconomic status: a prospective controlled trial. Medicine (Baltimore). 2018;97(40):1-5. doi: https://doi.org/10.1097/MD.0000000000012673.
3. Kitamura T, Nishiyama C, Murakami Y, et al. Compression-only CPR training in elementary schools and student attitude toward CPR. Pediatr Int. 2016;58(8):698-704. doi: https://doi.org/10.1111/ped.12881.
4. Weidenauer D, Hamp T, Schriefl C, et al. The impact of cardiopulmonary resuscitation (CPR) manikin chest stiffness on motivation and CPR performance measures in children undergoing CPR training-A prospective, randomized, single-blind, controlled trial. PLoS One. 2018; 13(8):1-14. doi: https://doi.org/10.1371/journal.pone.0202430.
5. Mpotos N, Iserbyt P. Children saving lives: Training towards CPR excellence levels in chest compression based on age and physical characteristics. Resuscitation. 2017;121(4):135-40. doi: https://doi.org/10.1016/j.resuscitation.2017.10.024.
6. Böttiger BW, Aken HV. Kids save lives – training school children in cardiopulmonary resuscitation worldwide. Resuscitation. 2015;94:A5-A7. doi: http://dx.doi.org/10.1016/j.resuscitation.2015.07.005.
7. Bánfai B, Pandur A, Pék E, Csonka H, Betlehem J. At what age can children perform effective cardiopulmonary resuscitation? Effectiveness of cardiopulmonary resuscitation skills among primary school children. Orv Hetil 2017; 158(4):147-52. doi: https://doi.org/10.1556/650.2017.30631.
8. Banfai B, Pek E, Pandur A, Csonka H, et al. The year of first aid': effectiveness of a 3-day first aid programme for 7-14-year-old primary school children. Emerg Med J. 2017;34(8):526-32. doi: https://doi.org/10.1136/emermed-2016-206284.
9. Kua PHJ, White AE, Ng WY, et al. Knowledge and attitudes of Singapore schoolchildren learning cardiopulmonary resuscitation and automated external defibrillator skills. Singapore Med J. 2018;59(9):487-99. doi: https://doi.org/10.11622/smedj.2018021.
10. Petris AO, Tatu-Chiţoiu G, Cimpoeşu D, et al. You can also save a life!": children's drawings as a non-verbal assessment of the impact of cardiopulmonary resuscitation training. Intern Emerg Med. 2017;12(3):365-9. doi: https://doi.org/10.1007/s11739-016-1469-8.
11. Jorge-Soto C, Abelairas-Gómez C, Barcala-Furelos R, et al. Automated external defibrillation skills by naive schoolchildren. Resuscitation. 2016;106(2):37-41. doi: https://doi.org/10.1016/j.resuscitation.2016.06.007.
12. Baldi E, Bertaia D, Contri E. School children learn BLS better and in less time than adults. Resuscitation. 2015;88(1):15-6. doi: https://doi.org/10.1016/j.resuscitation.2014.12.034.
13. Hori S, Suzuki M, Yamazaki M, Aikawa N, Yamazaki H. Cardiopulmonary resuscitation training in schools: a comparison of trainee satisfaction among different age groups. Keio J Med. 2016;65(3):49-56. doi: https://doi.org/10.2302/kjm.2015-0009-OA.
14. Stroobants J, Monsieurs K, Devriendt B, Dreezen C, Vets P, Mols P. Schoolchildren as BLS instructors for relatives and friends: Impact on attitude towards bystander CPR. Resuscitation. 2014;85(12):1769-74. doi: https://doi.org/10.1016/j.resuscitation.2014.10.013.

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