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Biology Teachers - Educators of Basic Resuscitation Procedures in Schools

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ABSTRACT

The aim was to examine the effectiveness of the education of elementary school students, conducted by teachers trained by physicians, in learning and applying basic resuscitation procedures (cardiopulmonary resuscitation, CPR) and the retention of the aforementioned knowledge and skills after one month. The research was conducted during one school year in Split-Dalmatia County, Republic of Croatia. Physicians trained biology teachers to implement CPR education in elementary schools, and the teachers then conducted systematic education of students according to the same program. The teacher and student education program included a lecture, video simulation and practical CPR exercises on first aid puppets. The initial knowledge and initial practical skills of the students were examined before the education and then after the education. Retention of knowledge and skills was checked after one month. The results show that after the two-hour course, teachers feel competent and successfully implement structured CPR education for students. Elementary school students do not have basic knowledge or practical CPR skills at the beginning. After education lasting two school hours, they show statistically significantly better results in CPR theoretical knowledge and practical skills. They also retain the acquired knowledge and skills after a period of one month. The model in which medicine doctors teach biology teachers, and they later teach CPR their students, has proven to be successful, and it is important to continue implementing it in schools so that students are health literate and can act adequately in an emergency situation.

Keywords: *Cardiopulmonary Resuscitation (CPR); Curriculum; elementary school students; Health Education*

INTRODUCTION

The elementary school period is crucial for the developing a positive attitudes, habits and life-long behaviors related to a healthy lifestyle, and it is the period of necessary health education of students. In addition to the educational outcomes of the compulsory subjects, during schooling students also realize the expectations of cross-curricular topics. In the Curriculum of the cross-curricular topic Health, one of the domains is *Help and self-help*. This domain focuses on the development of health literacy, which includes learning about the most common diseases and injuries, health services, and the acquisition of first aid and self-help skills. In the 3rd educational cycle (6th, 7th and 8th grade of elementary school), students should explain the application of resuscitation procedures, describe and provide first aid when another's life is threatened, and develop a positive attitude towards providing first aid (Curriculum and program of the cross-curricular topic Health for Primary and Secondary Schools, 2019).

Sudden cardiac death (SCD) is a tragic event for the outcome of which it is crucial to carry out secondary prevention procedures), cardiopulmonal resuscitation (CPR) and implementation of automated external defibrillator (AED) (Gräsner et al., 2016; Okubo et al., 2020; Virani, Alonso and Aparicio, 2021). If started early enough, CPR performance leads to a statistically significant improvement in terms of the likelihood of survival. It is important to have bystanders trained in CPR and AED use, such as schools

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and other public places (Son et al., 2017). The probability of survival in people who are not provided with CPR early enough decreases by 7-10% for each minute in which a person is not provided with CPR. Out-of-hospital cardiac arrest mortality could be significantly reduced if 15-20% of the population were capable of providing CPR (Abelsson & Nygårdh, 2019). Increasing the capacity of the general population (adults and children) for providing CPR would certainly reduce the mortality rate, one of the ways of education being the provision of CPR education in schools (Böttiger & Van Aken, 2015). The most effective and best way to achieve this goal is training school children for performing CPR, thus enabling a large part of the population to adopt basic life-saving skills. Broomfield defines CPR competency as the cognitive knowledge and psychomotor skills necessary to perform CPR effectively in cardiac arrest situations (Broomfield, 1996).

CPR Education in Schools

WHO recommends educating school children from the age of 12 for 2 hours in a school year. Lubrano et al. (2005) state that it is possible to involve students from the age of 11 and that it is crucial to develop an effective program for working with students in schools. Today, school education programs on CPR are implemented in many countries (Watanabe et al., 2015; Meštrović et al., 2016; De Smedt et al., 2019; Watts et al., 2024). Survival is known to be affected by the access to appropriate equipment and delays with the start of CPR (Rajeswaran, 2014), making it important to teach elementary school children basic resuscitation procedures because they are the first persons on the spot in case something happens to their peers or others in their vicinity. Current practice shows adults' reluctance to provide first aid and poor performance of life-saving measures, while the inclusion of CPR training in elementary schools would effectively improve rescue efforts initiated by people at the scene of an accident (Nakagawa et al., 2019; Gabriel and Aluko, 2019; Brown et al., 2018). Although it was previously thought that CPR should be taught by health professionals, and schools were reluctant to include first aid content in their curricula (Lafferty, Larsen and Galletly, 2003), nowadays researches show that schools present a good environment for CPR education. Researches on teachers' readiness to perform CPR (Abelairas-Gómez et al., 2020) indicate that teachers are committed to including first aid and CPR in educational programs, thus in many countries CPR education is part of the compulsory curriculum (School CPR). A number of researches have dealt with the possibilities of teaching CPR to students in elementary and secondary schools (Onyeaso, 2016; Salvatierra, Palazzo and Emery, 2017; Brown et al., 2018; López et al., 2018; Watts et al., 2024). They agree that students can acquire knowledge and skills necessary for CPR implementation.

The first step in teaching children CPR procedures should be teacher education, as teachers can successfully educate students (Alharbi et al., 2016; López et al., 2018; Nakagawa, 2019;). Moreover, teachers advocate for the inclusion of first aid and CPR in educational programs (Connolly et al., 2007). In the education system of the Republic of Croatia, the implementation of CPR education is part of the 7th grade elementary school biology curriculum, yet there is no single structured education implemented in all schools. Therefore, due to lack of educated teachers, most schools do not conduct CPR education and physicians do not have time to come to all classes and educate all students.

METHODS

The research was continued in 5 elementary schools, in which teachers educated CPR 406 students. The average student age was 13.6 years. The study is divided into two stages. The first part of the study included teacher education and the second part student education. Biology teachers (N=143) were taught by physicians who had passed the Advanced Pediatric Life Support (APLS) course (Samuels &

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Wieteska, 2016). Teachers then used identical methods in CPR student education (Meštrović et al., 2016). The respondents were students of the eighth grade of elementary schools in Split-Dalmatia County. Prior school and parental consents were obtained for research participation.

Physicians and an expert in teaching methods participated in the program design. The same program was used for the education of teachers and students, including the following points: 1. conversation, 2. Power Point presentation, 3. videoclip, and 4. practical demonstration of CPR on puppets. All the necessary materials were didactically and methodically shaped. The teachers tested student knowledge by applying a test the validity and reliability of which had been previously determined (Meštrović et al., 2016).

The necessary data were collected in three phases. Each phase had a written test and a practical skills test. In the written test, students chose or wrote down the correct answers to 12 questions. The practical part was taught by teachers for up to two school hours. At the end of each practical part of teaching resuscitation on puppets, the teachers used a structured questionnaire examining 13 points important for acquiring CPR skills and correctly performing the given CPR algorithm: 1. safety check; 2. checking consciousness; 3. body shaking 4. call for help; 5. call to emergency services; 6. chest compression site; 7. compressive strength; 8. frequency compression; 9. opening of the airway; 10. look, listen, feel; 11. rescue breaths; 12. ratio 30:2; 13. termination of CPR.

In the first phase of the research, the initial state of students' knowledge and skills related to CPR was determined. The students completed the initial test (T1) and approached the dummy (a person who had collapsed in front of them and was lying unresponsive) and reacted as desired (P1). The second phase of the research involved the implementation of classroom teaching. After the education, the participants wrote a test (T2) and practically independently performed CPR (P2). The third phase of the research took place after one month, when the students wrote an identical test (T3) and again independently demonstrated the acquired CPR skills (P3).

All data have been presented through mean, standard deviation, 95% confidence interval and minimal and maximal value. Due to identification of impact of within subjects factor Time (3 time points) and between subjects factor Gender, factorial 2-way mixed model ANOVA was applied. Repeated measures factor was examined for assumption of sphericity. Partial eta squared ($\eta 2$) was used for effect size assessment. Type I error was set at alpha=5%. All data were processed by using TIBCO Software Inc. (2018). Statistica (data analysis software system), ver. 13.

RESULTS

A team of physicians educated 15 Biology teachers during the study, they had not been conducting CPR education in their schools. All students participated in all three phases of the program, and none of them had previously taken a CPR course. Table 1 shows the results of descriptive statistics of all three research phases. The results show that girls and boys achieve the lowest value of practical skills before education (P1) because they do not know how to perform CPR. The highest values of practical verification are achieved immediately after the training (P2) during which they practiced CPR procedures on puppets. Acquired skills remain a month after the education (P3), regardless of gender. Following the theoretical knowledge of students, an identical trend of results can be observed. According to knowledge tests, the lowest values are recorded before education (T1). After the training, during which the students had a lecture followed by a Power Point presentation and a videoclip showing the CPR simulation, their knowledge increases, reaching the peak right after the training (T2).

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They retain the acquired knowledge even one month after (T3), regardless of their gender (Table 1). The results also show that 95.07% of students are ready to help a life-endangered person in case of need.

Table 1. Acquisition of knowledge and CPR skills in all three phases of research

Variable	Aggregate Results Descriptive Statistics							
	Gender	Valid N	Mean	Confidence -95,00%	Confidence 95,00%	Minimum	Maximum	Std.Dev.
P1	F	206	0,83	0,68	0,99	0,00	7,00	1,13
P2	F	206	12,50	12,38	12,62	9,00	13,00	0,87
P3	F	206	11,55	11,33	11,77	8,00	13,00	1,61
T1	F	206	7,16	6,93	7,39	0,00	11,00	1,70
T2	F	206	10,86	10,69	11,03	5,00	12,00	1,23
T3	F	206	10,53	10,36	10,70	4,00	12,00	1,24
P1	M	200	0,87	0,69	1,05	0,00	8,00	1,32
P2	M	200	12,50	12,37	12,63	7,00	13,00	0,92
P3	M	200	11,78	11,55	12,01	7,00	13,00	1,63
T1	M	200	6,99	6,77	7,22	0,00	11,00	1,59
T2	M	200	10,68	10,48	10,88	3,00	12,00	1,45
T3	M	200	10,36	10,13	10,59	1,00	12,00	1,64

(F = female, M = male)

The statistical significance of the main factors of gender and time and their interaction effects were examined by ANOVA, and a post-hoc Bonferroni test was performed. Regarding the practical exam, ANOVA revealed significant main effect of factor Time ($F_{808,2}=11358.28$; $p<0.001$; $\eta 2=0.966$) while main effect of factor Gender appeared not to be significant ($F_{808,1}=1.302$; $p=0.255$; $\eta 2=0.003$). Bonferroni post-hoc correction identified significant differences between all-time points. Similarly, interaction effect Time × Gender was found not to be significant ($F_{808,2}=1.029$; $p=0.358$; $\eta 2=0.003$). On the other side, regarding the theoretical exam, ANOVA revealed significant main effect of factor Time ($F_{808,2}=876.819$; $p<0.001$; $\eta 2=0.685$) while Bonferroni post-hoc correction identified significant differences between all-time points. Furthermore, main effect of factor Gender appeared not to be significant ($F_{808,1}=3.357$; $p=0.068$; $\eta 2=0.008$). Similarly, as in the case of the practical exam, interaction effect Time × Gender was found not to be significant ($F_{808,2}=0.005$; $p=0.995$; $\eta 2=0.000$). The obtained results of the research show that the expectations of the cross-curricular topic Health students should explain the application of resuscitation procedures, describe and provide first aid when another's life is threatened (Curriculum and program of the cross-curricular topic Health for Primary and Secondary Schools, 2019).

DISCUSSION

Researches on CPR training point to difficulties related to the availability of CPR instructors, cost, and lack of equipment (Salvatierra, Palazzo and Emery, 2017). Such barriers are avoided using a structured CPR program in schools according to school curriculum because the instructors are actually teachers working in schools. The equipment used, such as computers and projectors, is standard school equipment, and CPR exercise puppets are lent to teachers by doctors. Some authors state that schools do not implement CPR due to lack of space and lack of teacher time. They propose a unique strategy that includes increasing funding, curriculum hours, increasing the number of certified instructors as well as obligatory student equipment (Reder & Quan, 2003).

In Croatian educational system, health-related topics have been implemented in the National Curriculum. A detailed analysis was made to determine how best to apply student CPR education wanting to develop a unique and uniform educational program applicable by teachers in schools. The

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system of national curriculum documents in which the contents on health and first aid are implemented consists of the Biology curriculum (MZOŠ, 2010), the Health Education curriculum (2013) and the Cross-curricular topic Health (2019). These curricula require students to acquire basic knowledge and skills of providing first aid in grade 6, 7 and 8 of elementary school. During this time, it is necessary to teach first aid-related contents in situations where life is endangered, when the heart stops working, breathing stops and bleeding stops. Students should be able to present a proper resuscitation simulation at the end of the training. Although it is stated that in addition to teachers in two-hour CPR education, a physicians can also participate, this is very rare. That is why the team of experts, pediatricians and emergency physicians, experts on teaching methods, designed a structured education for elementary school teachers who were then able to conduct CPR education among students in their schools. Our education was conducted in school classrooms, meaning we permanently have at disposal space to teach. The research was conducted as part of regular classes, which is possible according to the above first aid and CPR curricula. There was no problem with certified instructors either, as a team of pediatric intensive care physicians educated biology teachers.

The conducted research showed that students do not have the necessary CPR-related knowledge or skills before education, which was expected. The same behavior modality was recorded in the CPR skills survey of high school students (Meissner, Kloppe and Hanefeld, 2012). The results of the research show that CPR education of eighth grade elementary school students led to statistically significant progress in student knowledge and skills after the education, and students retained the acquired knowledge and skills a month after. The results are in correlation with the results of other studies (Onyeaso, 2016). High school students show how they can learn and maintain CPR and AED skills for helping adult victims after a sudden cardiac arrest (Kelly et al., 2006). The results of this research show elementary school students can do it as well. In order for the CPR course in schools to be successfully implemented in the long run, it needs to be well structured and applicable in the education program implemented in a specific national school program. Therefore, we have applied successful methodologies of other similar educational programs in our program and adapted the program to the curriculum of the Republic of Croatia. Although video education alone can prepare adolescents for the proper application of CPR (Lorem, Steen and Wik, 2010), practical CPR exercises yield greater success than educational video material alone (Reder & Quan, 2006). Therefore, in our research we used a video, as well as exercises, in addition with an introductory conversation in which we explained to the students the importance of the course. Students in our study did not possess the desired CPR skills prior to education, as expected. In the introduction to the course, we talked to the students and explained the importance of CPR education, and after the course the students expressed satisfaction with what they have learned, as well as their willingness to help a life-endangered person in case of need. This finding corresponds to the attitudes recorded in other studies (Meissner, Kloppe and Hanefeld, 2012). Before starting the implementation of CPR education program, analyzed the attitudes of students and their parents, and the results showed that students are motivated and that parents want CPR education to be conducted in schools (Petric et al., 2013).

The equipment required for practical exercises for our program was funded by the Ministry of Science and Education. The instructors of the students were their teachers. The quality of teacher education is guaranteed by their educators, i.e., the instructors of the APLS course, who repeat teacher education before the start of the new school year. The training program is implemented and supervised by the Working Group for Education on the Resuscitation at the Croatian Pediatric Society. The physician and teacher team coordinators meet regularly, evaluate program implementation and results, and plan

further program implementation. The results of our research showed that it is possible to implement a CPR education program in schools as part of the regular school curriculum. In terms of organization, it is easiest to conduct education in schools wherein the educators are teachers, because they already know the students and the school. The entire system is designed to ensure the sustainability of the program and, where necessary, modernization and change. In relation to the coronavirus pandemic, the experts on teaching methods of our team plan to adjust the methodology of program implementation for the changed teaching circumstances.

Previous researches (Stroobants et al., 2014) have shown that adolescents can retain CPR knowledge and skills after training (Onyeaso, 2016). In our education program, elementary school students acquired CPR-related knowledge and skills, retaining them a month after the education. Of course, further research will be needed on the topic of retaining knowledge and skills, as well as their renewal in the years after the first course. However, a CPR course conducted in childhood is an incentive to repeat CPR education and renew knowledge and skills later in life. This helps to achieve the desired goal, which is to increase the number of citizens trained to directly perform CPR on victims of sudden cardiac arrest.

CONCULSION AND METODOLOGICAL SIGNIFICANCE

After a two-hour CPR education, the teachers independently conducted the CPR education among the students of the final grades of elementary school according to a structured didactic and methodological model. Students attending the final grades of elementary school can successfully acquire the necessary knowledge and learn the basic procedures of CPR and acquire the necessary CPR competency. Students practically perform CPR after education and retain the acquired knowledge and skills for a month. We conclude that CPR education can be successfully incorporated into elementary school curricula and that it can be permanently implemented. The model in which medicine doctors teach biology teachers, and they later teach CPR their students, has proven to be successful, and it is important to continue implementing it in schools so that students are health literate and can act adequately in an emergency situation if it occurs.

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Učitelji biologije - edukatori temeljnih postupka oživljavanja u školama

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SAŽETAK

Cilj rada bio je ispitati uspješnost edukacije učenika osnovne škole, koju provode učitelji educirani od strane liječnika, u učenju i primjeni osnovnih postupka oživljavanja (engl. cardiopulmonal resuscitation CPR) te retenciju navedenih znanja i vještina nakon jednoga mjeseca. Istraživanje je provedeno tijekom jedne školske godine u Splitsko-dalmatinskoj županiji, Republika Hrvatska. Liječnici su educirali učitelje biologije za provedbu CPR edukacije u osnovnim školama, a učitelji su zatim po istom programu proveli sustavnu edukaciju učenika. Program edukacije učitelja i učenika obuhvaćao je predavanje, video simulaciju i praktične vježbe CPR na lutkama.

U Kurikulumu međupredmetne teme Zdravlje jedna je od domena Pomoć i samopomoć. Ova domena usmjerena je na razvijanje zdravstvene pismenosti koja obuhvaća učenje o najčešćim bolestima i ozljedama, zdravstvenim službama te usvajanje vještina prve pomoći i samopomoći. U 3. obrazovnom ciklusu (6,. 7. i 8. razred osnovne škole) učenici trebaju objasniti primjenu osnovnih postupaka oživljavanja, opisati pružanje prve pomoći u situacijama kada je ugrožen život te usvojiti pozitivan stav o prvoj pomoći i pomaganju drugima. Iako se prije mislilo kako CPR trebaju poučavati zdravstveni radnici, a škole su oklijevale uključiti sadržaje prve pomoći u kurikulume, danas istraživanja pokazuju kako su škole dobro okružje te školski učitelji mogu uspješno provoditi CPR. WHO preporuča edukaciju školske djece od 12. godine života i to 2 sata godišnje.

Prvi dio provedenoga istraživanja obuhvaćao je edukaciju učitelja biologije, a drugi edukaciju učenika (N=406). Edukatori učenika bili su učitelji u osnovnim školama koji su prošli strukturiranu edukaciju od strane liječnika pedijatara intenzivista. Učitelji su zatim u CPR edukaciji učenika koristili identične materijale i metode. U istraživanju je sudjelovalo pet osnovnih škola Splitsko-dalmatinske županije, a prosječna dob učenika je 13,6 godina. Tijekom edukacije učitelja i učenika koristio se: 1. razgovor u razredu, 2. power point prezentacija, 3. video film i 4. praktična demonstracija CPR na lutkama. Svi potrebni materijali bili su didaktičko-metodički oblikovani. Učenici su tijekom svake faze istraživanja pisali pisanu provjeru znanja te su imali praktičnu provjeru stečenih vještina oživljavanja na lutkama. Provjeru znanja učenika učitelji su proveli primjenom testa kojem je utvrđena valjanost i pouzdanost. U testu su učenici zaokruživali ili dopisivali točne odgovore na 12 postavljenih pitanja. Praktične vještine učenika su također podučavali educirani učitelji, koji su zatim provjeravali stečene vještine učenika strukturiranim upitnikom. Ispitivalo se 13 točaka bitnih za stjecanje CPR kompetencije i pravilno izvođenje zadanog algoritma CPR (1. provjera sigurnosti; 2. provjera svijesti – pitanje; 3. provjera svijesti – protresanje; 4. glasan poziv u pomoć; 5. poziv hitnim službama; 6. efikasno otvaranje dišnog puta; 7. gledaj – slušaj - osjećaj; 8. efikasno početno upuhivanje; 9. točno mjesto pritiska za masažu srca; 10. dovoljna jačina pritiska; 11. pravilna brzina pritiska; 12. pravilan omjer pritiska i upuhivanja; 13. prestanak CPR tek kada se kaže). Potrebni podatci prikupljani u tri faze. Prva faza istraživanja odnosila se na utvrđivanje inicijalnog stanja učeničkih znanja i CPR vještina. Učenici su popunjavali test na početku (T1) istraživanja te su pristupali lutki (osobi koja se srušila ispred njih i leži te ne reagira) i reagirali prema nahođenju (P1). Druga faza istraživanja obuhvaćala je provedbu edukacije u učionici. Nakon edukacije učenici su pisali test (T2) i samostalno praktično izvodili CPR (P2). Treća faza istraživanja odvijala se nakon mjesec dana. Tada su učenici pisali identičan test (T3) te ponovo samostalno demonstrirali usvojene CPR vještine (P3).

Rezultati pokazuju kako učenici nemaju CPR znanja ni vještine prije edukacije. Nakon provedene edukacije i vježbanja praktičnih vještina u trajanju od dva školska sata aritmetička sredina je 12,5 (od maksimalno mogućih 13), a učenice su postizale i maksimalnih 13 točnih postupaka. Aritmetička sredina njihovih praktičnih postupaka nakon mjesec dana iznosi 11,55 ali je i tada je bilo učenica koje su točno izvele eve praktične postupke i dobile

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maksimalno mogućih 13 bodova. Praktične vještine dječaka pokazuju gotovo identičnu tendenciju. Teoretska znanja učenika također su nedostatna prije edukacije, a najbolja su neposredno nakon edukacije, što ukazuje na važnost edukacije učenika i sposobnost da nauče CPR u dva školska sata. Statistička značajnost glavnih faktora spola i vremena i njihovih interakcijskih efekata ispitana je ANOVA-om te je napravljen post-hoc Bonferroni test., ANOVA je otkrila značajan glavni učinak faktora Vrijeme kod izvođenja praktičnih aktivnosti ($F_{808,2}=11358,28$; $p<0,001$; $\eta 2=0,966$), dok se čini da glavni učinak faktora Spol nije značajan. Bonferronijeva post hoc korekcija identificirala je značajne razlike između svih vremenskih točaka. Učenici osnovne škole na početku nemaju osnovna znanja niti praktične CPR vještine. Nakon edukacije u trajanju od dva školska sata pokazuju statistički značajno bolje rezultate u teoretskom znanju CPR i praktičnim vještinama. Također usvojena znanja i vještine zadržavaju nakon razdoblja od jednoga mjeseca. Spol učenika nije imao utjecaj na njihova znanja i vještine te se može zaključiti kako dječaci i djevojčice jednako uspješno usvajaju CPR vještine i teoretska znanja.

Može se zaključiti kako je edukacija učitelja najjednostavniji i efikasan način za trajno provođenje edukacije o CPR u školama. Učitelji su nakon dvosatne CPR edukacije sposobni samostalno provoditi uspješnu CPR edukaciju učenika prema didaktičko-metodičko strukturiranom modelu. Stoga je potrebno raditi na podizanju svijesti o iznenadnom srčanom zastoju u djece i odraslih te educirati učenike i širu javnost o važnosti pravodobne i učinkovite CPR. Osnovnoškolsko razdoblje ključno je za usvajanje pozitivnih stavova, navika i cjeloživotnih ponašanja vezanih uz zdravi životni stil te je to doba neophodnog zdravstvenog odgoja i obrazovanja učenika. Osposobljavanje CPR vještina školske djece najučinkovitiji i najbolji je način za postizanje ovog cilja jer bi tako veliki dio stanovništva usvojio osnovne vještine za spašavanje života.