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# A five-finger mnemonic for teaching schoolchildren the theoretical components of adult basic life support: a modified reactive Delphi-guided development and memorability pilot test with schoolchildren

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## Abstract

**Background** A mnemonic is a cognitive aid frequently used in health-related education. The main goal of this study was to develop and test a 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult Basic Life Support (BLS) steps, a process rarely described in the context of instructing laypersons.

**Methods** Experts from the European Resuscitation Council's Basic Life Support Science and Education Committee (ERC BLS SEC), specializing in teaching adult BLS, participated in the first phase of the pilot study. This phase employed the modified reactive Delphi to develop a 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps, in accordance with the 2021 ERC BLS guidelines. The mnemonic underwent revision rounds based on expert suggestions and was evaluated using a 9-point Likert scale. The process was repeated until there was unanimous approval. In the second phase, a pilot test was conducted with schoolchildren at a summer camp to assess their recall of the 5-finger mnemonic. Following their training in adult BLS steps utilizing the 5-finger mnemonic, schoolchildren were tasked with arranging cards depicting images from the mnemonic both before and after the training.

**Results** From March to October 2022, a four-round modified reactive Delphi engaged four experts from the ERC BLS SEC. Initial expert consensus was moderate, 6.0 (IQR=4.5–7.5, min = 1, max = 9), on a scale 1 ("totally disagree") to 9 ("totally agree"). The experts consensus improved over subsequent rounds, resulting in two final versions of the 5-finger mnemonic. Both versions concentrate on the comprehensive adult BLS, differing only in their approach to cardiopulmonary resuscitation (CPR): one employs a method of 30 chest compressions followed by two rescue breaths, while the other utilizes compression-only CPR. In August 2023, a recall pilot test involved mostly female schoolchildren (12/13, 92.3%). Pre-training, no cards with 5-finger mnemonic content were arranged correctly, but post-training, progress improvement was observed, especially in older schoolchildren ( $Z = -2.727$ ,  $p = 0.006$ ).

The Delphi study investigators are listed in Appendix section.

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**Conclusions** The pilot study highlights the potential of using tailored educational tools, such as mnemonics, to teach important lifesaving skills to different age groups. This suggests that the 5-finger mnemonic effectively improved schoolchildren's understanding of the theoretical aspects of adult BLS steps.

**Keywords** Modified reactive Delphi, Hand mnemonic, Adult basic life support, Teaching, Schoolchildren

## Background

Cognitive aids are tools that assist individuals in completing tasks efficiently, using formats like posters, checklists, and mnemonics to provide guidance and improve performance [1–3]. A mnemonic is a learning strategy designed to improve the retention and recall of information using auditory, visual, or kinesthetic cues [4] and is commonly used in resuscitation education (e.g. ABC for Airway, Breathing, Circulation) [5–8]. Although most use letter- or word-based acronyms to teach adult basic life support (BLS), other visual mnemonics involve the human body, with the hand being the most common [5, 7–12]. In healthcare education, hand mnemonics have been used to memorize liver segments by using the fist, the cardiac cycle by opening/closing both hands, and the brachial plexus or serum protein electrophoresis by using the fingers [9–11, 13]. In these cases, hand mnemonics improved student retention [9, 10]. Such approaches may have relevance in adult BLS education, as there has been considerable research on the decline in adult BLS knowledge and skills retention among students and laypersons [14]. A team of educators from Norway previously used the 5-finger mnemonic to teach first aid to kindergarten children, finding improvements in learning outcomes such as cognitive understanding, motivation, and the behavior required to provide first aid [15, 16].

Not much is known about the process of developing mnemonics, as they are usually individual [11] or team [8, 9, 13] ideas or are part of common knowledge [17]. To our knowledge, only a few studies have developed cognitive aids for learning adult BLS that were validated by experts, with one of them employing a Delphi process [18]. The Delphi method is a structured process that leverages expert the judgment of experts through a series of rounds that integrate controlled feedback to develop consensus (e.g., guidelines) on a specific healthcare related topic [19, 20]. This method can be effectively employed in the development of mnemonics.

Our aim was 1) to use such a modified reactive Delphi [21, 22] to develop a 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps based on the recent European Resuscitation Council (ERC) BLS guidelines [23, 24] and 2) to test the memorability of the developed 5-finger mnemonic for teaching schoolchildren.

## Methodology

This pilot study comprised two phases: the first detailing the modified reactive Delphi [21, 22] for creating a 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps, and the second pilot testing its memorability in schoolchildren.

### Phase 1: Modified reactive Delphi of developing 5-finger mnemonic for teaching schoolchildren's theoretical aspects of adult basic life support

All experts ( $N=14$ ) of the European Resuscitation Council's Basic Life Support Science and Education Committee (ERC BLS SEC) were invited to participate. The ERC BLS SEC is an international interdisciplinary and interprofessional group of experts in the field of BLS education. Experts were invited to participate via an internet-based platform (Proofhub, California, USA) where the aim and the design of this modified reactive Delphi was explained. The modified reactive Delphi is similar to the classic Delphi process but typically involves experts providing feedback and reactions to pre-generated items in the first round, rather than creating new lists of items [21, 22]. Ethical approval was obtained from the National Ethics Committee (0120–157/2018). Interested experts were asked to participate voluntarily with informed consent and received further information.

In the first round of the modified reactive Delphi, experts were individually presented with a draft version of the 5-finger mnemonic designed for teaching schoolchildren about adult BLS (Fig. 1) [25, 26].

Experts anonymously evaluated their consensus with the content of the adult BLS in the 5-finger mnemonic using a 9-point Likert scale, ranging from 1 (“totally disagree”) to 9 (“totally agree”) [19, 20]. Additionally, they were encouraged to provide free-text comments and suggestions for alterations, deletions, or additions to the written and illustrated content of the 5-finger mnemonic, specifically aimed at teaching schoolchildren the theoretical aspects of adult BLS steps.

After the first modified reactive Delphi round and the following round, the study investigator worked with a professional graphic designer modifying the 5-finger mnemonic incorporating the expert comments and suggestions. The next modified reactive Delphi round provided the experts with a modified version of the 5-finger mnemonic with anonymized comments and ratings from



**Fig. 1** Draft version of 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps distributed in step one of the modified reactive Delphi

all the experts. This rounding modified reactive Delphi was repeated until all experts scored a content of 5-finger mnemonic from 7 to 9 on the 9-point Likert scale, aiming to achieve scores above 8 [20, 27, 28]. Experts demographic data (age, gender, profession, years of experience teaching adult BLS, and self-assessed knowledge of adult BLS) was recorded. Data for modified reactive Delphi was collected in Microsoft Excel spreadsheet format (Microsoft Corporation, Redmond, Washington, USA).

### Phase 2: The memorability of the 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult basic life support

To evaluate the memorability of the 5-finger mnemonic, we conducted an adult BLS training session for schoolchildren at the “Summer Camp 2023” in northern Slovenia, Europe. The trainings were led by a registered nurse from the Medical Dispatch Center in Maribor, Slovenia, who has five years of experience teaching adult BLS to schoolchildren. Enrolment criteria required schoolchildren to participate in the adult BLS training, with written informed consent obtained from their parents or guardians prior to their inclusion in the study. No exclusion criteria were identified.

Prior to the adult BLS training, the demographic data (age, gender, and prior experience with adult BLS training) was recorded from the schoolchildren. After that schoolchildren were categorized into two age groups: younger (6 to 8 years) and older (10 to 11 years). As a result, two separate adult BLS training sessions were organized, each lasting approximately 70 min. While one group participated in the adult BLS training, the other

group took part in a first aid session, where they learned how to control bleeding and immobilize injuries. Before the adult BLS training, each schoolchild was given a set of five cards illustrating the steps of adult BLS using the 5-finger mnemonic, emphasizing the sequence of 30 chest compressions and 2 rescue breaths, and asked to arrange them in the correct order. We photographed each set of arranged cards for later evaluation. The theoretical segment of the training then began, lasting approximately 15 min, during which the components of adult BLS were explained orally using the 5-finger mnemonic. This was followed by a practical session lasting around 45 min, where the Little Anne QCPR (*meaning quality cardiopulmonary resuscitation*) manikin (Laerdal Medical, Stavanger, Norway) and a simulated automated external defibrillator (AED) setup were used. The AED setup included a HeartSine vTrainer cardboard (Stryker Corporation, Michigan, U.S.) and a Samsung Galaxy A13 (Samsung Electronics, Suwon, South Korea) running the SAM Trainer application (Sugar Rush Creative Limited, London, UK). Data from the practical component of the adult BLS training was not collected, as it was not the focus of this study. The duration of the adult BLS training was aligned with similar studies in the field [15, 29–31] and adhered to the International Liaison Committee on Resuscitation (ILCOR) recommendation that teaching approaches combining theoretical and practical sessions ensure a sustainable learning effect [32]. Following the adult BLS training, each schoolchild was again provided with the set of five cards and asked to arrange them in the correct order, just as they had been instructed to do before the training. Once again, we photographed each

set of arranged cards for later evaluation. Each schoolchild arranged a total of 10 cards, with 5 cards arranged before and 5 cards after the adult BLS training (Fig. 2).

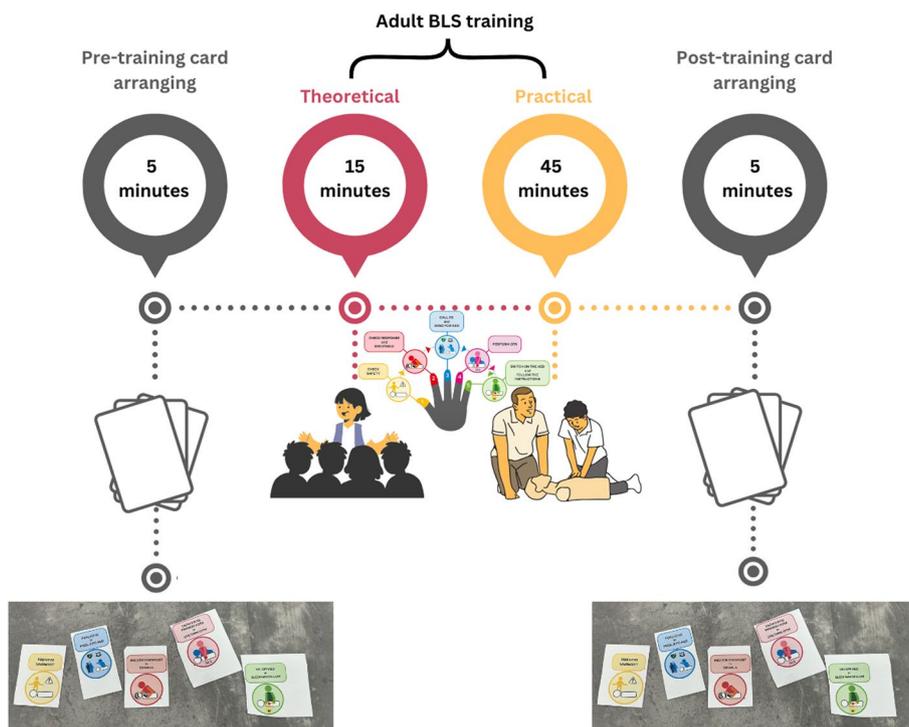
**Statistical analysis**

In both study phases we tested continuous variables for normal distribution. Each schoolchild arranged 10 cards in total which allowed us to record the numerical variable representing the number of correctly arranged cards for each schoolchild. Consequently, the results were reported as median with corresponding interquartile range (IQR). Mann–Whitney U test was used for comparison of independent groups (older vs. younger schoolchildren). *P*-value < 0.05 was considered significant. Data were analyzed using the SPSS 29.0.0 (International Business Machines Corporation, New York, USA). Data for memorability was collected in Microsoft Excel spreadsheet format (Microsoft Corporation, Redmond, Washington, USA). Our study’s cohort comprised schoolchildren enrolled in a “Summer camp 2023”, representing the entirety of its student population. We emphasize, however, that a power analysis for determining the sample size was not performed in this study.

**Results**

Phase 1. A four-round modified reactive Delphi was conducted between March 2022 and October 2022, involving four experts from the ERC BLS SEC (three men and one women). Two of the ERC BLS SEC experts were physicians working in clinical settings, while the other two were healthcare researchers. Their average age was 44.3 ± 20.9 years. They had an average of 12.0 ± 5.3 years of experience teaching adult BLS to both adults and children, and 13.0 ± 6.2 years of professional experience in adult resuscitation. Their level of adult BLS knowledge on a scale of 1 to 10 was self-rated as high (9.3 ± 1.0). Each of the four ERC BLS SEC experts successfully completed all four rounds of modified reactive Delphi (Appendix).

In the first modified reactive Delphi round, the median consensus of the ERC BLS SEC experts was 6.0 (IQR = 4.5–7.5, min = 1, max = 9). They made 32 comments and suggestions, 27 of which related to the written content of the 5-finger mnemonic and 5 to the illustrated content of the mnemonic. For the second, third, and fourth modified reactive Delphi rounds, the median consensus of the ERC BLS SEC experts increased from 8.0 (IQR = 6.5–8.0, min = 2, max = 9), 8.0 (IQR = 8.0–9.0, min = 5, max = 9) to 8.5 (IQR = 8.5–9.0, min = 8, max = 9).



**Fig. 2** Flow diagram of adult BLS training and example of the incorrect arranging of adult BLS steps using 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS (Slovenian version). Legend: Preveri varnost = Check safety, Pokliči 112 in pošlji po AED (meaning Automated External Defibrillator) = Call 112 and send for AED, Preveri odzivnost in dihanje = Check response and breathing, Začni s stisi prsnega koša in umetnimi vpihi = Perform CPR (meaning cardiopulmonary resuscitation), Vklopi AED in sledi navodilom = Switch on the AED and follow the instructions

In these three rounds, the ERC BLS SEC experts made a total of 15 comments and suggestions, of which 13 related to the written content and 2 related to the illustrated content of the 5-finger mnemonic. At the end of the modified reactive Delphi, two final versions of the 5-finger mnemonic for teaching adult BLS were developed. One version teaches adult BLS with performing 30 chest compressions and 2 rescue breaths (Fig. 3A), and the second version teaches chest compressions only BLS without rescue breaths (Fig. 3B).

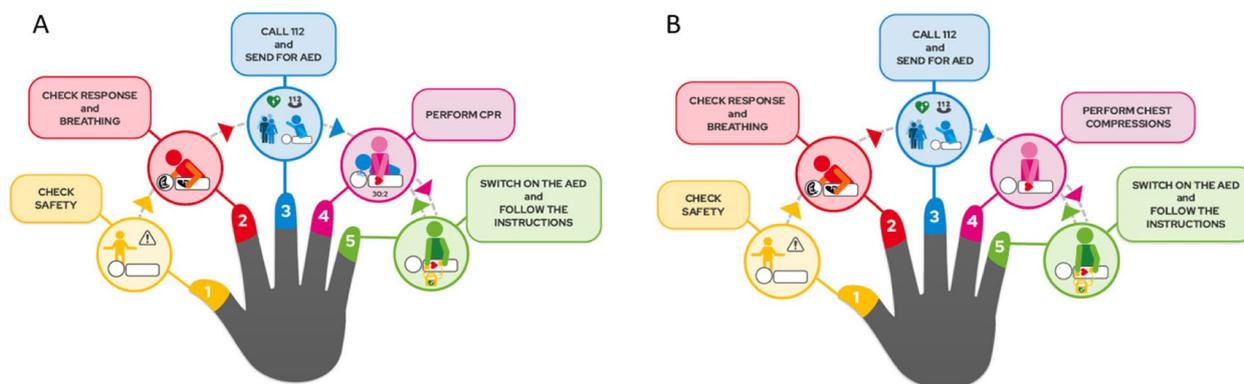
Phase 2. The memorability of the 5-finger mnemonic was conducted in August 2023 at a Summer camp. Twelve out of 13 schoolchildren were girls (92.3%) with a mean age of  $8.8 \pm 1.6$  years. Only two schoolchildren (15.4%) were exposed to previous adult BLS training. A cumulative count of 130 card was arranged activities featuring content based on the 5-finger mnemonic were completed by schoolchildren, with 60 undertaken by younger schoolchildren ( $n=7$ ) and 70 by their older schoolchildren ( $n=6$ ). Prior to adult BLS training, the median number of cards that were arranged correctly was similar in both age groups, 2 (IQR=1.5–2, min=1, max=3) for younger and 1.5 (IQR=1–2, min=1, max=3) for older schoolchildren ( $Z=-0.544$ ,  $p=0.314$ ). The most common mistake was incorrectly arranged Step 2: *Check response and breathing* with Step 3: *Call 112 and send for AED* (54.8%, 7/13). After BLS training, the median number of cards arranged correctly was 3 (IQR=2.5–4, min=1, max=5) for younger schoolchildren and 4 (IQR=3–5, min=3, max=5) for older schoolchildren ( $Z=-1.163$ ,  $p=0.147$ ). The most common mistake was incorrectly arranged Step 4: *Perform CPR* with Step 5: *Switch on the AED and follow the instructions* (38.5%, 5/13). None of the schoolchildren were able to correctly arrange the complete sequence of adult BLS steps before or after the adult BLS training.

The total median number of correctly arranged cards increased from 2 (IQR=1–2, min=1, max=3) before the adult BLS training to 3 (IQR=3–5, min=1, max=5) after the training ( $Z=-2.727$ ,  $p=0.006$ ).

**Discussion**

To our knowledge, this is the first study to develop a hand mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps with the help of a modified reactive Delphi. We successfully created two versions of the hand mnemonic versions tailored for schoolchildren on standard adult BLS and compression-only CPR. The first is designed to memorize a ratio of 30 chest compressions followed by two rescue breaths. The latter focuses on teaching compression-only CPR. Both versions are aligned with the latest Kids save lives scientific statement from the ILCOR [32] and reached a high level of consensus among ERC BLS SEC experts.

In terms of learning outcomes, our study focuses solely on the cognitive aspect (e.g., adult BLS knowledge) rather than the motivational (e.g., motivation to perform adult BLS) or behavioral aspects (e.g., adult BLS skills) as defined by Sailer and Hommer [16]. This focus persists even though our training covered both the theoretical and practical components of adult BLS. The ILCOR statement suggests that the development of cognitive skills requires both theoretical and practical training [32]. Compared to other studies that used similar cohort populations and covered both components of adult BLS, our study, like theirs [15, 29, 33], focuses only on the knowledge aspect of adult BLS. This focus is due to the physical ability limitations of schoolchildren in performing CPR [34, 35]. Although none of the schoolchildren were able to correctly arrange the complete sequence of adult BLS steps before or after the training, our pilot testing showed an improvement in the memorability of the correct adult



**Fig. 3** Five-finger mnemonic for teaching adult BLS after the modified reactive Delphi, for standard adult BLS (30 chest compressions with rescue breaths; Fig. 3A), and for compression only BLS (without rescue breaths; Fig. 3B)

BLS order when using the 5-finger mnemonic approach. A study with a similar number of schoolchildren demonstrated that using the 5-finger mnemonic improves cognitive learning outcomes [15]. Furthermore, our 5-finger mnemonic was integrated into a smartphone-based serious game called MOBICPR. The results showed that using the game at home improved the theoretical knowledge of nursing students, but not their practical skills, which aligns with the mnemonic's primary goal of helping users memorize the steps of adult BLS [36, 37].

We observed that nearly all studies involving schoolchildren as cohort populations share a common approach: the development of their own didactical materials, such as teaching cards [30], books [38], and toys [18, 38]. However, only a few of these tools have been evaluated by experts [31, 39], as was done in our study. In our research, we also utilized our didactical materials to teach and assess adult BLS knowledge, while other studies employed questionnaires [31, 34]. Future studies could incorporate software like Kahoot or similar platforms [40–42], which are better suited to the cohort, offering a more gamified and engaging approach to evaluating learning outcomes.

Both versions of the 5-finger mnemonics development in our study could serve as a *guide* for BLS instructors in teaching the theoretical part of adult BLS steps. First, the BLS instructor might demonstrate a closed fist on the left hand and compare the adult BLS steps to counting from 1 to 5 with the fingers, a method reminiscent of how schoolchildren learn to count. This technique of using the fingers to count, is known as “finger counting” or “dactylonomy”, which varies from culture to culture [43]. In the European setting, counting begins with the thumb for 1, adding the index finger for 2, including the middle finger for 3, then the ring finger for 4, and finally all four fingers plus the little finger signify 5 [44]. The next step in using the 5-finger mnemonic for teaching schoolchildren the theoretical aspects of adult BLS steps may include the Loci method, which assigns specific meanings to each finger and enhances memory through visualization along a familiar path [4, 25, 45]. For example, a “thumbs up” sign might symbolize checking for safety as the first step in adult BLS. The thumb and index finger forming an “OK sign” can help schoolchildren remember to check the victim's response by asking, “Are you OK?” as part of the next step in adult BLS. The “Gun sign” also symbolizes checking the victim's response as if pointing at them. To indicate checking for breathing, imagine a cartoon character, such as Lucky Luke, blowing smoke out the top of a gun barrel, but in the Loci approach, blowing into the “Gun sign”. The “finger snap” performed with middle finger and thumb represents two important BLS steps: 1) calling 112 and 2) sending for AED. This should be done

as soon as possible as “finger snapping” is performed. The ring finger, often associated with weddings and love between two people, could help to remind schoolchildren of CPR techniques. The presence of a ring on this finger symbolizes performing chest compressions and rescue breaths. Conversely, the absence of a ring on this finger can be associated with compression-only CPR. Finally, the little finger, being the smallest, may indicate the need for assistance when using an AED. Additionally, each of the three phalanges in the little finger could represent a letter in the acronym AED. Hand mnemonics such as ours can be particularly useful in resource-limited settings because they do not require special equipment or supplies. This makes BLS training more accessible to a wider audience [46]. To facilitate understanding we provide a demonstration video [47].

Future modifications of the 5-finger mnemonic could be developed for teaching adults in BLS too and include adaptations to local guidelines worldwide [48]. For example, the Norwegian Resuscitation Council's adult BLS algorithm recommends steps for managing adult victims with reduced consciousness or no signs of life. These include calling the emergency medical communication center (EMCC), opening the airway, and assessing breathing for 10 seconds in coordination with the EMCC. If the victim is not breathing or exhibits abnormal breathing, CPR is advised [49]. Such a sequence is easy to integrate in modified 5-finger mnemonics. The same counts for variations of the emergency number. We used in our versions the 112, which is the widely available European emergency phone number, and even available in countries outside of Europe (e.g. South Africa) [50].

Several limitations of this study are worth mentioning. First, it is a “Summer camp” study with a limited number of schoolchildren, which limits the generalizability of the results. Following this, one limitation of this study is the gender imbalance among schoolchildren, as almost all of them were girls, with only one male schoolchild. This uneven distribution could influence the results and limit the generalizability of the findings to broader populations, including males or mixed-gender groups. Future studies should aim for a more balanced gender representation to validate and extend these findings. Second, despite the few experts involved, we successfully developed a 5-finger mnemonic for teaching adult BLS using the modified reactive Delphi. Third, the participants in this pilot study were schoolchildren aged between 6 to 11 years old. It is unclear how effective this type of learning would be in younger schoolchildren or adolescents like college students or adults. Fourth, while our study involved four experts from ERC BLS SEC, we recognize that including professionals from other fields, such as child psychologists or educators, could have provided

additional insights into the learning and retention processes of schoolchildren. Future studies could benefit from a multidisciplinary approach to enhance the understanding and effectiveness of adult BLS training in school settings. Lastly, while attempting to adhere to recommendations for schoolchildren's BLS training, we were unable to achieve the optimal instructor-to-group size ratio recommended [32, 51].

Despite its limitations, the results of this pilot study suggest that the 5-finger mnemonic may be an effective tool for teaching adult BLS to schoolchildren. Considering published reviews [32, 52, 53] indicating that schoolchildren may struggle with the physical demands of performing effective CPR yet can grasp the cognitive elements of adult BLS, our modified reactive Delphi study has developed two variants of the 5-finger mnemonic. These versions are specifically designed to teach schoolchildren the theoretical aspects of adult BLS steps, accommodating their learning abilities.

## Conclusion

This 2-phase pilot study developed first in a modified reactive Delphi including BLS experts a refined 5-finger mnemonic for theoretical aspects of adult BLS steps. The process resulted in two final mnemonic versions, one for standard adult BLS including chest compressions with rescue breaths, and the other focusing solely on compressions-only CPR. The effectiveness of this mnemonic was tested in a pilot on a limited number of schoolchildren at a summer camp. The schoolchildren's participants initially had difficulty sequencing the correct steps of adult BLS. However, after training in adult BLS using the 5-finger mnemonic, an improvement in their ability to sequence the BLS steps correctly, with schoolchildren aged 10 to 11 years of age showing a higher rate of accuracy compared to younger schoolchildren (6 to 8 years of age). This suggests that the 5-finger mnemonic improved schoolchildren's understanding of the BLS steps. The study highlights the potential of using tailored educational tools, such as mnemonics, to teach important lifesaving skills to different age groups, although further research is needed comparing tailored with non-tailored education tools.

## Appendix

ERC BLS SEC experts in alphabetical order: *Cristian Abelairas-Gómez*, Sciences and CLINURSID Research Group, Universidade de Santiago de Compostela, Santiago de Compostela, Spain; Simulation and Intensive Care Unit of Santiago (SICRUS) Research Group, Health Research Institute of Santiago, University Hospital of Santiago de Compostela-CHUS, Santiago de Compostela,

Spain; *Kaushila Thilakasiri*, Ministry of Health, Sri Lanka; *Tommaso Scquizzato*, Department of Anesthesia and Intensive Care, IRCCS San Raffaele Scientific Institute, Milan, Italy; *Walter Renier*, Department of Public Health and Primary Care (General Practice), KU Leuven, University of Leuven, Leuven, Belgium.

## Abbreviations

ABC	Airway, Breathing, Circulation
AED	Automated external defibrillator
BLS	Basic life support
CPR	Cardiopulmonary resuscitation
ERC	European Resuscitation Council
ILCOR	International Liaison Committee on Resuscitation
IQR	Interquartile range
QCCPR	Quality cardiopulmonary resuscitation
SEC	Science and Education Committee
USA	United states of America

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## Authors' contributions

Nino Fijačko: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. Benjamin S Abella: Writing – review & editing. Špela Metličar: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. Gregor Štiglic: Data curation, Writing – review & editing. Robert Greif: Methodology, Visualization, Writing – review & editing. Matej Strnad: Writing – review & editing.

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## Data availability

Data supporting this study are openly available from University of Maribor at [https://univerzamb-my.sharepoint.com/:x/g/personal/nino\\_fijacko\\_um\\_si/EdxuTbWfNrpPqUG6p9XfHdsBQbfCubd7nxWC49WhgSq2pw?e=c5jUdt](https://univerzamb-my.sharepoint.com/:x/g/personal/nino_fijacko_um_si/EdxuTbWfNrpPqUG6p9XfHdsBQbfCubd7nxWC49WhgSq2pw?e=c5jUdt).

## Declarations

### Ethics approval and consent to participate

Ethical approval was obtained from the National Ethics Committee (0120–157/2018) and from schoolchildren parents or guardians with all participants signing informed consent.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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