



KIDS SAVE LIVES: a narrative review of associated scientific production

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Purpose of review

In sudden out-of-hospital cardiac arrest, bystander cardiopulmonary resuscitation (CPR) is one of the most important elements of the chain of survival. Since 2015, international health societies and associations have recognized KIDS SAVE LIVES (KSL) as an essential initiative on CPR principles dissemination among schoolchildren. Children can be potential multipliers of the CPR competencies by teaching families, relatives, and friends. This review aimed to determine the main CPR issues raised in the KSL-associated publications.

Recent findings

We found 12 Editorials, 9 Letters, 2 Special Reports, 4 Reviews, 2 Guidelines, 9 Original Articles and 17 Conference Presentations on KSL history, the schoolchildren CPR education, and KSL program implementation in several countries. In nine original studies, the main issues were instructors' and learners' CPR knowledge, skills, and retention, gender and physical aspects affecting CPR performance, types of KSL programs and new technologies to teach CPR.

Summary

The KSL-associated literature is limited to support KSL benefits. However, the KSL could potentially contribute to improve out-of-hospital CPR performed by lay people at earlier age in different countries. Children are an important target group to diffuse CPR principles ('CHECK-CALL-COMPRESS'), as they are curious, motivated and enjoy teaching others.

Keywords

children, education, KIDS SAVE LIVES, resuscitation, school

INTRODUCTION

Several national resuscitation councils and other health professional associations have made continuous education programs to improve bystander cardiopulmonary resuscitation (CPR). In Europe, KIDS SAVE LIVES (KSL) proposed that children can do CPR according to age and physical characteristics and be potential multipliers of the CPR principles and competencies in the communities by teaching families, relatives and friends. KSL was recently incorporated in the 'Systems Saving Lives' of the ERC Guidelines 2021. Children are open-minded and curious about CPR hands-on principles ('CHECK-CALL-COMPRESS'), and they enjoy showing to others what they learn and can do.

This review highlights the worldwide scientific production associated with the KSL initiative, including Editorials, Letters to the Editor, Special Reports, Reviews, Guidelines, Original Articles and Conference or Poster Abstracts. We aimed to

determine the main CPR issues raised in the KSL-associated publications.

SEARCH STRATEGY

We identified publications up to the cutoff date of 25 April 2021, via systematic searches of 'KIDS SAVE

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KEY POINTS

- This review pointed out all scientific productions directly associated with the KIDS SAVE LIVES initiative since 2015 up to 2021.
- From several publications, there were 12 Editorials, 9 Letters to the Editor, 2 Special Reports, 2 Guidelines, 9 Original Articles, 17 Conference Abstracts and 4 Reviews (1 Systematic Review in German).
- The original articles were characterized by study design: randomized trials (one poor, one fair and one good study), observational studies (two fair and two good studies) and before–after studies (two good studies).
- The main focuses of these associated scientific productions were the Kids Save Lives history, the schoolchildren CPR education, competencies development and the successful implementation in several countries around the world.

LIVES' in the following databases: PubMed, Web of Science, Embase, Scopus, the Cochrane Central Register of Controlled Trials and the CINAHL with Full Text. We did not apply any restrictions considering language and publication date.

SELECTION CRITERIA

We selected scientific publications associated with 'KIDS SAVE LIVES' classified as Editorials, Letters to the Editor, Special Reports, Reviews, Guidelines, Original Articles and Conference or Poster Abstracts.

STUDY SELECTION

Two authors (N.K.N. and I.C.S.) independently screened the publications, and both verified the titles and abstracts for eligibility. They reviewed the full texts, extracted data and performed tables. Separately, two authors independently screened publications, excluding duplicates.

DATA EXTRACTION

One author (I.C.S.) filled a table (Table 1) [1–10,11^{••},12–28,29^{••},30–36,37[•],38[•],39–55] with general information on the type of publication, first author, country, year, journal, and study title. For data extraction, we used the original articles. Two authors (I.C.S. and N.K.N.) independently assessed, and extracted data of the studies containing the following information: first author, journal, year, study design, country, objectives, subjects, assessments, outcomes, results and conclusions (Table 2).

OUTCOMES

We determined as the primary outcome KSL scientific production in the world.

QUALITY ASSESSMENT

We critically analyzed the potential of bias in each study using the Study Quality Assessment Tools of the National Institutes of Health (SQATNIH) [56], determining for each question the following: yes, no, cannot determine (CD), not applicable (NA), not reported (NR) (see in Supplementary Materials, <http://links.lww.com/COCC/A36>).

RESULTS

We screened 204 publications (four publications from other sources), and from these studies, we excluded 109 duplicates. Of the remaining 95 records, we excluded 40 publications as they slightly mentioned the initiative without direct connection with the KIDS SAVE LIVES initiative. Only 55 were associated with KIDS SAVE LIVES (49 in English and six in German). The study flowchart (Fig. 1) showed that we downloaded the 55 records, among them 9 original articles that were randomized trials, longitudinal and cross-sectional studies. We reviewed all references cited in the nine original articles to search for different works.

We found 12 Editorials [1–12], 9 'Letters to the Editor' [13–21], 2 'Special Reports' [22–23], 4 Reviews [24–27], 2 Guidelines [28,29^{••}], 9 Original Articles [30–36,37[•],38[•]], and 17 Conference or Poster Abstracts [39–55], which are in Table 1. Among the nine original articles, we found three randomized controlled trials (RCT), two longitudinal studies and four cross-sectional studies (Table 2).

We also reported the KSL-authorized logos (Fig. 2).

DISCUSSION

The worldwide scientific production associated with KIDS SAVE LIVES is broad. Among editorials, letters and special reports, we found the initiative for health education among children [2,3,5–7,23] endorsed by the WHO [1], the association between the KSL and the World Restart a Heart Initiative [4,8,10,12,22], and the association with the European Resuscitation Council (ERC) [11^{••},13,16], the implementation [7,14,15,17–19,23] and follow-up [17,20,23] in several countries, and during the pandemic coronavirus disease 2019 (COVID-19) [20].

The narrative reviews [24,25], and one of the systematic reviews [26] highlight the KSL initiative

Table 1. The worldwide scientific production associated with the KIDS SAVE LIVES initiative

Type of publication	Author	Country	Year	Journal	Study title
Editorial	Böttiger and Aken [1]	Germany	2015	<i>Resuscitation</i>	KIDS SAVE LIVES: training school children in cardiopulmonary resuscitation worldwide is now endorsed by the WHO
Editorial	Böttiger [2]	Germany	2015	<i>Eur J Anaesthesiol</i>	'A Time to Act' – anaesthesiologists in resuscitation help save 200 000 lives per year worldwide
Editorial	Böttiger <i>et al.</i> [3]	Germany	2016	<i>Resuscitation</i>	KIDS SAVE LIVES-ERC position statement on school children education in CPR: 'Hands that help - Training children is training for life'
Editorial	Olson [4]	United Kingdom	2016	<i>Brit J Card Nursing</i>	KIDS SAVE LIVES: European Restart a Heart Day 2016
Editorial	Böttiger <i>et al.</i> [5]	Germany	2017	<i>J Am Heart Assoc</i>	'KIDS SAVE LIVES': educating schoolchildren in cardiopulmonary resuscitation is a civic duty that needs support for implementation
Editorial	Böttiger <i>et al.</i> [6]	Germany	2017	<i>Notfall Rettungsmed</i>	KIDS SAVE LIVES –training schoolchildren in resuscitation
Editorial	Böttiger <i>et al.</i> [7]	Germany	2017	<i>Eur J Anaesthesiol</i>	KIDS SAVE LIVES: school children education in resuscitation for Europe and the world
Editorial	Böttiger <i>et al.</i> [8]	Germany	2018	<i>Resuscitation</i>	'All citizens of the world can save a life' – The World Restart a Heart (WRAH) initiative starts in 2018
Editorial	Rücker <i>et al.</i> [9]	Germany	2019	<i>Notfall Rettungsmed</i>	KIDS SAVE LIVES – modular teachers training course of the German Resuscitation Council (GRC) for resuscitation training in schools
Editorial	Rott <i>et al.</i> [10]	Germany	2020	<i>Gen Reanimatol</i>	Community programmes, KIDS SAVE LIVES, world restart a heart and other campaigns to increase survival after out-of-hospital cardiac arrest
Editorial	Böttiger <i>et al.</i> [11**]	Germany	2020	<i>Resuscitation</i>	KIDS SAVE LIVES: ERC Position statement on schoolteachers' education and qualification in resuscitation
Editorial	Böttiger <i>et al.</i> [12]	Germany	2020	<i>Eur J Anaesthesiol</i>	BIG FIVE strategies for survival following out-of-hospital cardiac arrest
Letter to the Editor	Semeraro <i>et al.</i> [13]	Italy	2016	<i>Resuscitation</i>	KIDS SAVE LIVES implementation in Europe: a survey through the ERC Research NET
Letter to the Editor	Semeraro <i>et al.</i> [14]	Italy	2017	<i>Resuscitation</i>	'KIDS SAVE LIVES' campaign in Italy: a picture from a nationwide survey on the web
Letter to the Editor	Semeraro <i>et al.</i> [15]	Italy	2017	<i>Resuscitation</i>	'Virtual Reality for CPR training: How cool is that? Dedicated to the 'next generation'
Letter to the Editor	Böttiger [16]	Germany	2017	<i>Resuscitation</i>	ERC Research NET: the network for sudden cardiac arrest and resuscitation research in Europe
Letter to the Editor	Bánfai <i>et al.</i> [17]	Hungary	2018	<i>Resuscitation</i>	'KIDS SAVE LIVES' in Hungary: implementation, opportunities, programmes, opinions, barriers
Letter to the Editor	Semeraro <i>et al.</i> [18]	Italy	2018	<i>Resuscitation</i>	KIDS SAVE LIVES: 3 years of implementation in Europe
Letter to the Editor	Nakagawa <i>et al.</i> [19]	Brazil	2019	<i>Resuscitation</i>	KIDS SAVE LIVES BRAZIL: a successful pilot program to implement CPR at primary and high schools in Brazil resulting in a state law for a training CPR week
Letter to the Editor	Semeraro <i>et al.</i> [20]	Italy	2020	<i>Resuscitation</i>	Renewed KIDS SAVE LIVES campaign to further increase awareness and fight sudden cardiac death in the era of COVID-19
Letter to the Editor	Bánfai <i>et al.</i> [21]	Hungary	2021	<i>Resuscitation</i>	KIDS SAVE LIVES in Hungary (KSLH): overview of the last 2 years – how does it work and how could it be better with children and teachers?

Table 1 (Continued)

Type of publication	Author	Country	Year	Journal	Study title
Special Report	Böttiger <i>et al.</i> [22]	Germany	2020	<i>J Am Heart Assoc</i>	Up to 206 million people reached and over 5.4 million trained in cardiopulmonary resuscitation worldwide: the 2019 ILCOR World Restart a Heart initiative
Special Report	Felzen <i>et al.</i> [23]	Germany	2021	<i>Der Anaesthesist</i>	Evaluation des Projekts zur Einführung von Laienreanimation an Schulen in Nordrhein-Westfalen
Narrative Review	Ecker <i>et al.</i> [24]	Germany	2015	<i>Trends Anaesth Crit Care</i>	'KIDS SAVE LIVES': school resuscitation programs worldwide and WHO initiative for this
Narrative Review	Bohn <i>et al.</i> [25]	Switzerland	2015	<i>Curr Opinion Crit Care</i>	KIDS SAVE LIVES: why schoolchildren should train in cardiopulmonary resuscitation
Systematic Review	Schroeder <i>et al.</i> [26]	Germany	2017	<i>Der Anaesthesist</i>	'KIDS SAVE LIVES'—resuscitation training for schoolchildren
Systematic Review	Finke <i>et al.</i> [27]	Germany	2018	<i>Resuscitation</i>	Gender aspects in cardiopulmonary resuscitation by schoolchildren: a systematic review
Guidelines	Böttiger <i>et al.</i> [28]	Germany	2016	<i>Notfall Rettungsmed</i>	KIDS SAVE LIVES – ERC position statement on school children education in CPR
Guidelines	Semeraro <i>et al.</i> [29 [■]]	Italy	2021	<i>Resuscitation</i>	European Resuscitation Council Guidelines 2021: Systems Saving Lives
Original Article	Beck <i>et al.</i> [30]	Germany	2016	<i>Resuscitation</i>	Teaching school children basic life support improves teaching and basic life support skills of medical students: a randomised, controlled trial
Original Article	Lukas <i>et al.</i> [31]	Germany	2016	<i>Resuscitation</i>	KIDS SAVE LIVES: a 6-year longitudinal study of schoolchildren learning cardiopulmonary resuscitation: who should do the teaching and will the effects last?
Original Article	Mpotos and Iserbyt [32]	Belgium	2017	<i>Resuscitation</i>	Children saving lives: training towards CPR excellence levels in chest compression based on age and physical characteristics
Original Article	Semeraro <i>et al.</i> [33]	Italy	2017	<i>Resuscitation</i>	KIDS (learn how to) SAVE LIVES in the school with the serious game Relive
Original Article	Wingen <i>et al.</i> [34]	Germany	2018	<i>Eur J Anaesthesiol</i>	Self-confidence and level of knowledge after cardiopulmonary resuscitation training in 14 to 18-year-old schoolchildren
Original Article	Süss-Havemann <i>et al.</i> [35]	Germany	2020	<i>BMC Public Health</i>	Implementation of basic life support training in schools: a randomized controlled trial evaluating self-regulated learning as alternative training concept
Original Article	Wingen <i>et al.</i> [36]	Germany	2021	<i>Notfall + Rettungsmedizin</i>	Die Ausbildung von Lehrerinnen und Lehrern als Multiplikatoren für den Wiederbelebungsunterricht an Schulen
Original Article	Nakagawa <i>et al.</i> [37 [■]]	Brazil	2021	<i>Am J Cardiol</i>	Effectiveness of the 40 min handmade manikin program to teach hands-on cardiopulmonary resuscitation at school communities
Original Article	Abelairas-Gómez C <i>et al.</i> [38 [■]]	Spain	2021	<i>Eur J Pediatrics</i>	KIDS SAVE LIVES in schools: cross-sectional survey of schoolteachers
Poster abstract	Semeraro F <i>et al.</i> [39]	Italy	2016	<i>Resuscitation</i>	Let's play Relive! Young people may learn how to save lives with a serious game
Poster abstract	Semeraro F <i>et al.</i> [40]	Italy	2016	<i>Resuscitation</i>	Italian Resuscitation Council: when the 'Viva! week' feat the 'KIDS SAVE LIVES' campaign
Poster abstract	Zalewski T <i>et al.</i> [41]	Poland	2017	<i>Resuscitation</i>	KIDS SAVE LIVES: comparison of different CPR teaching methods in the framework of safety education program in Poland

Table 1 (Continued)

Type of publication	Author	Country	Year	Journal	Study title
Poster abstract	Harding <i>et al.</i> [42]	United Kingdom	2018	<i>Anaesthesia</i>	Building bridges through the “KIDS SAVE LIVES” campaign
Poster abstract	Damjanovic <i>et al.</i> [43]	Germany	2018	<i>Resuscitation</i>	“Löwen retten Leben” – A federal state wide KIDS SAVE LIVES project in Germany
Poster abstract	Paris <i>et al.</i> [44]	Greece	2018	<i>Resuscitation</i>	The impact of ‘KIDS SAVE LIVES’ program on knowledge, skills and attitude of Greek students
Poster abstract	Stefanakis <i>et al.</i> [45]	Greece	2018	<i>Resuscitation</i>	KIDS SAVE LIVES in Greece: national training program of schoolchildren in cardiopulmonary resuscitation – preliminary results
Poster abstract	Achilleas <i>et al.</i> [46]	Greece	2018	<i>Resuscitation</i>	The impact of the basic life support courses and ‘KIDS SAVE LIVES’ program on attitude of Greek students
Poster abstract	Palla <i>et al.</i> [47]	Greece	2019	<i>Resuscitation</i>	Differences in the implementation of ‘KIDS SAVE LIVES’ project in schools of secondary education with different curriculums in area of Thessaly, Greece
Poster abstract	Bouletis <i>et al.</i> [48]	Greece	2019	<i>Resuscitation</i>	Knowledge and beliefs of Greek schoolteachers towards cardiopulmonary resuscitation (CPR)
Poster abstract	Paris <i>et al.</i> [49]	Greece	2019	<i>Resuscitation</i>	Differences in the implementation of KIDS SAVE LIVES programme between students coming from rural and urban places of Thessaly region, Greece
Poster abstract	Paris <i>et al.</i> [50]	Greece	2019	<i>Resuscitation</i>	Implementation of ‘KIDS SAVE LIVES’ program on students from different levels of secondary education in the Thessaly region, Greece.
Poster abstract	Sigala <i>et al.</i> [51]	Greece	2020	<i>Eur Heart J</i>	KIDS SAVE LIVES in Greece-National training program of schoolchildren in cardiopulmonary resuscitation: evaluating the impact of a nationwide educational seminar in a cohort07/03/2020 17 :30
Poster abstract	Paris <i>et al.</i> [52]	Greece	2020	<i>Eur Heart J</i>	The impact of KIDS SAVE LIVES program on knowledge, skills and attitude of students, preliminary results from 2 years of implementation
Poster abstract	Stefanakis <i>et al.</i> [53]	Greece	2020	<i>Resuscitation</i>	“KIDS SAVE LIVES in Greece-National training program of schoolchildren in cardiopulmonary resuscitation”: Evaluating the impact of a 4 year nationwide educational seminar
Poster abstract	Paris <i>et al.</i> [54]	Greece	2020	<i>Eur Heart J</i>	The impact of KIDS SAVE LIVES program on knowledge of students after the first and second year of implementation in Thessaly region of Greece
Poster abstract	Nakagawa <i>et al.</i> [55]	Brazil	2020	<i>Resuscitation</i>	Hands-only CPR training for children, adolescents and adults at the school community: The KIDS SAVE LIVES BRAZIL experience

Table 2. Original articles associated with KIDS SAVE LIVES

Authors, journal and year Study design Country	Objectives	Subjects, assessments and outcomes	Results	Conclusions
Beck et al. [30] <i>Resuscitation</i> (2016) Randomized trial Germany	To evaluate if involving medical students in public health education (BLS training of schoolchildren) is effective to improve both, teaching behavior and BLS-skills	n = 53 medical students (68% women, mean age 28 years.) Groups division: (a) Control group: 25 medical students, 16 women, mean age: 27 years. 10 with teaching experience and 9 with previous teaching training (b) Intervention group: n = 28 medical students, 20 women, mean age: 28 years, 19 individuals with teaching experience and 13 individuals with previous teaching training Outcomes: (1) Success rate BLS skills: -Checking responsiveness -Checking breathing -EMS activation - Compression quality -Effective ventilation -Electrode positioning (2) Effective teaching (8 dimensions): -Structure and clear explanation -Group interaction -Friendly teaching -Stiff neck and mask ventilation	(1) Success rate BLS exam: -43% intervention group passed BLS exam more often than 8% control [OR:10 (95%CI: 1.9-54.0; P= 0.007)] (2) Scores in eight dimensions for effective teaching: -Intervention group of students had higher mean scores in five of eight dimensions relevant for effective teaching (P= 0.031)	Medical students participating in BLS-instructor course improve their effectiveness of teaching and BLS skills. Teaching school children in BLS may prepare medical students for their future role as a clinical teacher and support the implementation of the 'Kids Save Lives' statement on training all school children worldwide in BLS at the same time
Wingen et al. [34] <i>Eur J Anaesthesiol</i> (2018) Randomized trial Germany	To evaluate a guideline-compliant 2h CPR training on knowledge and self-confidence in schoolchildren, and to identify predictors of short-term and long-term CPR knowledge and self-confidence	n = 424 schoolchildren (51% women, median age 15 years) Groups division: (a) Control group: 217 schoolchildren (49% women, median age 15 years) (b) Intervention group: 404 schoolchildren (53% women, median age 15 years) Outcomes: (1) CPR knowledge -Ensuring scene safety -Checking responsiveness -Checking breathing -EMS activation -Chest compression (2) Self-confidence	(1) CPR knowledge -Intervention (control – reference): OR: 1.59, P=0.040 -Native (immigrant – reference): OR: 1.79, P=0.011 -Previous experience [yes – reference]: OR: 0.49, P= 0.017 -Prior CPR course [yes – reference]: OR: 0.51, P=0.002 (2) Self-confidence -Intervention (control – reference): OR: 4.14, P<0.001 -Age (younger – reference): OR: 1.20, P=0.032 -Native (immigrant – reference): OR: 1.67, P=0.024	The CPR training was effective to increase knowledge and self-confidence. Older schoolchildren are more likely to develop more self-confidence after being trained

Table 2 (Continued)

Authors, journal and year Study design Country	Objectives	Subjects, assessments and outcomes	Results	Conclusions
Süss-Havemann <i>et al.</i> [35] BMC Public Health (2020) Randomized trial Germany	To assess if self-regulated learning is effective in BLS training and knowledge retention	<p><i>n</i> = 600 students (seventh and eighth grade, 52% women)</p> <p>Groups division:</p> <p>(a) Control group: <i>n</i> = 293, 50% women, mean age 12 years, 94% had no previous CPR training</p> <p>(b) Intervention group: <i>n</i> = 307, 55% women, mean age 12 years, 93% had no previous CPR training.</p> <p>Students guided their learning self-regulated and trainers supervised and supported the communication process because of comprehension and execution of the learned BLS</p> <p>Outcomes (quantification using a 1–4 points Likert-scale (two questions for each, total of 8 points):</p> <p>(1) CPR efficacy after training using self-report (<i>n</i> = 600)</p> <p>(a) Helping in general</p> <p>(b) Helping in cardiac arrest</p> <p>(c) Diminished emotional arousal</p> <p>(d) Number of correct CPR-tasks</p> <p>(2) Success rate of retention after 9-month using self-report (<i>n</i> = 494)</p> <p>(a) Helping in general</p> <p>(b) Helping in cardiac arrest</p> <p>(c) Diminished emotional arousal</p> <p>(d) Number of correct CPR-tasks</p>	<p>Control and intervention groups:</p> <p>(1) Self-evaluation of CPR efficacy after training:</p> <p>(a) Helping in general: 7.0 vs. 6.9</p> <p>(b) Helping in cardiac arrest: 7.2 vs. 7.1</p> <p>(c) Diminished emotional arousal: 6.2 vs. 6.1</p> <p>(d) Number of correct CPR-tasks: 7.4 vs. 7.7</p> <p>(2) Self-evaluation of retention after 9 months:</p> <p>(a) Helping in general: 6.5 vs. 6.4</p> <p>(b) Helping in cardiac arrest: 6.1 vs. 6.0</p> <p>(c) Diminished emotional arousal: 5.3 vs. 5.1</p> <p>(d) Number of correct CPR-tasks: 6.7 vs. 7.1</p> <p>Statistical analysis of the score means between groups and periods:</p> <p>(a) Helping in general: control > intervention (<i>P</i> = 0.038)</p> <p>(b) Helping in cardiac arrest: control = intervention (<i>P</i> = 0.135)</p> <p>(c) Diminished emotional arousal: control > intervention (<i>P</i> = 0.045)</p> <p>(d) Number of correct CPR-tasks: control = intervention (<i>P</i> = 0.052); however, boys had higher number of passed items than girls (<i>P</i> = 0.015)</p>	<p>The study did not show a higher effectiveness of self-regulated learning in comparison to the control group. The global odds ratio was not significantly different between the groups. Male individuals particularly benefited from self-regulated learning</p>
Lukas <i>et al.</i> [31] Resuscitation (2016) Longitudinal study Germany	To assess who should teach CPR (schoolteachers vs. emergency physicians) and how long it lasts (1, 3 and 6 years)	<p><i>n</i> = 177 students fifth grade</p> <p>Groups division:</p> <p>(a) Emergency physician trained <i>n</i> = 133 pupils</p> <p>-Training continued: <i>n</i> = 39</p> <p>-Training paused: <i>n</i> = 39</p> <p>(b) Schoolteachers trained <i>n</i> = 128 pupils</p> <p>-Training continued: <i>n</i> = 51</p> <p>-Training paused: <i>n</i> = 48</p> <p>Outcomes:</p> <p>(1) Students CPR knowledge (after 6 years) taught by schoolteachers or physicians</p> <p>(2) Students CPR skills (after 6 years) by schoolteachers or physicians (compressions/min, depth, ventilations/min, ventilation volume)</p> <p>(3) Students self-efficacy on CPR by schoolteachers or physicians</p>	<p>Schoolteacher vs. physicians:</p> <p>(1) Student CPR knowledge: 92.9 vs. 90.1% (<i>P</i> = 0.004)</p> <p>(2) Students CPR skills (after 6 years):</p> <p>-Compressions rate (cpm): 72.7 vs. 69.5 (NS)</p> <p>-Compression depth (mm): 40 vs. 41.9 (NS)</p> <p>-Ventilations rate (vpm): 4.8 vs. 3.8 (<i>P</i> = 0.040)</p> <p>-Ventilations volume (ml): 724 vs. 841 (NS)</p> <p>(3) Students self-efficacy on CPR (grade 1 1–4): 3.3 vs. 3.5 (NS)</p>	<p>Trained teachers can provide adequate CPR in schools. Healthcare professionals are not mandatory for CPR training (easier for schools to implement CPR training). The final evaluation after 6 years showed that CPR skills are retained even when training is interrupted for 3 years).</p>

Table 2 (Continued)

Authors, journal and year Study design Country	Objectives	Subjects, assessments and outcomes	Results	Conclusions
Semeraro et al. [34] Resuscitation (2017) Longitudinal study Italy	To assess if the game 'Relive' is effective in BLS training delivery	n = 65 (25% women, median age: 1.6 years, mean BMI: 22, mean weight: 65 kg) Groups division: (a) BMI ≤ 8 (b) BMI 19–24 (c) BMI 25–29 (d) BMI ≥ 30 Outcomes: (1) Improvement in CPR skills at baseline, competition and 3-month retention in compression depth (2) Improvement in CPR skills at baseline, competition and 3-month retention in compression rate (3) Usability of Relive as a tool to learn CPR (Likert scale 1–7)	(1) At baseline, competition and retention in compression depth (mm): (a) BMI ≤ 18: 31, 38 and 31 (b) BMI 19–24: 32, 46 and 49 (c) BMI 25–29: 39, 49 and 54 (d) BMI ≥ 30: 22, 51 and 67 Male (P < 0.01) and higher BMI (P < 0.01) affected this task Pearson Coefficient correlations: Compression depth and BMI: r = 0.46 and P < 0.001 (2) At baseline, competition and retention in compression rate (cpm): (a) BMI ≤ 18: 95, 112 and 127 (b) BMI 19–24: 97, 112 and 123 (c) BMI 25–29: 90, 108 and 171 (d) BMI ≥ 30: 49, 109 and 134 (3) The usability of Relive as a tool to learn CPR It was perceived to have a good feedback presentation (mean grade 6) and an effective visual/audio guidance (mean grade 5–6)	Relive is a useful tool to spread CPR knowledge and improve CPR skills in schoolchildren.
Mpotos and Iserbyt [33] Resuscitation (2017) Cross-sectional study Belgium	To assess the variability of compression depth in different age groups in relation to physical characteristics and to define minimal compression excellence levels for training	n = 6 schoolteachers (one woman, physical educators, age range: 35–53 years, teaching experience of 5–30 years) n = 265 students from a secondary school (42% women, age range: 12–18 years, gender-mixed, heterogeneous on the level of students' socioeconomic background) with no previous CPR course: Groups division: (a) Grade 1: 24 girls and 27 boys (b) Grade 2: 42 girls and 76 boys (c) Grade 3: 45 girls and 53 boys Outcomes: (1) Proportions of compressions with depth 5–6 cm as determinants of high-quality CPR according to grades (2) Associations between compression depth and BMI, height and weight	(1) Achievement of excellent levels of compressions (% compression depth 5–6 cm): (a) Grade 1: 25% of boys (75Q) (b) Grade 2: 25% of girls (75Q) (c) Grade 3: 60% girls (75Q) and 90% of boys (75Q) (2) the Pearson Coefficient Correlations between: -Compression depth and BMI: r = 0.30 and P < 0.01 -Compression depth and height: r = 0.35 and P < 0.01 -Compression depth and weight: r = 0.42 and P < 0.01	A minimum excellence level of 25% is achievable by boys with 12–14 years and by girls with 14–16 years and can be gradually improved to 60 and 90% according to age and gender. This might necessitate more exertion and training for some younger children, especially girls, and will probably be more easily achieved for children weighing greater than 50 kg

Table 2 (Continued)

Authors, journal and year Study design Country	Objectives	Subjects, assessments and outcomes	Results	Conclusions
Nakagawa <i>et al.</i> [37] Am J Cardiol (2021) Cross-sectional study Brazil	To assess the success rates of two Kids Save Lives Brazil face-to-face hands-on CPR programs	n = 1 977 (63% women, mean age 17 years) Groups division: (a) 120 min program with intermediate-fidelity manikins: 347 subjects, mean age: 27 years, 235 (68%) women (b) 40 min program with low-cost and handmade manikins with recycled materials: n = 1630 subjects, mean age: 16 years, 1010 (62%) women Outcomes: (1) Success rate in eight CPR tasks: (a) Checking local safety: (b) Checking victims' responsiveness (c) Calling for help (d) Checking victims' respiration (e) Hands and straight arms placement (f) Adequate compression rate (g) Adequate compression depth (h) Adequate chest release	(1) All subjects had success rate $\geq 84.5\%$ in CPR tasks: (a) local safety: -age (OR: 13.2; 95% CI: 1.80–96) -longer program (OR: 7.4; 95% CI: 1.01–53.7) (b) victims' responsiveness: -longer program (OR: 10.7; 95% CI: 1.46–77.90) (c) calling for help: -longer program (OR: 3.9; 95% CI: 1.39–10.85) (d) victims' respiration: -longer program (OR: 9.0; 95% CI: 1.22–65.80) (e) hands and straight arms placement: -age (OR: 1.7; 95% CI: 1.06–2.68) -longer program (OR: 4.0; 95% CI: 1.94–8.35) (f) compression rate: -age (OR: 2.5; 95% CI: 1.54–3.96) (g) compression depth: -age (OR: 2.7; 95% CI: 1.70–4.43) (h) chest release: -age (OR: 1.8; 95% CI: 1.12–2.80) -longer program (OR: 2.2; 95% CI: 1.22–3.83)	A 40-min and cheaper (low-cost handmade manikin) CPR program was adequate to develop and acquire the overall CPR skills for at least 89% at school communities, independently of gender. However, some individual CPR skills can be further improved with increasing age and using the longer and intermediate-cost program.

Table 2 (Continued)

Authors, journal and year Study design Country	Objectives	Subjects, assessments and outcomes	Results	Conclusions
Abelairas-Gómez et al. [38] <i>Eur J Pediatrics</i> (2021) Cross-sectional study Spain	To evaluate the knowledge related to first aid and BLS in schoolteachers in Spain	n = 3423 schoolteachers (81% women, median age: 42 years) Outcomes: (1) Assessment of first aid knowledge should be included in curricula: (a) Number of schoolteachers that know and teach first aid (b) Number of schoolteachers that agree with first aid inclusion in school curricula (2) CPR knowledge and willingness to perform CPR: (a) Number of schoolteachers that know and teach the EMS number (b) Number of schoolteachers that teach CPR at school (c) Number of schoolteachers that know compression rate and depth in babies and children (d) Number of schoolteachers that know when to use AED (e) Number of schoolteachers that know the correct CPR sequence in babies and children (f) Number of schoolteachers that are willing to perform CPR (3) Proportions of schoolteachers who know the KSL initiative and want to give their support to KSL	(1) First aid knowledge and inclusion in curricula: (a) 75% reported knowing first aid and 17% reported teaching first aid. knowledge (b) 77% reported it as fundamental 8% agreed to include first aid in schools (2) CPR knowledge and willingness to perform: (a) 89% know the EMS phone number and 87% reported to teach the EMS phone number (b) 50% taught practical CPR (c) 6% knew the compression rate and depth in babies and 16% know them in children (d) 27% knew when to use AED (e) 2% knew the right BLS sequence (f) 65% were willing to perform CPR (3) 20% knew on KSL initiative and 98% supported KSL statement	Schoolteachers who participated in the study showed a worrying lack of knowledge on BLS and first aid. BLS education of schoolteachers is a key measure to sustainably increase bystander CPR rates and integration of high-quality BLS in University curricula may increase knowledge and skills of the next generation of schoolteachers and children.
Wingen et al. [36] <i>Notfall Rettungsmedizin</i> (2021) Cross-sectional study Germany	To evaluate the role of schoolteachers as multipliers and the implementation of basic resuscitation lessons at the school-specific level under real conditions	n = 228 schoolteachers with 8612 trained schoolchildren Groups division: (a) Students trained by schoolteachers (b) Students trained by medical staff Outcomes: (1) Schoolteachers medical staff to teach CPR in schools (a) Students knowledge on resuscitation (b) Students ventilation rate (2) The ratio of teacher/student to CPR learning (3) Schoolteachers' self-confidence to teach CPR	(1) Schoolteachers vs. medical staff: (a) Students knowledge on resuscitation: 93 vs. 90% (P = 0.04) (b) Ventilation rate (rpm): 4.8 vs. 3.8 (P = 0.04) (2) Average ratio: 1 schoolteacher: 38 students (3) Schoolteachers stated to feel 'very confident' carrying out CPR on their own	Especially qualified schoolteachers reliably introduce CPR training at their schools. To reach even more pupils with the training, multiplication factors must be further increased to target support services.

AED, automated external defibrillator; BLS, basic life support; CPR, cardiopulmonary resuscitation; KSL, KIDS SAVE LIVES; OR, odds ratio.

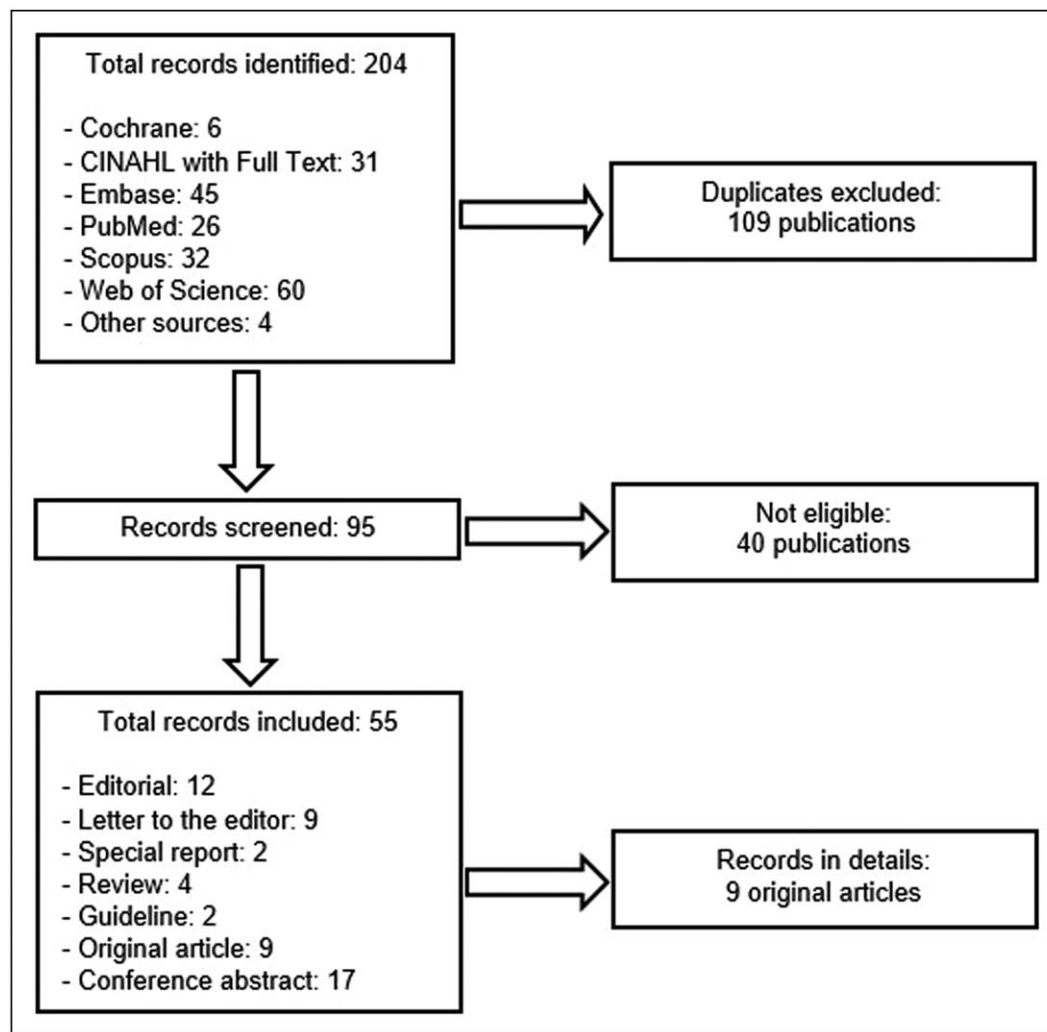


FIGURE 1. Study selection and screening flowchart.

history, purpose, the pedagogical aspects of the schoolchildren CPR training, the positive effects for developing CPR skills in schoolchildren, independent of age, increasing the number of saved lives around the world. The other systematic review [27] investigated gender aspects on CPR by schoolchildren. Girls were recognized to be more motivated in CPR training, potentially better multipliers, and boys were found to achieve better physical performance on chest compressions. All reviews pointed out that the education program should be progressive in complexity, beginning at the age of 4 years by recognizing the cardiac arrest (checking victim responsiveness) and calling for help. At the age of 12 years, people can achieve similar competence to provide high-quality CPR than adults. The expected CPR competencies: the correct recognition of sudden cardiac arrest, the adequate communication of the event making an emergency call, the adequate chest compressions rate, depth and chest return

after compression and the correct use of the automatic external defibrillator. This education program should be yearly applied, lasting 2 h. Healthcare providers, citizen-volunteers and trained schoolteachers can quickly and inexpensively multiply the CPR knowledge, skills and attitudes (CPR competencies) among children.

The main issues raised in the few original studies were instructors and learners' CPR knowledge, skills, and retention, gender and physical aspects affecting CPR performance, types of KSL programs and new technology to teach CPR. Using the SQATNIH [56] presented in the supplementary material, <http://links.lww.com/COCC/A36>, we identified one RCT [35] that assessed self-regulated continuous learning. Another RCT [30] analyzed the teaching basic life support of medical students after teaching schoolchildren. The main flaws of that study were a possible allocation bias as the researchers chose the alternation process for randomization and a high

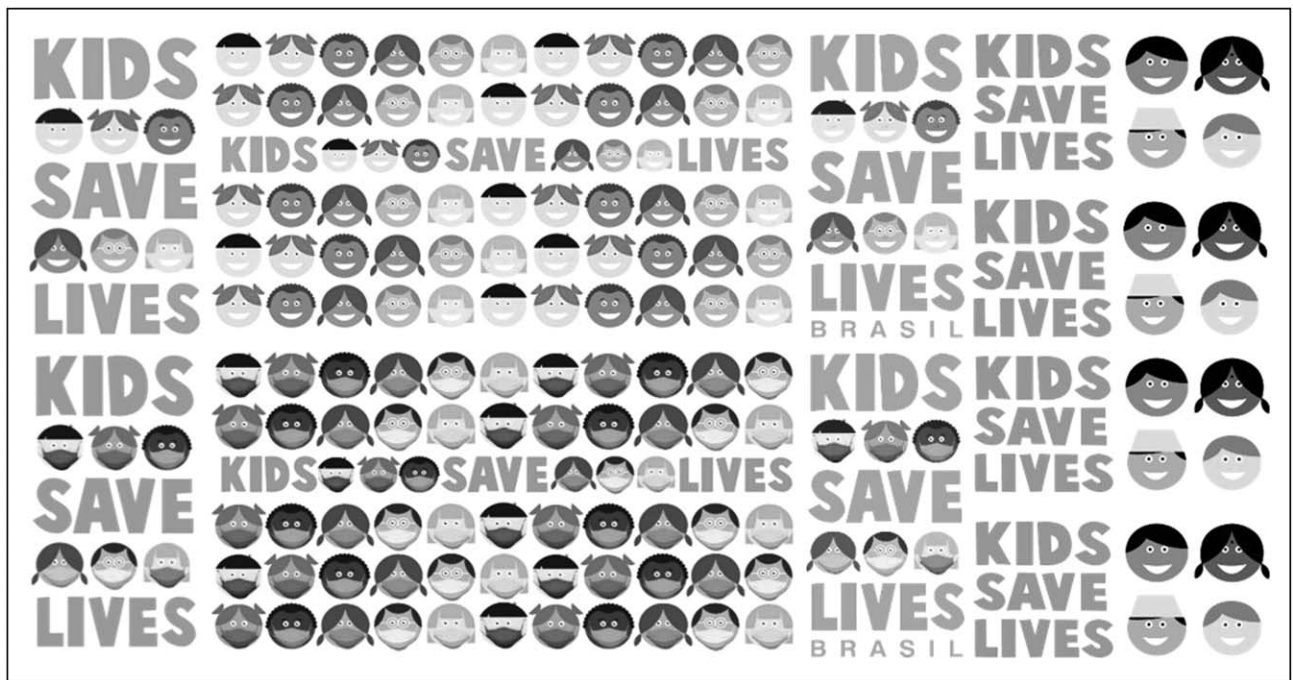


FIGURE 2. KIDS SAVE LIVES logos.

drop-out rate of schoolchildren resulting in an insufficient sample size. The last RCT study showed that CPR training increases knowledge (1.6-fold) and schoolchildren self-confidence (4.1-fold). On the other hand, having immigrant background decreases the probability of CPR knowledge and self-confidence. No previous experience and no prior course also decrease the probability of CPR knowledge in schoolchildren [34]. In this context, we found very few KSL-associated RCT. Therefore, studies with high methodological quality should be implemented to support scientific evidence of the KSL benefits.

Between the four cross-sectional studies, two studies included remarkable numbers of schoolchildren, adolescents and teachers. In one study [37[■]], the success rate was at least 84.5% for schoolchildren and adolescents on CPR knowledge, skills and attitudes using two types of KSL programs (a shorter low-cost one, and a more extended intermediate-cost program). Another study [38[■]] found that most schoolteachers reported having CPR knowledge, 50% used to teach practical CPR. However, very few knew the compression rate and depth, and the correct sequence of basic life support. Among schoolteachers, most of them were willing to perform CPR, and supported the KSL initiative. The other cross-sectional study [32] with students showed few proportions of the boys (aged 12–14 years) and girls (aged 14–16 years) reached the proper compression depth (5–6 cm), making final

considerations that to acquire CPR skills, more exertion and training are needed for younger children and adolescents. The fourth cross-sectional study [36] found that schoolteachers are slightly more effective than medical staff to improve students' CPR knowledge and skills.

One [31] of the two before–after studies with no control group focused on schoolchildren CPR knowledge, skills and retention comparing schoolteachers and physicians as instructors. One study [31] found that both instructors were able to provide adequate CPR training at schools. After three consecutive years of training, one group continued more than 3 years and another group quit after three years and both showed similar CPR skills. The second longitudinal study [33] showed a new free technology ('Relive') as a useful tool in CPR knowledge and skills acquisition for teaching with fun competition between schoolchildren. The study demonstrated that the serious game 'Relive' was able to improve awareness significantly in terms of knowledge of cardiac arrest and chest compression skills in a group of schoolchildren without any previous experience in CPR. Relive was able to improve retention of knowledge and was able to ensure retention of chest compression depth skill at 3 months after only one session of competition.

Several national resuscitation councils and other health professional associations have made continuous education proposals, initiatives and campaigns to improve CPR by bystanders. In

Europe, the KSL initiative raised important health education messages that children can do CPR according to age and physical characteristics. They could be potential multipliers of the CPR principles and competencies in the communities by teaching families, relatives and friends. The KSL initiative was recently incorporated in the 'Systems Saving Lives' of the ERC Guidelines 2021 [29^{••}]. Children are motivated to be multipliers of CPR in the school community. Healthcare professionals, citizen-volunteers and schoolteachers are motivated to teach CPR to children. Instructors' engagement can be associated with personal willingness to help victims of sudden cardiac arrest and by the epidemiological data that show an increase in victim survival rates in out-of-hospital sudden cardiac arrest by improving bystander CPR rates. The KSL has inspired the world and is changing the citizen's mindset to empower bystanders in CPR competencies by education at all levels.

CONCLUSION

Since 2015, the KSL is one of the most successful European initiatives that can potentially contribute to improve out-of-hospital CPR performed by lay people at earlier age in different countries. Children are an important target group to diffuse CPR principles ('CHECK-CALL-COMPRESS'), as they are curious, motivated, and enjoy teaching others. However, the KSL-associated literature is limited. Therefore, studies with high methodological quality should be implemented to support scientific evidence of the KSL benefits.

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Conflicts of interest

F.F.S. is the Chair-Elect and SEC BLS co-chair of the European Resuscitation Council; Member of the Basic Life Support (BLS) Task Force of the International Liaison Committee on Resuscitation (ILCOR); Member of the scientific committee of Italian Resuscitation Council. N/ K.N. is the National Coordinator of KIDS SAVE LIVES BRASIL. Co-Editor of Clinics. B.W.B. is the treasurer of the European Resuscitation Council (ERC); Chairman of the German Resuscitation Council (GRC); Member of the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR); Member of the Executive Committee of the German Interdisciplinary Association for Intensive Care and Emergency Medicine (DIVI), Founder of the German Resuscitation Foundation, Co-Editor of 'Resuscitation'; Editor of the Journal 'Notfall + Rettungsmedizin'; Co-Editor of the Brazilian Journal of Anaesthesiology. He received fees for lectures from the following companies: Forum für medizinische Fortbildung (FomF), Baxalta Deutschland GmbH, ZOLL Medical Deutschland GmbH, C.R. Bard GmbH, GS Elektromedizinische Geräte G. Stemple GmbH, Novartis Pharma GmbH, Philips GmbH Market DACH, Bioscience Valuation BSV GmbH.

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