



Long-term Effects of a Two-day First-aid Workshop in Primary Schools in Brandenburg, Germany: Two-year Follow-up Evaluation

Anika Dietrich* , Nicolas Volz , Josephina Kehlert , Philipp Humbsch , Robert Gintrowicz , Klemens Pawloy , Katja Icke , Stephanie Roll , Thomas Keil

*Corresponding author

ABSTRACT

Background: Long-term evaluation of studies on school-based training on cardiopulmonary resuscitation (CPR) is lacking. We aimed to determine CPR knowledge among primary school students two years after receiving first-aid training in primary school.

Methods: Two years after a school-based two-day first-aid training in three primary schools in Brandenburg, Germany, students were compared with students without school-based first-aid training using a self-reported questionnaire. The endpoints were knowledge of compression point, depth, rate, all three parameters, and the emergency phone number. We used logistic regression, adjusting for sex, age, and language spoken at home, to calculate odds ratios of four endpoints.

Results: The training and control groups included 360 (median age 11 years, 51% girls) and 458 students (10 years, 44%), respectively. Two years after the training, 51% of the trained students knew the right compression point, whereas 8%, 7%, and 3% knew the right compression depth, compression rate, and all three CPR parameters, respectively.

Submitted: 19 October 2025

Accepted: 15 December 2025

Published: 19 January 2026

International Journal of First Aid Education is a peer-reviewed open access journal published by the Aperio. © 2025 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)), which enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, so long as attribution is given to the creator.



OPEN ACCESS

More students in the intervention group knew the correct CPR parameters compared to control students (adjusted odds ratio [95% confidence interval]): compression point 2.3 [1.7–3.0]; compression depth 3.0 [1.5–5.9]; and compression rate 1.7 [0.9–3.3]. The knowledge of the right emergency number was similar at about 90% in both groups.

Conclusions: Primary school students knew more CPR parameters two years after a school-based first-aid training compared to students without such training; however, the intervention group's knowledge level of basic CPR was rather low. Further research should focus on the timing of regular school-based CPR refresher courses and include the assessment of practical CPR skills.

Key Words: basic life support, primary school children, elementary school, first aid, long-term effects, resuscitation

ABSTRAKT

Hintergrund: Da es bisher wenige Untersuchungen dazu gibt, wie langfristig das Wissen über die Herz-Lungen-Wiederbelebung bei Grundschulkindern erhalten bleibt, war es unser Ziel, dieses zwei Jahre nach einer Ersten-Hilfe-Schulung zu untersuchen.

Methoden: Zwei Jahre nach einer zweitägigen Erste-Hilfe-Schulung an drei Grundschulen im Bundesland Brandenburg (Deutschland) wurden die Schülerinnen und Schüler anhand eines selbstausgefüllten Fragebogens mit einer Gruppe verglichen, die keine Erste-Hilfe-Schulung erhalten hatten. Die Endpunkte beinhalteten die Kenntnis der richtigen Parameter einer Herzdruckmassage (Druckpunkt, -tiefe, -geschwindigkeit, einzeln und in Kombination) sowie der Notrufnummer. Mittels logistischer Regression wurden Odds Ratios zu den Endpunkten, unter Berücksichtigung von Geschlecht, Alter und der zuhause gesprochenen Sprache, berechnet.

Ergebnisse: Die Interventionsgruppe bestand aus 360 Kindern (Altersmedian 11 Jahre, 51% Mädchen) und die Kontrollgruppe aus 458 (Altersmedian 10 Jahre, 44% Mädchen). Zwei Jahre nach der Schulung gaben 51% den Druckpunkt, 8% die Drucktiefe, 7% die Druckgeschwindigkeit und 3% alle drei Parameter richtig an. Im Vergleich zu den Kindern der Kontrollgruppe kannten mehr Kinder der Interventionsgruppe die richtige Anwendung der HLW-Parameter (adjustiertes Odds Ratio [95 %-Konfidenzintervall]): Druckpunkt 2,3 [1,7–3,0]; Drucktiefe 3,0 [1,5–5,9]; und Druckgeschwindigkeit 1,7 [0,9–3,3]. Das Wissen der richtigen Notrufnummer war in beiden Gruppen mit etwa 90 % ähnlich.

Zusammenfassung: Zwei Jahre nach einer Ersten-Hilfe-Schulung wussten mehr Grundschülerinnen und Grundschüler die richtige Anwendung von Parametern der Herzdruckmassage als gleichaltrige Kinder ohne Schulung. Trotzdem war ihr Wissensstand zwei Jahre nach der Erste-Hilfe-Schulung insgesamt nur auf einem niedrigen Niveau. Weitere Studien sollten den optimalen Zeitpunkt eines Auffrischungskurses untersuchen und den Fokus auf die Evaluation praktischer Fertigkeiten legen.

Schlüsselwörter: Grundschule, Erste Hilfe, Wiederbelebung, Reanimation, Laienschulung, Schulkinder, Schüler, Laien-Wiederbelebung

ABSTRAKCYJNY

Wstęp (Tło): Brakuje danych dotyczących długoterminowej skuteczności szkolnych programów nauczania resuscytacji krążeniowo-oddechowej (RKO). Celem niniejszego badania była ocena poziomu wiedzy na temat RKO wśród uczniów szkół podstawowych dwa lata po ukończeniu szkolenia z pierwszej pomocy.

Metody: Dwa lata po przeprowadzeniu dwudniowego szkolenia z pierwszej pomocy w trzech szkołach podstawowych w Brandenburgii (Niemcy) porównano uczniów objętych szkoleniem z rówieśnikami, którzy takiego szkolenia nie

odbyli. Dane zebrano za pomocą kwestionariusza samoopisowego. Oceniano znajomość: prawidłowego miejsca uciśnięć klatki piersiowej, ich głębokości, częstości, wszystkich trzech parametrów łącznie oraz numeru alarmowego. Do analizy wykorzystano regresję logistyczną z korektą o płeć, wiek oraz język używany w domu, obliczając ilorazy szans dla czterech punktów końcowych.

Wyniki: Do badania włączeno 360 uczniów po szkoleniu (mediana wieku 11 lat, 51% dziewcząt) oraz 458 uczniów z grupy kontrolnej (mediana wieku 10 lat, 44% dziewcząt). Dwa lata po szkoleniu 51% uczniów z grupy interwencyjnej wskazało prawidłowe miejsce uciśnięć klatki piersiowej. Znajomość pozostałych parametrów była znacznie niższa: prawidłową głębokość uciśnięć znało 8% uczniów, częstość – 7%, a wszystkie trzy parametry jedynie 3%.

Uczniowie po szkoleniu istotnie częściej wykazywali poprawną wiedzę na temat parametrów RKO w porównaniu z grupą kontrolną (skorygowany iloraz szans [95% przedział ufności]): miejsce uciśnięć 2,3 [1,7–3,0]; głębokość uciśnięć 3,0 [1,5–5,9]; częstość uciśnięć 1,7 [0,9–3,3]. Znajomość prawidłowego numeru alarmowego była wysoka i podobna w obu grupach (około 90%).

Wnioski: Uczniowie szkół podstawowych, którzy uczestniczyli w szkoleniu z pierwszej pomocy, wykazywali po dwóch latach lepszą znajomość podstawowych zasad RKO niż ich nieprzeszkoleni rówieśnicy. Mimo to ogólny poziom wiedzy pozostawał niski. Przyszłe badania powinny koncentrować się na ustaleniu optymalnej częstotliwości szkoleń przypominających RKO w szkołach oraz uwzględniać ocenę praktycznych umiejętności resuscytacyjnych.

Słowa kluczowe: szkoła podstawowa, pierwsza pomoc, resuscytacja, reanimacja, szkolenie dla laików, dzieci w wieku szkolnym, uczniowie

The proportion of bystander cardiopulmonary resuscitation (CPR) in patients who experienced an out-of-hospital cardiac arrest in countries like Sweden is about 80% (Jerkeman et al., 2022). In Germany, where affected persons are on average 70 years old, it is still lower, although it increased over the past years from 20% (2012) to 50% (2022) (Fischer et al., 2023). In 2024, the bystander CPR rate in Germany rose to approximately 55% (Fischer et al., 2025).

Thus, the World Health Organization (WHO) has endorsed the program “Kids save lives” as one way of improving the number of bystander resuscitation. Schoolchildren may also function as multipliers and may spread the knowledge on resuscitation to their families. The program targets 12-year-old students learning how to perform CPR in school (Bohn et al., 2015).

The current recommendations for basic life support training in schools according to the International Liaison Committee on Resuscitation (ILCOR) scientific statement of 2023 focus on both a hands-on and a theoretical approach of training students annually in school and training the teachers as instructors. Children as young as four years of age seem to be able to learn

how to call for help as a first step. Thus, the careful development (and evaluation) of age-specific training of first aid and CPR may start earlier in school-age children than previously thought appropriate (Schroeder et al., 2023).

Evaluations of school-based first-aid training have shown positive short-term effects (e.g., over periods of one year and six months), but long-term evaluations for 12 months or more are scarce (Bánfai, et al., 2017; Calicchia et al., 2016; Connolly et al., 2007).

Thus, to explore possible long-term effects of school-based first-aid training, the present study aimed to evaluate cardiopulmonary resuscitation knowledge (as main outcomes) and willingness to help (as further outcomes) among students two years after first-aid training in primary school compared to students of schools in the same region without such school-based training.

MATERIAL AND METHODS

Study setting and design

In 2016 and 2017, selected primary schools in the rural German state of Brandenburg conducted a two-day first-aid training program coordinated by the registered non-

profit organization Pépinière. The trainers were specifically trained paramedics, medical students, and volunteers from other health professions. First-aid training took place on two consecutive school days (in total 10–12 hours of teaching), followed by an assessment on the third day, which was also regarded as a repetition of the training. Methods and first results have been published previously (Humbsch et al., 2023).

The anonymous two-year follow-up assessment using self-report questionnaires on paper for the evaluation was conducted in three of these schools (schools A–C) between March 2019 and February 2020. In the same regions as the intervention schools, we recruited students of similar ages from three primary schools (schools D–F) without previous formal school-based first-aid training. In Brandenburg, Germany, primary schools include six grades (i.e., usually children from 6 to 12 years of age). For the intervention group, longitudinal data is available, but not for the control group.

Participating schools

Out of the six primary schools that were recruited for the initial short-term evaluation of the school-based training workshop, we were able to include three schools (labeled as Schools A–C) for the two-year follow-up assessment of the present study. Among the remaining three schools, two with a focus on integrating children with special needs were excluded because their training differed from the other four intervention schools. We did not consider it to be comparable with the training course for primary schools in general. The third school was excluded because the principal denied participation in the two-year follow-up assessment without giving any reason.

The follow-up assessment took place two years after the primary school-based first-aid training course. Only students up to 11 years of age were included as the older students who were in grades five and six had left primary school since the training took place.

The initial planning of the study did not include a two-year follow-up assessment. However, in addition to the before-and-after comparisons with the students from the intervention group, we additionally included similarly aged students from three other primary schools

(Schools D–F), which did not have any school-based first-aid training course. These three schools were from the same rural regions as the intervention schools (A–C). Due to a post-hoc decision to include a control group, randomization of the participating schools was not possible.

Questionnaire assessment

For the follow-up of Schools A–C (intervention) and the assessment in Schools D–F (control), the parents were notified in advance via a standardized letter of information about the study's aims. We explained that it was an anonymous assessment "about important health related topics" to avoid parents preparing their children specifically for first aid and resuscitation topics. The parents' consent was handled by each school individually. Some schools considered the questionnaire as part of the regular classes, while others considered it as an add-on to the regular class and gave the parents the choice to deny their children's participation in the questionnaire assessment.

Outcome and Exposure

The main exposure was the school-based first-aid training (two years ago among students at Schools A–C), the reference category was no such training (control group, Schools D–F). As main outcomes, we evaluated five important resuscitation and first-aid parameters:

Knowledge of:

- (i) compression point (correct answer: crossing of sternum and line between the mammillae, lower third of sternum, middle of chest),
- (ii) compression depth (correct answer: 5–6 cm),
- (iii) compression rate (correct answer: 100–120/min or 2/sec),
- (iv) all three basic CPR parameters (compression point, depth and rate)
- (v) the emergency telephone number (correct answer: 110 or 112).

Furthermore, we descriptively evaluated the willingness of the students to help in an emergency situation as an additional outcome.

Ethics

The ethical review board of the university hospital Charité – Universitätsmedizin Berlin (Berlin, Germany) approved the study (application number: EA2/123/18). The individual questionnaires included the names of schools, but were answered anonymously by the students.

Statistical methods

We followed an explorative approach for this evaluation. The basic sociodemographic characteristics were presented by absolute and relative frequencies for categorical variables and by median, 25th and 75th percentile, minimum, and maximum for continuous variables.

For the four main outcomes, logistic regressions were performed. We present the crude results and results adjusted for age, sex, and language spoken at home as potential confounders. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). Since all results are considered exploratory, there is no level of significance, and we did not adjust for multiple testing. For the fifth endpoint (knowledge of all three resuscitation parameters), odds ratios were not calculated because the number of cases was too small. For outcomes, we compared the changes in the five first-aid parameters (listed above) from baseline to two years after the school-based training course among students of the intervention group. Statistical analyses were performed using IBM SPSS Statistics 28 (Armonk, New York, USA).

RESULTS

Participants in the intervention group

In the intervention group (Schools A–C), 716 students aged up to 11 years took part in the two-day school-based first-aid training in 2017. Out of these, 115 former students from fifth and sixth grade had moved on to secondary school (i.e., grade 7 and higher in this German state) and thus were excluded from our two-year follow-up assessment. Of all primary school students, 239 were excluded because they had left school since the training took place or were not present on the day of our two-year evaluation (e.g. due to sickness). Thus, in total, 360 students (60.1% of 599 grade 1–4 students) took part in the two-year follow-up assessment and were included in the present analysis (Figure 1). Fifty-five students (across all three schools), mainly those who joined after the training course two years prior, were allowed to fill out the questionnaire but were excluded from the present analysis.

Participants in the control group

Out of 459 students in the control group, one student was excluded due to participation in the same first-aid training at a different school. This resulted in 458 students from schools D–F without school-based first-aid training as the control group for the present analysis.

Baseline characteristics

At baseline, the intervention group included 599 students with a mean age of 8.4 years (standard deviation (SD) 1.4). At the two-year follow-up, we were able to

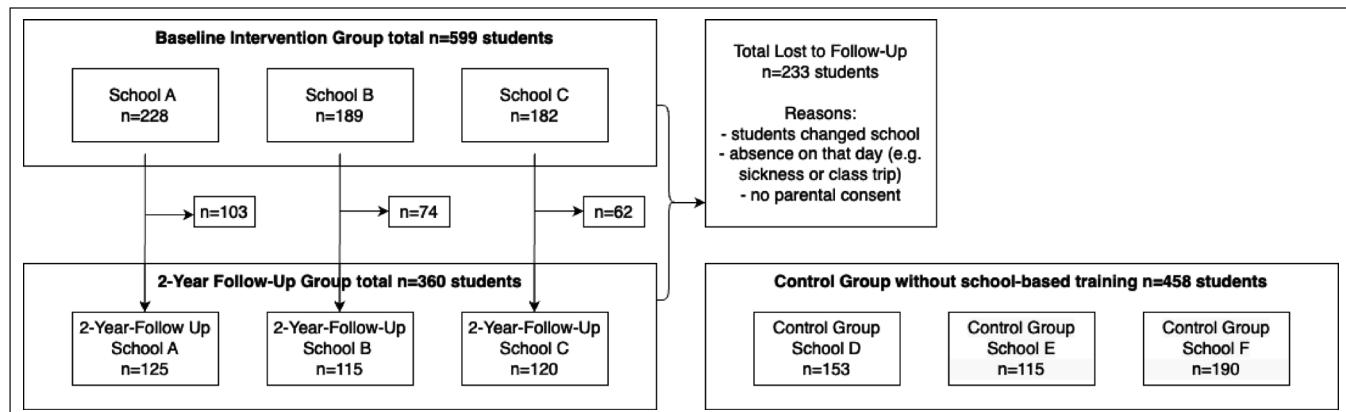


Figure 1: Flow Chart of the Study Population for the Evaluation of Resuscitation Knowledge and Willingness to Help Among Primary School Students Two Years after a Two-day School-based Training Course ('Intervention').

include 360 students with a mean age of 10.4 years (SD 1.3) (Table 1). Over the two years, the proportion of male students stayed constant at 49%. At baseline in the intervention group, there were slightly more students who did not speak German at home (5%) than in the two-year follow-up (3%).

The control group (without school-based first-aid training) included 458 students with a mean age of 10.1 years (SD 1.3) and slightly more male students (56%) than the intervention group. Among the control group students only 2% did not speak German at home.

Knowledge of compression point

The location of the compression point was correctly answered by 29% of the intervention group students immediately after the two-day training and 51% at the two-year follow-up (schools A–C). In the control group (schools D–F) 30% answered it correctly (Table 2 and Figure 2). After adjusting for age, sex, and language spoken at home, the odds of correctly identifying the compression point were twice as high in the two-year follow-up intervention group as in the control group. The odds of knowing the compression point were higher

among female vs. male students. Each one-year increase in age was associated with 1.3 times higher odds of a correct response. There was no difference between students who spoke German vs those who did not speak German at home (Table 3).

Knowledge of compression depth

In the intervention group, the compression depth was answered correctly by 49% immediately after the two-day training and 8% at the two-year follow-up (schools A–C). In the control group (schools D–F), only 3% answered it correctly (Figure 2). After adjusting the odds of correctly answering the compression depth they were three times as high in the two-year follow-up intervention group as in the control group. There were no considerable differences regarding the socio-demographic factors in the adjusted analysis (Table 3).

Knowledge of compression rate

In the intervention group, the compression rate was answered correctly by 43% immediately after the two-day training and 7% at the two-year follow-up (schools A–C). Only 4% of the control group (schools D–F)

Basic Characteristic	Intervention Group (Schools A–C)	Control Group (Schools D–F)
Immediately after Two-Day Training N = 599 students, grades 1–4 n (%)	Two-Year Follow-Up N = 360 students*, grades 3–6 n (%)	N = 458 students, grades 3–6 n (%)
Male sex, % (n)	49% (294)	49% (175)
Age, in years		
Mean (SD)	8.4 (1.4)	10.4 (1.3)
Median	8	11
(Minimum – Maximum)	(6–11)	(8–13)
Language spoken at home, % (n)		
Only or mainly German	94% (565)	97% (349)
Only other languages than German	5% (31)	3% (10)
		2% (7)

Table 1: Sociodemographic Characteristics of Primary School Students in Intervention Group (Schools A–C) and Control Group (Schools D–F).

Note: *All 360 students in the anonymous two-year follow-up assessment were also part of the assessment directly after the two-day training. Rounded percentages may not add up to a 100%.

SD = standard deviation, n = number of cases

Basic Characteristic	Intervention Group (Schools A–C)		Control Group (Schools D–F)
	Immediately after Two-Day Training N = 599 students % (n)	Two-Year Follow-Up N = 360 students % (n)	N = 458 students % (n)
Correct emergency phone number (112 and/or 110)	87.0% (521)	91.1% (328)	89.7% (411)
Correct resuscitation knowledge			
Compression point	29.4% (176)	51.1% (184)	30.3 (139)
Compression depth (5–6cm)	49.2% (295)	8.1% (29)	2.8% (13)
Compression rate (100–120/min or 2/sec)	42.9% (257)	6.9% (25)	3.5% (16)
All three resuscitation parameters	14.5% (87)	0.8% (3)	0.2% (1)
Willingness to help someone in an emergency (only 1 answer possible)			
Would help everyone	73.3% (412)	70.5% (253)	79.6% (363)
Would help only if person is known to me	15.3% (86)	11.4% (41)	6.6% (30)
Not sure	10.0% (56)	17.0% (61)	12.9% (59)
Would not help	1.4% (8)	1.1% (4)	0.9% (4)

Table 2: Knowledge of the Emergency Phone Number and the Willingness to Help in an Emergency Situation and the Knowledge of the **Resuscitation Parameters** Compression Point, Compression Depth and Compression Rate among Primary School Students of the Intervention Group (at Baseline and Two-year Follow-up) and Control Group.

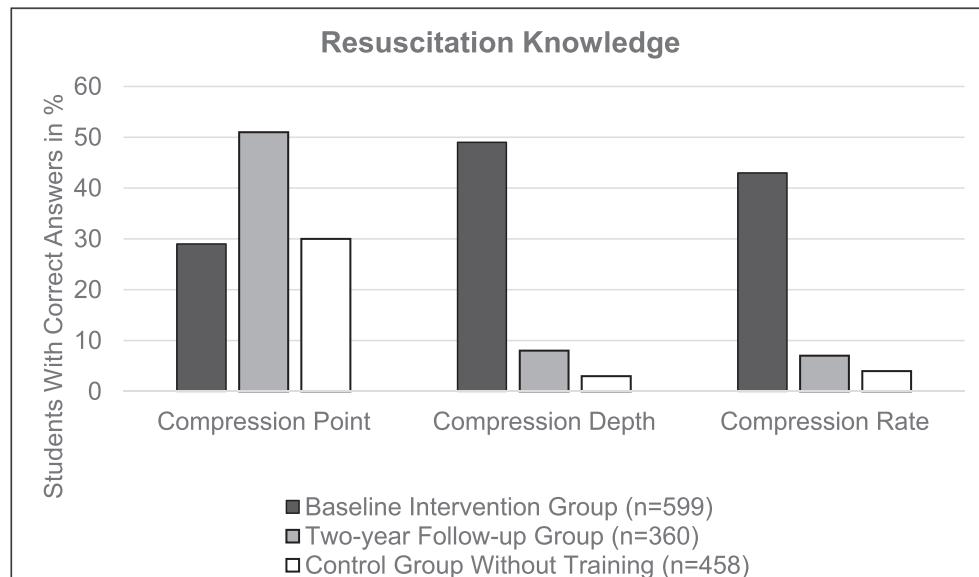


Figure 2: Resuscitation Knowledge in the Intervention Group (Schools A–C) at Baseline (Directly after the Two-day Training Session, Black Bars) and at the Follow-up Two Years Later (Grey Bars) and in the Control Group (Schools D–F Without a School-based Training, White Bars).

Outcome and Covariates	Crude Odds Ratio	Crude 95%-Confidence Intervals	P-Value	Adj. Odds Ratio	Adj. 95%-Confidence Intervals	P-Value
Correct Compression Point						
Intervention first-aid training (Ref. = Control)	2.4	1.8–3.2	<0.001	2.3	1.7–3.0	<0.001
Female sex (Ref. = male)	–	–	–	1.5	1.1–2.0	0.009
Age, per year	–	–	–	1.3	1.1–1.4	<0.001
No German spoken at home (Ref. = German language spoken at home)	–	–	–	1.0	0.4–2.7	0.972
Correct Compression Depth (5–6cm)						
Intervention first-aid training (Ref. = Control)	3.0	1.5–5.9	0.001	3.0	1.5–5.9	0.001
Female sex (Ref. = male)	–	–	–	1.0	0.6–2.0	0.892
Age, per year	–	–	–	1.0	0.8–1.2	0.824
No German spoken at home (Ref. = German language spoken at home)	–	–	–	1.0	0.1–8.1	0.987
Correct Compression Rate (100–120/min or 2/sec)						
Intervention first-aid training (Ref. = Control)	2.1	1.1–2.9	0.028	1.7	0.9–3.3	0.110
Female sex (Ref. = male)	–	–	–	1.5	0.8–2.8	0.250
Age, per year	–	–	–	1.8	1.3–2.3	<0.001
No German spoken at home (Ref. = German language spoken at home)	–	–	–	0.7	0.1–5.4	0.712
Correct Emergency Number (112 or 110)						
Intervention first-aid training (Ref. = Control)	1.2	0.7–1.9	0.510	1.1	0.7–1.8	0.761
Female sex (Ref. = male)	–	–	–	1.8	1.1–2.9	0.024
Age, per year	–	–	–	1.2	1.0–1.5	0.053
No German spoken at home (Ref. = German language spoken at home)	–	–	–	0.3	0.1–0.9	0.030

Table 3: Crude and Adjusted Multiple Logistic Regression Analyses for Four First-aid and Resuscitation Outcomes Comparing 360 Students of the Two-Year Follow-up Intervention Group (Schools A–C) with 458 Students of the Control Group Without School-based Training (Schools D–F).

Note. 'Ref' = reference group in the binary logistic regression. 'Adj.' = adjusted.

answered this correctly (Figure 2). After adjusting, a tendency toward higher odds of correctly identifying the compression rate was observed in the intervention group compared with the control group. Regarding the socio-demographic factors, only increasing age was associated with higher odds of a correct response (Table 3).

Knowledge of all three basic CPR parameters: compression point, depth and rate

Only about 1% of the students in the intervention group and about 0.2% of the students in the control group answered all three questions correctly in the two-year follow-up assessment. Two years before (i.e. immediately after the school-based two-day training) 14.5% of the intervention group were able to answer all three CPR questions correctly.

Willingness to help in an emergency situation

The percentage of students who thought that they would not help a person in an emergency situation stayed at about 1% across all groups. Immediately after the two-day training and at the two-year follow-up in the intervention group (Schools A–C), almost three-quarters would help everybody in an emergency situation. In the control group (Schools D–F without school-based first-aid training) slightly more than three-quarters would help everybody in an emergency situation (Table 2).

Emergency telephone number

The emergency telephone number was correctly answered by approximately 90% in all groups (Table 2). After adjusting, there was no considerable difference between the two-year follow-up intervention and the control group. Girls (vs. boys), and students who spoke German at home (vs. no German) answered it correctly more often (Table 3).

DISCUSSION

Main findings

Primary school students who participated in a school-based first-aid training course were more likely to know important resuscitation parameters two years later than

students from comparable schools without such training. However, the two questions on compression depth and compression rate were each answered correctly by less than 10%, compared to almost half of all students immediately after they participated in the first-aid course. The knowledge of the emergency phone number was similarly high (about 90%) in both the intervention and control groups. Furthermore, the willingness to help others in an emergency situation was comparable with over 80% in both groups.

Comparison with other studies

The ABC for Life program in the United Kingdom is a first-aid training course that targets a similar age group (10–12 years) as in our study. A single-choice questionnaire of 22 items was used to evaluate the knowledge retention after six months following a two-hour first-aid training of 79 students. The question about the compression point was correctly answered by 85% and the compression rate by 78% directly after training. The results of the follow-up after six months were not presented individually by question but summarized in a score. The score declined significantly but stayed at a higher level than the baseline score (Connolly et al., 2007). These baseline values were almost twice as high as our results directly after the two-day first-aid training. In our questionnaire, we only used open questions, which are generally harder to answer than multiple-choice questions with one correct answer out of three options.

Bánfai et al. (2019) conducted a 15-month theoretical and practical follow-up assessment after a three-day first-aid intervention in a school in Hungary. The correct hand position was practically assessed (71% correct), the correct compression depth was reported by 27% in the 15-month test, and the compression rate was reported by 20%. The hand position was correctly reported at a similar level in a Slovenian two-year follow-up study in seventh grade. The training period in that study was only 45 minutes (Borovnik Lesjak et al., 2022). In our study, the corresponding values were lower after two years. We found that 51 % reported the correct hand position, 8% the correct compression depth and 7% of the students reported the correct compression rate. Our study included a higher number of cases and multiple schools.

What may explain the better results from the students in the study of Banfai et al. (2019), is the shorter follow-up assessment (after four months) and that the students were informed about the assessment a few days before it took place. Our lower results could indicate that for younger students, earlier refresher training (e.g., annually) could be necessary.

In a longitudinal study by Lukas et al. (2016), 261 students in fifth grade were divided into two groups and received annual three-hour training for either three or six years. Both groups were evaluated after six years, but no significant differences in skills or knowledge were found. The three-year annual training group and the six-year annual training group were also divided again into emergency physician vs trainer teacher groups. The arithmetic mean percentage of the correct answers of the knowledge test was 90% after six years, no matter if the training lasted three or six years. If students were taught by a teacher, they received slightly better results in the knowledge test and in the practical assessment of the ventilation (Lukas et al., 2016). The same cohort was examined after four years regarding the starting age of 10 vs. 13 years by Bohn et al. (2012), with the result, that the older students showed higher knowledge throughout all assessments (Bohn et al., 2012).

Brief refresher courses every four months seemed to increase the practical performance in a two-year prospective study in Spain with 472 students aged 8–12 years. Three groups were examined: no refresher course, one refresher training with 50 minutes after one year and very brief (5 min) refresher trainings every four months (Abelairas-Gómez et al., 2021). A relatively large German study with 1,657 teenagers and young adults from six different cities using six different first aid training concepts showed that even with different concepts and a very short training period of 90 minutes per year a good knowledge retention after three years can be achieved in this age group. Almost 90% of the students knew the correct compression point and 77% knew the correct compression rate (Felzen et al., 2021). In our study in a younger age group, the knowledge retention was at a much lower level, which would indicate superiority of shorter intervals between refresher trainings (Abelairas-

Gómez et al., 2021). Since we could not evaluate the 5th and 6th grade, it is also possible, that this older age group would have answered similarly to the results of the other studies with older students (Bohn et al., 2012; Felzen et al., 2021).

Hindrances of first aid trainings in schools in Germany

Despite federal legal recommendations by the 16 German state ministries for education and cultural affairs in 2014, comprehensive first aid training has only been implemented in two federal states (Baden-Württemberg and Bavaria) in 2024. In other German states, CPR is part of the curriculum (e.g. in Mecklenburg-Western Pomerania), but training is not implemented throughout the whole state (yet) (Humbsch et al., 2025).

Using teachers as instructors for first-aid trainings in secondary schools was also part of the “Herzensretter” Project (English: Heart Saver) in Brandenburg, Germany. The evaluation showed that even after a 90-minute resuscitation course taught by specially trained schoolteachers may improve short term knowledge and skills, i.e., after one month. However, the project did not include a long-term evaluation (Kehlert et al., 2024).

In a qualitative study, German secondary-schoolteachers were asked about their obstacles of implementing and teaching first aid to their students. Half of the teachers interviewed were BLS-trained. Important factors that the teachers emphasized were the need for practical training and deeper knowledge before teaching it to students, the lack of time in the busy schedule for the year, the need for teaching and training equipment and the need for a room big enough for practical exercises (Dumcke et al., 2024).

Strengths and limitations

The strengths of our study included the relatively large number of students from six different schools and the same rather rural background. Furthermore, the school system with six years of primary school in the German state of Brandenburg (as opposed to only four years in many other states) made it possible to assess the knowledge

of students from grades 1 to 4 in a follow-up assessment after two years. We used a similar self-report questionnaire immediately after the training course two years before (Humbesch et al., 2023). Only the compression point was assessed differently. Whereas immediately after the course, an open question was used, in the follow-up assessment and the control group's assessment, we used a sketch of the human body, where the students had to mark the position of the compression point.

Additionally, our study contributes to filling the research gaps in younger age groups. So far, the great majority of studies in the domain of first aid education have focused on students ages 12 or older. However, the ILCOR scientific statement recently emphasized the importance of starting to teach children earlier in life, even as young as 4 years of age (Schroeder et al., 2023).

However, our study also had several limitations. Firstly, a major limitation in our study was the lack of randomization to a control and an intervention group. Thus, we cannot exclude a possible selection bias. Schools showed interest in first aid trainings and contacted the volunteer organization Pépinière. So, it is possible that only the more dedicated schools applied. Secondly, due to our anonymous approach, the data of the students in the intervention group could not be matched individually between the two assessment time points. This was another important limitation but had to be done to reduce data protection issues and increase parental consent in general. For the analysis, the students in each group had to be considered statistically independent, even though they were mostly the same students in the follow-up and the baseline group. Thirdly, we did not examine whether previous first-aid situations or experiences led to a stronger interest in first-aid topics and perhaps better results. Fourthly, there was no previous evaluation of the students in the control group two years prior to when we enrolled them in the present evaluation, since the schools were recruited later for comparison.

Fifthly, it was unclear what role the socioeconomic status of the families played since primary school students were too young to know this about their parents. Sixthly, although we included several schools

from various regions in the state of Brandenburg, our results may not be generalizable to other German states or more urban areas. Seventhly, our questionnaire assessment was labelled as a survey about "important health related topics;" however, the principals of the schools knew what the real purpose was. Thus, we cannot eliminate the possibility that the teachers might have revised first-aid measures to prepare their students. Eighthly, there was no practical exam in the follow-up assessment as compared to the assessment immediately after the course. Thus, we could not assess whether the students may have performed better practically than they did theoretically (as was shown in the previous evaluation immediately after the course).

CONCLUSIONS

Primary school students in the rural German state of Brandenburg knew more CPR parameters two years after a school-based first-aid training compared to students from the same region without such school-based training. However, the knowledge level of basic CPR was overall low two years after the course compared to the assessment immediately afterwards.

Our results suggest that annual or biannual CPR refresher training courses are necessary to retain the higher first-aid knowledge level that was achieved immediately after the training courses. Further research should focus on the number and timing of school-based refresher courses and include practical assessments, since young students may perform better in practical than in theoretical first-aid assessments.

DATA ACCESSIBILITY STATEMENT

Data will be available from A.D. upon reasonable request with restrictions regarding scientific purpose and data protection.

ARTIFICIAL INTELLIGENCE (AI) DISCLOSURE

Artificial Intelligence was not used in the study design, editorial process or data analysis. ChatGPT-5 by OpenAI was only used for rephrasing an existing SPSS Syntax code.

ADDITIONAL FILE

The additional file for this article can be found as follows:

- **Supplementary file.** Questionnaire about First Aid.
DOI: <https://doi.org/10.25894/ijfae.3097.s1>

ACKNOWLEDGEMENTS

We are very grateful to all staff and students who participated in this study. We also thank Johanna Weckwerth, Carmen Schultze-Berndt, Rafael Dolabella Portella, Kiona Keil, Konrad Bohm (Berlin), Anne Nasert (Frankfurt (Oder)), Simone Schmöche (Eisenhüttenstadt, Germany), and all other members of the Pépinière charity who contributed to this project at various stages. Furthermore, we are grateful to the volunteers from the local German rescue services, civil protection units, voluntary working firefighters, and members of the German federal agency for technical relief for their contributions and participation as trainers and supporters in the first-aid courses. We thank Carolyn Kraus (Vienna, Austria) for proofreading the manuscript. We also thank Robert Pagel (Halle (Saale), Germany) for initial statistical advice.

COMPETING INTERESTS

Anika Dietrich, Josephina Kehlert, Philipp Humbsch, Robert Gintrowicz and Klemens Pawloy are members of the voluntary organization Pépinière (Frankfurt (Oder), Germany), which received funding from the Ministry of Science, Research and Culture of the federal German State of Brandenburg to organize and conduct the first aid training. Furthermore, Anika Dietrich received a student research grant from Pépinière Stiftung, Frankfurt (Oder), Germany, for the current project. Josephina Kehlert and Robert Gintrowicz received different student research grants for other projects from Pépinière Stiftung, Frankfurt (Oder), Germany. The other authors declared no competing interests.

AUTHOR AFFILIATIONS

Anika Dietrich  orcid.org/0000-0002-7556-8587

Department of Anesthesiology, Intensive Care and Pain Medicine, Vivantes Humboldt-Hospital, Academic

Teaching Hospital of Charité – Universitätsmedizin Berlin, Berlin, Germany, Am Nordgraben 2, 13509, Berlin, Germany

Nicolas Volz  orcid.org/0009-0001-0227-3227

Institute of Social Medicine, Epidemiology and Health Economics, Charité – Universitätsmedizin Berlin, Berlin, Germany

Josephina Kehlert  orcid.org/0000-0003-2685-164X

Pépinière INP gGmbH Frankfurt (Oder), Germany

Philipp Humbsch  orcid.org/0000-0002-0414-1287

Department of Anesthesiology, Intensive Care, Emergency and Pain Medicine, Helios Hospital Bad Saarow, Bad Saarow, Germany

Robert Gintrowicz  orcid.org/0000-0002-2972-6943

Pépinière INP gGmbH Frankfurt (Oder), Germany

Klemens Pawloy  orcid.org/0000-0002-9895-7614

Pépinière INP gGmbH Frankfurt (Oder), Germany

Katja Icke  orcid.org/0000-0002-4170-8430

Datamanager, Institute for Social Medicine, Epidemiology and Health Economics, Charité Universitätsmedizin Berlin, Berlin, Germany

Stephanie Roll  orcid.org/0000-0003-1191-3289

Institute of Social Medicine, Epidemiology and Health Economics, Charité – Universitätsmedizin Berlin, Berlin, Germany

Thomas Keil  orcid.org/0000-0002-9108-3360

Institute of Social Medicine, Epidemiology and Health Economics, Charité – Universitätsmedizin Berlin, Berlin, Germany

REFERENCES

Abelairas-Gómez, C., Martínez-Isasi, S., Barcala-Furelos, R., Varela-Casal, C., Carballo-Fazanes, A., Pichel-López, M., Méndez, F. F., Otero-Agra, M., Santos, L. S., & Rodríguez-Nuñez, A. (2021). Training frequency for educating schoolchildren in basic life support: Very brief 4-month rolling-refreshers versus annual retraining—a 2-year prospective longitudinal trial. *BMJ Open*, 11(11), e052478. <https://doi.org/10.1136/bmjopen-2021-052478>

Bánfaí, B., Pandur, A., Schiszler, B., Pek, E., Radnai, B., Csonka, H., & Betlehem, J. (2019). 'The (second) year of first aid': A 15-month follow-up after a

3-day first aid programme. *Emergency Medicine Journal*, 36(11), 666–669. <https://doi.org/10.1136/emermed-2018-208110>

Bánfai, B., Pek, E., Pandur, A., Csonka, H., & Betlehem, J. (2017). “The year of first aid”: Effectiveness of a 3-day first aid programme for 7-14-year-old primary school children. *Emergency Medicine Journal: EMJ*, 34(8), 526–532. <https://doi.org/10.1136/emermed-2016-206284>

Bohn, A., Lukas, R. P., Breckwoldt, J., Böttiger, B. W., & Van Aken, H. (2015). “Kids save lives”: why schoolchildren should train in cardiopulmonary resuscitation. *Current Opinion in Critical Care*, 21(3), 220–225. <https://doi.org/10.1097/MCC.0000000000000204>

Bohn, A., Van Aken, H. K., Möllhoff, T., Wienzek, H., Kimmeyer, P., Wild, E., Döpker, S., Lukas, R. P., & Weber, T. P. (2012). Teaching resuscitation in schools: Annual tuition by trained teachers is effective starting at age 10. A four-year prospective cohort study. *Resuscitation*, 83(5), 619–625. <https://doi.org/10.1016/j.resuscitation.2012.01.020>

Borovník Lesjak, V., Šorgo, A., & Strnad, M. (2022). Retention of Knowledge and Skills After a Basic Life Support Course for Schoolchildren: A Prospective Study. *Inquiry: A Journal of Medical Care Organization, Provision and Financing*, 59, 00469580221098755. <https://doi.org/10.1177/00469580221098755>

Calicchia, S., Cangiano, G., Capanna, S., De Rosa, M., & Papaleo, B. (2016). Teaching Life-Saving Manoeuvres in Primary School. *BioMed Research International*, 2016, 2647235. <https://doi.org/10.1155/2016/2647235>

Connolly, M., Toner, P., Connolly, D., & McCluskey, D. R. (2007). The ‘ABC for life’ programme—Teaching basic life support in schools. *Resuscitation*, 72(2), 270–279. <https://doi.org/10.1016/j.resuscitation.2006.06.031>

Dumcke, R., Wegner, C., Wingen, S., & Rahe-Meyer, N. (2024). Facilitators and Barriers Perceived by German Teachers Considering Basic Life Support Education in School—A Qualitative Study. *European Journal of Investigation in Health, Psychology and Education*, 14(6), Article 6. <https://doi.org/10.3390/ejihpe14060117>

Felzen, M., Schröder, H., Beckers, S. K., Böttiger, B. W., Rott, N., Koch-Schultze, R., Wingen, S., Meißner, A., Santowski, I., Picker, O., Rahe-Meyer, N., Dumcke, R., Wegner, C., van Aken, H., Gottschalk, A., Weber, O., & Rossaint, R. (2021). Evaluation des Projekts zur Einführung von Laienreanimation an Schulen in Nordrhein-Westfalen. *Der Anaesthetist*, 70(5), 383–391. <https://doi.org/10.1007/s00101-020-00889-1>

Fischer, M., Wnent, J., Bein, B., Ramshorn-Zimmer, A., & Bohn, A. (2025). Jahresbericht des Deutschen Reanimationsregisters Außerklinische Reanimation im Notarzt- und Rettungsdienst 2024. *Anästh Intensivmed*. <https://doi.org/10.19224/ai2025.V99>

Fischer, M., Wnent, J., Bein, B., Ristau, P., & Bohn, A. (2023). Jahresbericht des Deutschen Reanimationsregisters Außerklinische Reanimation im Notarzt- und Rettungsdienst 2022. *Anästh Intensivmed*, 64, V161–V169. <https://doi.org/10.19224/ai2023.V161>

Humbsch, P., Bohm, K., Gintrowicz, R., & Jastrzebska, I. (2025). Difficulties and challenges in the implementation of resuscitation training in Germany based on surveys from the Heart Saver Project in Brandenburg. *International Journal of First Aid Education*, 8(1). <https://doi.org/10.25894/ijfae.2703>

Humbsch, P., Gintrowicz, R., Dietrich, A., Weckwerth, J., Schultze-Berndt, C., Nasert, A., Dolabella, R., Kehlert, J., Keil, K. C., Bohm, K., Schmöche, S., Icke, K., & Keil, T. (2023). Evaluation of a 2-day First Aid Course Including Basic Resuscitation With 1,268 Primary School Children Aged 6–13 Years – A Multicenter Intervention Study. *International Journal of First Aid Education*, 6(1), Article 1. <https://doi.org/10.25894/ijfae.6.1.11>

Jerkeman, M., Sultanian, P., Lundgren, P., Nielsen, N., Helleryd, E., Dworeck, C., Omerovic, E., Nordberg, P., Rosengren, A., Hollenberg, J., Claesson, A., Aune, S., Strömsöe, A., Ravn-Fischer, A., Friberg, H.,

Herlitz, J., & Rawshani, A. (2022). Trends in survival after cardiac arrest: A Swedish nationwide study over 30 years. *European Heart Journal*, 43(46), 4817–4829. <https://doi.org/10.1093/eurheartj/ehac414>

Kehlert, J., Icke, K., Sick, R., Cüppers, C., Ergec, I., Bödeker, M., Berghöfer, A., Humbsch, P., & Keil, T. (2024). Evaluation of a 90-minute school-based resuscitation course with 340 middle school students – a multicenter intervention study. *International Journal of First Aid Education*, 7(1), Article 1. <https://doi.org/10.25894/ijfae.2310>

Lukas, R.-P., Aken, H. V., Mölhoff, T., Weber, T., Rammert, M., Wild, E., & Bohn, A. (2016). Kids save lives: A six-year longitudinal study of schoolchildren learning cardiopulmonary resuscitation: Who should do the teaching and will the effects last? *Resuscitation*, 101, 35–40. <https://doi.org/10.1016/j.resuscitation.2016.01.028>

Schroeder, D. C., Semeraro, F., Greif, R., Bray, J., Morley, P., Parr, M., Kondo Nakagawa, N., Iwami, T., Finke, S.-R., Malta Hansen, C., Lockey, A., Del Rios, M., Bhanji, F., Sasson, C., Schexnayder, S. M., Scquizzato, T., Wetsch, W. A., & Böttiger, B. W. (2023). KIDS SAVE LIVES: Basic Life Support Education for Schoolchildren: A Narrative Review and Scientific Statement From the International Liaison Committee on Resuscitation. *Resuscitation*, 188, 109772. <https://doi.org/10.1016/j.resuscitation.2023.109772>