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Simulation and education

Teaching resuscitation in schools: annual tuition by trained teachers is effective starting at age 10. A four-year prospective cohort study[☆]

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ABSTRACT

Aims: Evaluation of school pupils' resuscitation performance after different types of training relative to the effects of training frequency (annually vs. biannually), starting age (10 vs. 13 years) and facilitator (emergency physician vs. teacher).

Methods: Prospective longitudinal study investigating 433 pupils in training and control groups. Outcome criteria were chest compression depth, compression frequency, ventilation volume, ventilation frequency, self-image and theoretical knowledge. In the training groups, 251 pupils received training annually or biannually either from emergency physicians or CPR-trained teachers. The control group without any training consisted of 182 pupils.

Results: Improvements in training vs. control groups were observed in chest compression depth (38 vs. 24 mm), compression frequency (74 vs. 42 min^{-1}), ventilation volume (734 ml vs. 21 ml) and ventilation frequency (9/min vs. 0/min). Numbers of correct answers in a written test improved by 20%, vs. 5% in the control group. Pupils starting at age 10 showed practical skills equivalent to those starting at age 13. Theoretical knowledge was better in older pupils. Self-confidence grew in the training groups. Neither more frequent training nor training by emergency physicians led to better performance among the pupils.

Conclusions: Pupils starting at age 10 are able to learn cardiopulmonary resuscitation with one annual training course only. After a 60-min CPR-training update, teachers are able to provide courses successfully. Early training reduces anxieties about making mistakes and markedly increases participants' willingness to help. Courses almost doubled the confidence of pupils that what they had learned would enable them to save lives.

1. Introduction

It is becoming increasingly clear that shortening the treatment-free interval following cardiac arrest is extremely important. When bystander CPR is carried out the survival rate doubles or triples.[1,2]

The current lay resuscitation rate is less than 30%,[3] with variations between countries and regions. The major reasons for low bystander CPR rates are: missed recognition of a cardiac arrest, lack of knowledge about first aid,[4] fear of infection,[5] and fear of doing something wrong.[6] In addition to the problem of "agonal breathing" as a major reason for laypersons not starting CPR,[4,7] there may be an aversion to mouth-to-mouth ventilation, as even resuscitation trainers are willing to carry out mouth-to-mouth ventilation in only 10% of patients.[4,8,9]

Approaches in which CPR training is offered as early as school age are not new.[10,11] However, published research on the topic has been limited to study periods of only a few weeks or months,[10,11] limiting the validity of the investigations. Studies conducted over several years involve a high level of logistic effort and are therefore rare. The present study addresses this challenge. The influence of training frequency, starting age and type of facilitator were explored over 4 years. It was hypothesized that annual CPR training in schools starting at age 10 and provided by trained teachers leads

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to results comparable with biannual training starting at age 13 with training provided by emergency physicians. It was also expected that annual resuscitation courses would reduce participants' anxiety about providing CPR. The results were compared with those obtained in a control group over a 2-year period.

2. Methods

After approval and patronage from the Ministry of Schools and Education and the chamber of the medical association had been received, individual consent to participate was obtained.

2.1. Study design and assessment time-points

A total of 433 pupils from two grammar schools (*Gymnasien*) in Münster and Aachen (223 male, 210 female) were included. The 132 pupils in Münster received instruction from emergency physicians, while CPR-trained teachers were used with the 119 pupils in Aachen. All teachers had previously attended a first-aid course (12 h) as part of their studies. This is in accordance with German state law, which requires all student teachers to attend a first-aid course before their final examinations. Apart from that, none of the teachers had received any CPR training. None of the teachers was a basic life support (BLS) instructor. Teachers attended a 60-min theoretical and practical CPR update course provided by emergency physicians before participating in the study.

In each city, pupils at age 10 and at age 13 were allocated class-wise to the two training intervals. One class received training courses biannually, while another class in each age group received an annual training course (Fig. 1 and Table 1).

The content of the training courses were based on the 2005 ERC guidelines[4] and consisted of 1 h of teaching with a standardized computer presentation and 2 h of hands-on training with six manikins (Laerdal Resusci Anne SkillReporter© manikin adjusted to medium chest stiffness) for each class (27–36 pupils). Instruction focused on chest compression and the fact that this can be decisive even without mouth-to-mouth ventilation.[4,12] Theoretical teaching was provided by one emergency physician or one CPR-trained teacher. Hands-on training was supervised by two emergency physicians or CPR-trained teachers. The classes consisted of 27–36 pupils. Both teaching and hands-on training were conducted during school hours. Tuition and assessments were carried out at different time-points (Table 1). The teaching materials and manikins were similar at both schools.

The control group (CG) consisted of 182 grammar-school pupils in a separate grammar school (in Münster) who had not received any training in resuscitation. To avoid creating uncertainty and anxiety about participation in a scenario-based cardiac arrest assessment without any previous training, the school was promised a full CPR training course identical to that provided for the training groups for all participants after the 2 years of serving as a control group. With this precondition, the teachers and parents additionally agreed to the requirement that none of the pupils in the control group should be allowed to participate in a CPR training or first-aid course for 2 years.

Previous theoretical information and the practical abilities of all pupils were noted at the start of the study (=pretest/baseline). The CG was tested on theory and practice a second time after 2 years. The data for the 251 pupils in the training group (TG) were collected annually (Table 1), as differences were expected in these groups.

2.2. Practical assessment

All of the pupils taking part at the participating schools were tested in the same way on the same day. The assessment was scenario-based and identical in both the TG and CG – the pupils were faced with an unconscious person lying on the ground at a bus-stop. Data were recorded during 5 min CPR. Chest compression depth, compression rate, tidal volume and ventilation frequency were measured using the Laerdal PC SkillReporting System©.

2.3. Written assessment

The pupils' state of knowledge regarding aspects of CPR in accordance with the ERC guidelines[4,7] was tested using an 11-item multiple-choice questionnaire. The same questions were used in a different order at each assessment during the study. Correct answers were added up to provide an overall score – i.e., the higher the numerical value, the better the pupils' state of CPR knowledge. Testing was similar in the TG and CG.

The pupils in the TG were also asked to what extent they regarded themselves as being capable of carrying out lay resuscitation. It was also explored how willing they would be to intervene in an emergency and to what extent they were afraid of doing something wrong. The evaluation of the self-image was only done in the TG, to document changes during the study period. Teachers and parents did not find it acceptable to evaluate the pupils in the CG, as they were not offered a chance to improve through training during the study period. The baseline evaluation and follow-up of the self-image findings in the TG provided the desired information about the development of self-confidence.

2.4. Statistical analyses

All data analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). As this was a longitudinal study, the effectiveness of the training courses was tested using general linear models (GLMs) with repeated measurements. Only those pupils were included for whom data were available at all of the assessment time-points. The Greenhouse–Geisser correction procedure, which calculates the significance level on the basis of corrected degrees of freedom, was used to exclude any violation of the sphericity requirement.[13,14]

A statistically significant interaction effect ($p < 0.05$) implies that observed differences in the means for performance development can be attributed to specific group memberships. Paired comparisons of differences in average learning, using Fisher's least significant difference (LSD)-adjusted post hoc tests, provided evidence of the extent to which the effectiveness of the resuscitation course varied in total, relative to (a) the frequency of the training provided, (b) the starting age and/or (c) the teaching method used. In addition, the effect size (η^2) makes it possible to assess the practical relevance of the results observed.[15] In accordance with the conventions established in the literature, values below 0.25 are regarded as a small effect, values between 0.25 and 0.40 as a moderate effect, and values above 0.40 as a large effect.[15]

3. Results

3.1. Is the resuscitation course effective?

The consistently better results in the TG in comparison with the CG for all performance parameters (Table 2) are attributable to the resuscitation course. This is further supported by the effect sizes observed in the interaction effects (Table 3).

After 2 years, participants in the TG were able to answer more questions correctly (Table 2). No significant differences in the evaluations of the different training groups were observed. The initially better results in theory observed in the CG were regarded as a random effect. After 2 years, the TG showed better results both with regard to compression depth and compression frequency. With regard to ventilation, performance only improved in the TG.

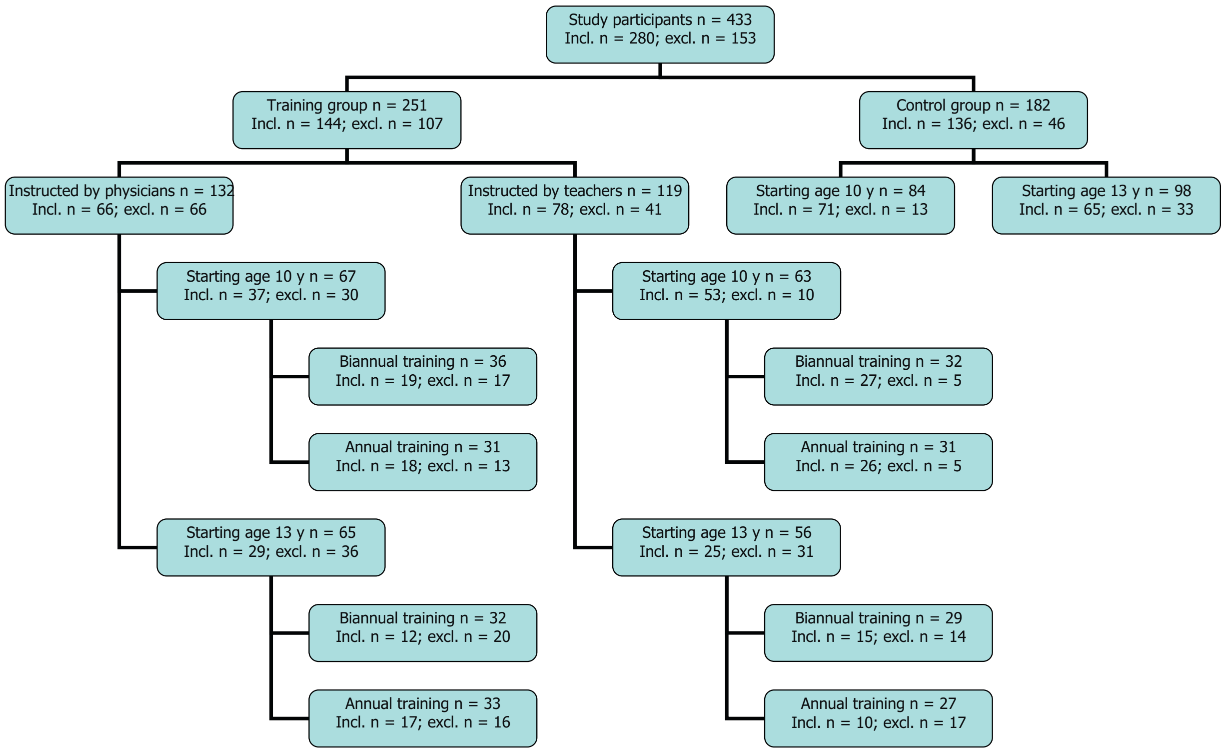

Fig. 1. Flow chart for the pupils.

Although tidal volumes increase up to 780 ml and the frequency of ventilation increases, it is still difficult to teach and learn ventilation correctly.

3.2. *Effects of training frequency*

Despite some significant differences at the individual assessment time-points for various performance parameters, seen in Table 4, strong interaction effects due to training frequency were only seen in the knowledge test and for compression depth (Table 3).

The pupils with annual training were slightly better in the pretest (baseline) for compression depth, but this finding did not persist even after 1 year of the project. It can be assumed that this was a random effect. No effects of the frequency of training courses were observed either in relation to compression frequency or ventilation performance. This observation is underlined by low effect sizes.

3.3. *Effects of age*

Comparison of the two age groups (starting age 10 vs. 13 years) showed that older pupils were better in the theoretical part at all assessment time-points.

As can be seen from Table 3, statistically significant differences between groups were also observed for compression performance (frequency and depth of compression), but the effect is not consistent (Table 4).

Table 1
Temporal sequence of assessment and training time-points.

Date			Training frequency of group		Control group[b]
			1/*y*	2/*y*	
August	2006	Assessment[a] (baseline)	X	X	X
September	2006	Training in 1st semester	X	X	
January	2007	Training in 2nd semester		X	
August	2007	Assessment[a] after 1 year	X	X	
September	2007	Training in 1st semester	X	X	
January	2008	Training in 2nd semester		X	
August	2008	Assessment[a] after 2 years	X	X	X
September	2008	Training in 1st semester	X	X	
January	2009	Training in 2nd semester		X	
August	2009	Assessment[a] after 3 years	X	X	
September	2009	Training in 1st semester	X	X	
January	2010	Training in 2nd semester		X	
August	2010	Assessment[a] after 4 years	X	X	

[a] Included practical and written assessment.
[b] Due to study design control group was conducted for 2 years.

Table 2
Abilities in the training group and control group: arithmetic means (M) and standard deviations (s) for all performance variables recorded.

	Baseline M (s)	After 2 years M (s)
Correct answers (x/11)		
Training group	8.43 (±1.57)	10.06 (±0.98)*
Control group	8.91 (±1.37)†	9.36 (±1.40)*,†
Ventilation volume (ml)		
Training group	0.00 (±0.00)	734.24 (±406.24)*
Control group	14.79 (±104.88)	21.46 (±132.27)†
Ventilations (1/min)		
Training group	0.00 (±0.00)	4.81 (±3.23)*
Control group	0.16 (±1.30)	0.29 (±2.38)†
Compression depth (mm)		
Training group	13.33 (±14.83)	37.92 (±9.84)*
Control group	14.46 (±13.77)	23.89 (±13.39)*,†
Compressions (1/min)		
Training group	25.49 (±34.94)	74.37 (±15.19)*
Control group	29.79 (±31.45)	41.92 (±25.36)*,†

* Significantly different from the previous assessment time-point ($p < 0.05$).
† Significantly different from the control group ($p < 0.05$).

As expected, the pupils starting at age 13 consistently achieved higher compression frequencies in comparison with their younger fellow-pupils, starting from the second assessment. In contrast to expectations, the younger pupils showed better performance with regard to compression depth starting from the third year of the project (Table 4). The participants' age at the start of the study had no effect on ventilation performance.

3.4. Effects of the facilitator

With regard to the pupils' level of theoretical knowledge, it was found that the initial information advantage seen in the groups taught by teachers was already cancelled out by the first training course.

Comparison of compression performances (frequency and depth of compression) only showed sporadic differences at the individual assessment time-points. The data thus showed no advantages in the emergency physicians groups. However, it is notable that, starting in the second year of the project, pupils taught by emergency physicians showed better results with regard to ventilation volume (Table 4).

3.5. Effects on self-image

Before the start of the courses, 43.5% of the pupils in the TG stated that they agreed with the statement "I'm good at CPR!" After 2 years, the figure was already 76.7%, and after 4 years 85.1%. Their assessments of their own ability to be effective were similarly positive: while at the time of the initial questionnaire survey approximately half of the learners thought they would be able to perform CPR, the figure after 4 years was nearly 90%. There were no significant differences in the evaluations of the different training groups.

After 4 years of the project, pupils in the TG were asked how they assessed the project. In all, 85.4% responded positively to the question of how well the courses had prepared them for an emergency situation; 85.2% thought they would be capable of carrying out a lay resuscitation, and 83.1% were sure they would be able to intervene in an emergency. Despite the training received, 25.3% of the pupils in the TG thought they would be too afraid to intervene.

4. Discussion

The major result of this study is that resuscitation courses for schoolchildren starting at the age of 10 are useful, as the children are capable of carrying out vigorous chest compression on a manikin. They also have the theoretical knowledge required, even after a single training course.

Surprisingly, pupils in both groups did well in the theoretical test. This might be due to the fact that the level of the questions was not high enough. Some questions were too easy to answer, others dealt with the human body itself and may have been influenced by biology classes, TV series and movies. We are unable to explain the significant difference in theoretical knowledge between

Table 3
Relative interaction effects on the different endpoints (2 or 4 years).

	F value	Degrees of freedom	Significance (p value)	Effect size (η^2)
Effects relative to *training* (training groups vs. control group); after 2 years				
Correct answers	36.37	1;317	<0.01*	0.10[a]
Compression frequency	72.40	1;317	<0.01*	0.19[a]
Compression depth	71.88	1;317	<0.01*	0.18[a]
Ventilation frequency	196.07	1;317	<0.01*	0.38[b]
Ventilation volume	392.84	1;317	<0.01*	0.55[c]
Effects relative to *frequency* of training (annual vs. biannual training); after 4 years				
Correct answers	2.93	3.31;403.37	0.03*	0.02[a]
Compression frequency	1.37	2.17;256.30	0.26	0.01[a]
Compression depth	4.51	2.79;328.81	0.01*	0.04[a]
Ventilation frequency	0.58	2.75;324.68	0.62	0.00[a]
Ventilation volume	1.80	3.53;416.55	0.14	0.02[a]
Effects relative to *starting-age* (starting-age 10 vs. 13 years); after 4 years				
Correct answers	6.04	3.31;403.37	<0.01*	0.05[a]
Compression frequency	3.29	2.17;256.30	0.03*	0.03[a]
Compression depth	4.94	2.79;328.81	<0.01*	0.04[a]
Ventilation frequency	0.51	2.75;324.68	0.66	0.00[a]
Ventilation volume	1.36	3.53;416.55	0.25	0.01[a]
Effects relative to *facilitator* (emergency physicians vs. teachers); after 4 years				
Correct answers	6.16	3.31;403.37	<0.01*	0.05[a]
Compression frequency	2.85	2.17;256.30	0.06*	0.02[a]
Compression depth	4.63	2.79;328.81	<0.01*	0.04[a]
Ventilation frequency	0.21	2.75;324.68	0.87	0.00[a]
Ventilation volume	7.08	3.53;416.55	<0.01*	0.06[a]

* Significant.
[a] Small effect.
[b] Moderate effect.
[c] Large effect.

Table 4
Abilities relative to training frequency, starting age and facilitator: arithmetic means (*M*) and standard deviation (*s*) for all performance variables recorded.

	Baseline *M* (*s*)	After 1 year *M* (*s*)	After 2 years *M* (*s*)	After 3 years *M* (*s*)	After 4 years *M* (*s*)
Correct answers (*x*/11)					
Annual training	8.60 (±0.17)	9.44 (±0.15)*	9.96 (±0.13)*	10.32 (±0.10)*	10.29 (±0.15)
Biannual training	8.21 (±0.17)	9.81 (±0.14)*	10.11 (±0.13)	10.32 (±0.10)	9.97 (±0.15)*
Starting age 10	7.71 (±0.14)	9.16 (±0.12)*	9.79 (±0.11)*	10.20 (±0.09)*	9.87 (±0.13)*
Starting age 13	9.10 (±0.19)†	10.09 (±0.16)*,†	10.28 (±0.15)†	10.45 (±0.12)	10.39 (±0.17)†
Teachers	8.93 (±0.17)	9.73 (±0.15)*	10.00 (±0.13)	10.33 (±0.10)*	10.20 (±0.15)
Emergency physicians	7.88 (±0.17)†	9.52 (±0.14)*	10.07 (±0.13)*	10.31 (±0.10)	10.06 (±0.15)
Compressions per min.					
Annual training	24.04 (±4.18)	62.50 (±2.56)*	72.94 (±1.85)*	73.77 (±1.71)	74.28 (±1.53)
Biannual training	21.68 (±4.36)	70.32 (±2.67)*,†	78.76 (±1.93)*,†	80.51 (±1.78)†	80.13 (±1.59)†
Starting age 10	23.95 (±3.62)	59.81 (±2.22)*	70.13 (±1.60)*	71.16 (±1.48)	73.80 (±1.32)*
Starting age 13	21.77 (±4.83)	73.01 (±2.96)*,†	81.57 (±2.14)*,†	83.12 (±1.97)†	80.61 (±1.77)†
Teachers	27.54 (±4.34)	74.98 (±2.66)*	77.58 (±1.92)	79.20 (±1.77)	79.12 (±1.59)
Emergency physicians	18.17 (±4.20)	57.84 (±2.58)*,†	74.12 (±1.86)*	75.09 (±1.71)	75.29 (±1.54)
Compression depth (mm)					
Annual training	14.68 (±1.81)	35.31 (±1.35)*	36.78 (±1.32)	38.31 (±1.20)	38.34 (±1.16)
Biannual training	9.88 (±1.88)	38.36 (±1.40)*	38.92 (±1.38)	39.94 (±1.25)	41.30 (±1.21)
Starting age 10	11.92 (±1.56)	34.75 (±1.17)*	37.80 (±1.14)*	40.86 (±1.04)*	42.02 (±1.00)
Starting age 13	12.64 (±2.09)	38.91 (±1.56)*,†	37.91 (±1.53)	37.39 (±1.39)†	37.62 (±1.34)†
Teachers	14.20 (±1.87)	38.43 (±1.40)*	38.13 (±1.37)	38.59 (±1.24)	37.64 (±1.20)
Emergency physicians	10.36 (±1.82)	35.24 (±1.35)*	37.58 (±1.33)	39.66 (±1.20)*	42.01 (±1.17)*,†
Ventilations per min.					
Annual training	0.00 (±0.00)	4.17 (±0.76)*	4.48 (±0.43)	5.29 (±0.57)	4.26 (±0.40)
Biannual training	0.00 (±0.00)	5.38 (±0.79)*	4.96 (±0.45)	5.28 (±0.60)	5.20 (±0.42)
Starting age 10	0.00 (±0.00)	4.81 (±0.66)*	4.90 (±0.37)	4.94 (± 0.50)	5.06 (±0.35)
Starting age 13	0.00 (±0.00)	4.74 (±0.88)*	4.54 (±0.50)	5.63 (±0.66)	4.39 (±0.46)
Teachers	0.00 (±0.00)	5.16 (±0.79)*	4.83 (±0.45)	5.25 (±0.59)	4.86 (±0.42)
Emergency physicians	0.00 (±0.00)	4.39 (±0.77)*	4.60 (±0.44)	5.32 (±0.58)	4.59 (±0.40)
Ventilation volume (ml)					
Annual training	0.00 (±0.00)	482.54 (±62.99)*	675.51 (±51.96)*	701.03 (54.79)	769.41 (±55.31)
Biannual training	0.00 (±0.00)	634.10 (±65.60)*	778.11 (±54.12)	730.04 (±57.06)	974.06 (±57.60)*,†
Starting age 10	0.00 (±0.00)	579.81 (±54.50)*	788.32 (±44.96)*	803.43 (±47.41)	945.15 (±47.85)*
Starting age 13	0.00 (±0.00)	536.83 (±72.81)*	665.29 (±60.06)	627.64 (±63.33)†	798.32 (±63.93)*
Teachers	0.00 (±0.00)	571.75 (±65.31)*	650.98 (±53.88)	627.61 (±56.81)	675.47 (±57.34)
Emergency physicians	0.00 (±0.00)	544.88 (±63.29)*	802.64 (±52.21)*,†	803.46 (±55.06)†	1068.00 (±55.57)*,†

* Significantly different from the previous assessment time-point.
† Significantly different from the comparison group.

the control group and the training group. Despite surprisingly good performance in the questionnaire, pupils were unable to resuscitate a manikin during the practical assessment (Table 2) and improved significantly through training.

The advantages expected for the older groups of pupils as a result of their greater physical strength were not observed. Although the older pupils carried out chest compression at a higher frequency, the younger pupils achieved greater depth of compression. The importance for survival of achieving a sufficient compression depth has recently been demonstrated by our own research group[16] and the ERC guidelines[4] emphasise this.

Comparison of different training intervals showed that 6-monthly courses provided no additional advantage and that annual courses are sufficient for passing on the relevant skills. This is not only desirable from the economic point of view, but also reduces the risk that pupils may become weary of excessively frequent training courses. Even after 2 years of the project, the pupils in the biannual training groups in both age groups were showing signs of fatigue and motivational problems. They repeatedly stated during the study that they were bored by the frequent training events. Skill retention showed a tendency to fade in all training groups. Regardless of whether annual or biannual training was performed, differences were only minor for most parameters. It is known that skill retention fades quickly after CPR classes.[17,18] Future studies will have to show how frequently retraining can be conducted without causing a decline in motivation.

Comparison of the facilitator showed that teachers are capable of providing effective training in resuscitation. It was expected that pupils taught by emergency physicians would achieve better results. However, this advantage was not observed. Apart from the quality of ventilation (tidal volumes), the results were identical with the two facilitators. The differences in ventilation performance suggest, however, that future training courses for the teachers should give more attention to the practice of mouth-to-mouth ventilation. Although chest compression is extremely important[12] the guidelines[4] still emphasize the great importance of mouth-to-mouth ventilation.

Approximately a quarter of the pupils were still afraid of performing CPR despite having received training. The psychological effects – i.e., the reduction in anxieties about starting CPR – should certainly not be underestimated. Willingness to start resuscitation is directly dependent on the extent to which bystanders are fearful about intervening. It is therefore all the more welcome to see that nearly 85% of the participants after the study were certain that they would be able to intervene in an emergency. In comparison with the current lay resuscitation rate of approximately 30%,[3] this would represent a major improvement.

Jones et al.[10] measured the quality of chest compressions provided by children in different age-groups for 3 min. The study showed that children in the 9–10-year-old age groups are not able to achieve an adequate depth of compression, whilst 19% of 11–12-year-olds and as many as 45% of 13–14-year-olds were able to apply adequate compression. However, the study did not take account of the extent to which ventilation affects the quality of chest compression. The authors hypothesized that providing instruction in resuscitation might be useful starting in the 10–12-year-old age group. The present report, covering a long study period of 4 years, confirms this earlier hypothesis, although the usual limitations affecting manikin studies apply – e.g., that a manikin may provide less or more resistance than a real patient.

5. Conclusions

Annual resuscitation training provided by trained teachers are effective and adequate in children aged 10 years. More frequent courses and the use of emergency physicians did not provide any advantages in relation to either theoretical or practical skills. Although improvements were achieved, the CPR training provided was unable to ensure that guideline targets in terms of compression depth and rate were met. Whilst pupils in the CG were unable to ventilate the manikin, the ventilation volume achieved in the TG exceeded the recommendations.

Implementation of CPR training in schools can nevertheless be considered practicable. Only minimal changes in the curriculum are necessary (3 h/year). Training can be provided by the existing teaching staff. The cost and lack of skilled personnel must not stand in the way of efforts to implement life-saving CPR training for pupils who are young and motivated to help.

6. Limitations

This study included three schools in two cities. The extent to which motivation, social structure, and the local teaching staff influenced the results remains unclear. The starting age of 10 years was selected on the basis of the educational system in Germany, where secondary school starts at that age. It can be expected that even younger children may be capable of contributing to survival after cardiac arrest if trained.

As a result of the study design, a total of 153 of the 433 participants were excluded from the final data evaluation. If a pupil failed to attend just one assessment or training session (Table 1), he or she was excluded even if all previous and further assessments or training sessions were completed. Reasons for incomplete participation were sick leave, change of school, or leaving school before the final secondary-school examinations.

Although the pupils in the control group did not receive any CPR training during the study period, their results partly improved (Table 2). This could be explained by the pupils' increasing age. Attending an assessment might also involve learning to some extent, in the same way as seeing CPR on the television. The possibility that participants prepared for the assessment by reading medical books or searching the Internet cannot be excluded. The possibility that pupils in the control and training groups might exchange information about the study during playtime, for example, was avoided by having the control group in a different school from the training group.

Pupils in both the training and control groups were not allowed to participate in any additional CPR training events during the study period. No other measures were taken to assess exposure to previous CPR training.

This study did not bring the pupils' CPR skills to perfection. However, it documented the pupils' acquisition of theoretical knowledge and improvement in their self-image and practical skills.

Ethical approval

This study (reference: 621-6.08.03 no. 40386) was conducted with the approval and patronage of the Ministry of Schools and Education of the state of North Rhine-Westphalia (*Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen*) and the chamber of the medical association of Westphalia.

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Conflicts of interest

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.resuscitation.2012.01.020.

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