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Training and education

Impact of community initiatives on non-EMS bystander CPR rates in West Yorkshire between 2014 and 2018



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Abstract

Aim: Bystander CPR rates have steadily increased in England between 2014 and 2018. In West Yorkshire, there have been two important developments during this time. We aimed to describe whether postcode districts (PCDs) with more cumulative annual 'Restart a Heart' (RSAH) and/or Community First Responder (CFR) scheme activity between 2014 and 2018 were associated with greater improvements in non-EMS bystander CPR rates for out-of-hospital cardiac arrest (OHCA) when compared with PCDs in the same region with lesser or no such historic activity during the same time period.

Method: We collated data from the OHCA Outcomes Registry for all non-EMS witnessed OHCA in West Yorkshire treated by Yorkshire Ambulance Service. We analysed clusters of PCDs with high and low levels of RSAH and CFR activity between 2014 and 2018 using descriptive statistics, and comparisons were made between groups using chi-square and t-test.

Results: The reported bystander CPR rate for non-EMS witnessed OHCA cases for West Yorkshire rose from 38.4% in 2014 to 69.7% in 2018. The largest increases were seen in PCDs with high RSAH activity (+34.3%) and in the combination of high RSAH and low CFR activity (+38.5%). There was no significant difference when considering the interaction between RSAH and CFR groups.

Conclusion: The data infers the possibility of a non-significant association between improved non-EMS bystander CPR rates and RSAH training and CFR scheme activity. We recommend coordinated mass training, in particular for children in regions where CPR is not a mandatory part of the school curriculum.

Keywords: Out of hospital cardiac arrest, EMS, Mass training, Bystander cardiopulmonary resuscitation

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of premature mortality in England.¹ Survival is dependent upon swift initiation of the four links in the Chain of Survival; namely recognition of the arrest and calling for help, instigation of bystander cardiopulmonary resuscitation (CPR), early defibrillation, and access to high quality post resuscitation care.² The role of the bystander is critical in this situation³, and

efforts to strengthen the first two links of the chain are particularly important in ensuring patient survival.⁴

In England, there has been a rise in bystander CPR rates over recent years. When specifically considering OHCA cases that are not witnessed by Emergency Medical Service (EMS) personnel in England, the bystander CPR rates rose steadily from 58.2% in 2014 to 69.5% in 2018.⁵ There are various potential reasons for this, including more widespread CPR training, greater awareness of the benefits of CPR, and a greater willingness to provide bystander CPR.

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In the English county of Yorkshire, two important developments during this time period were the delivery of a coordinated mass training initiative (Restart a Heart) and increased coverage of Community First Responder (CFR) schemes.

Restart a Heart (RSAH) was introduced throughout Europe as the result of a Written Declaration passed by the European Parliament in 2012 that called on member states to promote CPR training through an annual awareness campaign.⁶ The initial target audience for this training initiative was schoolchildren, and the aim was to increase the number of lay people with the capability to perform bystander CPR. Yorkshire Ambulance Service (YAS) first delivered mass CPR training to schoolchildren as part of European RSAH day in October 2014. To our knowledge, no other similar initiatives existed on this scale in the UK at the time. In 2016, the work by YAS was used as an exemplar to develop a national UK approach, co-ordinated by Resuscitation Council UK and supported by all 14 UK Ambulance Services, British Heart Foundation (BHF), St John Ambulance, and the British Red Cross.

CFR schemes are a partnership between the ambulance service and community volunteers. They were first established in Yorkshire in 2000, and between 2014 and 2018 the number of active schemes in West Yorkshire increased from 52 to 62. It is possible that having these trained members of the public in a community may also impact upon bystander CPR rates if, rather than being dispatched by the ambulance service, they happen to be present at the time of cardiac arrest.

The additional two years of organised RSAH activity in Yorkshire compared with the rest of the UK affords the unique opportunity to analyse the impact of RSAH on bystander CPR rates over that longer period of intervention. The aim of this study was therefore to test the *a priori* hypothesis that postcode districts (PCD) in the study population with more cumulative annual RSAH and/or CFR scheme activity between 2014 and 2018 were associated with greater improvements in bystander CPR rates for non-EMS witnessed OHCA when compared with PCDs in the same region with lesser or no such historic activity during the same time period.

Methods

Study design

This retrospective observational study descriptively analyses fully anonymised data routinely collected as part of an ongoing clinical audit programme and therefore ethical approval was not required. The primary outcome analysed was the bystander CPR rate for non-EMS witnessed OHCA cases in West Yorkshire treated by YAS personnel. Demographics for the study population are also described.

Data sources

The OHCA Outcomes (OHCAO) Registry, based at the University of Warwick,⁷ collates data relating to OHCA from UK Ambulance services and was used as the data source for demographics and bystander CPR rates for 2014 and 2018. Data is unavailable for 2015 to 2017 as YAS did not submit data to the OHCAO Registry during that time. Details of RSAH event and CFR scheme locations for each year from 2014 to 2018 were obtained from YAS.

Study setting

The study setting comprised the residents of the PCDs beginning with BD, HX, HD, WF and LS. This region was selected due to the greater accuracy of location records for CFR schemes compared with other parts of Yorkshire. These PCDs lie predominantly in and are centred around West Yorkshire, which is an inland metropolitan county in the north of England. The population has increased from 2.264 million in 2014 to 2.325 million in 2018.⁸ It has areas of high population density (in particular in Leeds and Bradford), a large proportion of ethnic minority populations, and areas of considerable deprivation.

Study population

The study population included patients sustaining a non-EMS witnessed OHCA treated by YAS in these PCDs (hereafter referred to as West Yorkshire). Cases that were not treated by YAS were excluded. Data was also excluded for OHCA cases that were witnessed by the EMS (as this does not reflect the direct impact of mass training initiatives), or where no bystander CPR was performed. Data submitted to the OHCAO Registry does not specifically identify cases that were subsequently attended to by a dispatched CFR.

The final study population was stratified and clustered according to 'Low' and 'High' PCDs for RSAH and CFR scheme activity between 2014 and 2018. We elected to compare high and low activity PCDs within the same region, rather than compare with a neighbouring region or county, to minimise cultural, ethnic, and socio-economic confounding factors. The year 2014 was used as a baseline for this study as RSAH training commenced in West Yorkshire in October 2014, so the annual figure for that year provides an indication of bystander CPR rates immediately prior to the intervention. We categorised each PCD by the number of years a RSAH campaign was held in that location between 2014 and 2017 inclusive, irrespective of whether they were consecutive or not. The categories were Low (0–2 years) and High (3–4 years). The presence or absence of RSAH training in October 2018 was deemed not to have impacted on bystander CPR rates for that year. Similarly, PCDs were categorised according to the number of years a CFR programme was in operation between 2014 and 2018. Here the categories were Low (0–3 years) and High (4–5 years). The areas of high and low RSAH and CFR activity are shown in Fig. 1.

Statistical analysis

The data was analysed using descriptive statistics, and comparisons made between groups using chi-square and t-test. Logistic regression analysis was carried out to assess the relationship between the likelihood of receiving bystander CPR in 2018 and the number of years RSAH training and CFR schemes had been running in the PCD in which the OHCA had occurred. A significance level was set at $p < 0.05$.

Results

Anonymised data were analysed for OHCA cases in West Yorkshire treated by YAS personnel that occurred in 2014 and 2018. A total of 2387 OHCA cases in 2014 and 2464 OHCA cases in 2018 were treated by YAS throughout all of Yorkshire (Fig. 2). It was not possible to determine the PCD of the OHCA location in only 12 cases (2014: 10; 2018: 2). A total

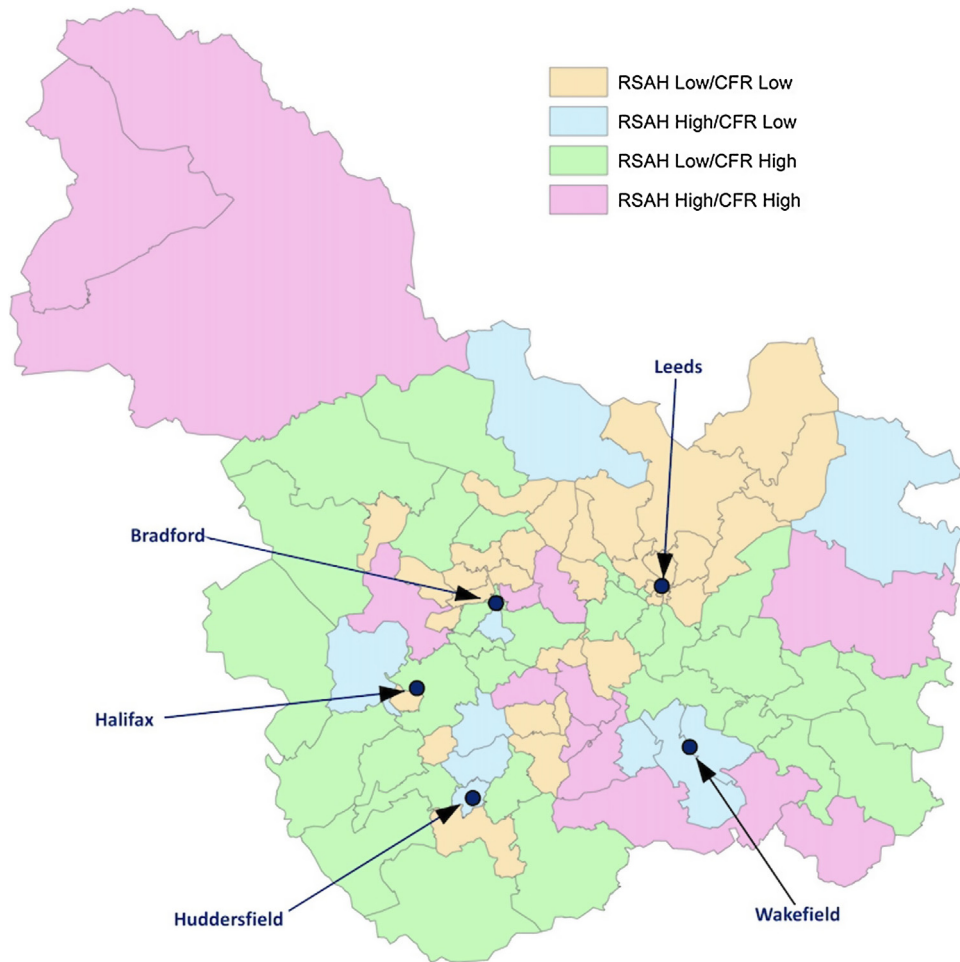


Fig. 1 – Areas of high and low RSAH and CFR activity in West Yorkshire.

of 1002 (42.2%) and 1072 (43.5%) of the OHCA cases occurred in West Yorkshire in 2014 and 2018 respectively. All cases where the OHCA was witnessed by the EMS (2014: 94; 2018: 128) would not, in all probability, receive CPR by a bystander, and so were excluded from the analysis as were those with insufficient information. Consequently, a total of 908 and 944 cases were analysed.

Table 1 shows the demographic information of non-EMS witnessed OHCA cases treated by YAS personnel from 2014 and 2018 that occurred in West Yorkshire. Cases in the area in 2014 were significantly older compared to those in 2018 ($p < 0.05$). In 2018, a significantly greater proportion of cases were reached by EMS staff in 8 minutes or less ($p < 0.001$).

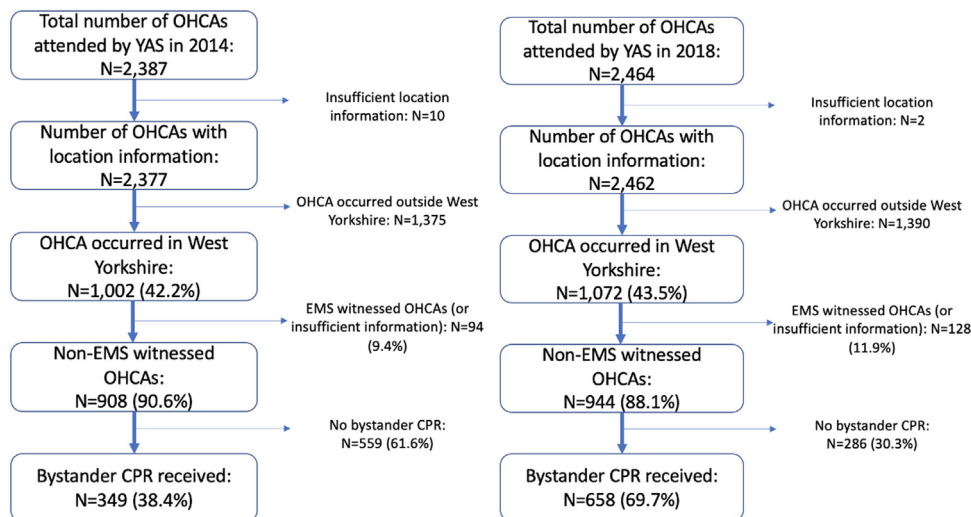


Fig. 2 – Flow diagram of OHCA cases receiving bystander CPR in 2014 and 2018.

Table 1 – Demographic details of non-EMS witnessed OHCA cases treated by YAS in West Yorkshire 2014 and 2018.

	2014 (n = 908)	2018 (n = 944)
Gender (%):		
Male	373 (41.1)	615 (65.2)
Female	219 (24.1)	301 (31.9)
Unknown	316 (34.8)	28 (2.9)
Age (years):	(n = 864)	(n = 912)
Mean (sd)	65.4 (20.8) ^a	63.4 (21.4) ^a
Median	69.0	68.4
Initial rhythm (%) ^b :		
VF/VT	64 (7.1)	210 (22.3)
Asystole		511 (54.1)
PEA		194 (20.5)
Proportion (%) of cases reached by EMS in 8 min	52.0 (n = 542)	73.5 ^c (n = 937)

NB: No statistical difference was observed between years ($p > 0.05$) with following exceptions: ^a Mean age of cases in West Yorkshire in 2014 significantly greater than in 2018 ($p = 0.046$); ^b Data for initial rhythm in 2014 is incomplete; ^c Proportion in 2018 significantly greater than 2014 ($p < 0.001$).

In West Yorkshire, the bystander CPR rate in 2014 for non-EMS witnessed OHCA cases was 38.4% (Fig. 2). The corresponding figure for 2018 was 69.7%. National figures for bystander CPR in non-EMS witnessed OHCA cases for 2014 to 2018, obtained from the OHCAO Registry, were 58.2%, 56.6%, 62.3%, 68.1%, and 69.5% respectively. This demonstrates that West Yorkshire had considerably less reported bystander CPR activity for this group in 2014 in comparison with the rest of the country, but that by 2018 rates were marginally exceeding the national picture.

Table 2 gives the difference in bystander CPR rates in clustered PCDs between categories of cumulative RSAH and CFR activity by 2018. It is apparent that bystander CPR rates significantly increased over the five years in all groups, irrespective of the number of years RSAH or CFR programmes had been in operation. The increase was slightly higher in PCDs where RSAH campaigns had been running for 3 to 4 years, although the difference was not statistically significant when compared with the other groups. The bystander CPR rates for the 'high' group for both RSAH and CFR activity was marginally greater than the national mean for 2018 (69.5%).

Table 3 gives the bystander CPR rates for combinations of RSAH and CFR groups. The rate amongst those OHCA cases that occurred in PCDs in 2018 with high historic RSAH and CFR scheme activity was 6.5% better than in those that occurred in PCDs with low historic RSAH

and CFR scheme activity, although the difference was not statistically significant. In OHCA cases that occurred with high/low or low/high categories in 2018, the bystander CPR rate was more than 5.5% greater than those with low/low activity.

When comparing groups between 2014 and 2018, the lowest positive trend was seen in the group with low activity in both RSAH and CFR throughout the whole time period. Increased positive trends were seen in PCDs that had low RSAH activity and high CFR scheme activity (+31.5%) and those with both high RSAH and CFR scheme activity (31.9%). The highest increase in bystander CPR rates, however, was seen in the PCDs that had low CFR activity between 2014 and 2018 but high levels of RSAH activity (+38.5%). None of these differences were statistically significant between the groups.

Logistic regression analysis of whether an OHCA received bystander CPR or not and the number of years RSAH and CFR schemes had been running in the PCD where the OHCA had occurred, showed a non-significant increase in the odds of receiving bystander CPR with increasing number of years (see Table 4). There was also no significant difference when considering the interaction between RSAH and CFR groups, although the group with high RSAH and CFR activity had 1.49 times more chance of receiving bystander CPR than other areas with the difference approaching statistical significance ($p = 0.08$).

Table 2 – Comparison of OHCA case numbers and bystander CPR rate between number of years RSAH campaigns and CFR schemes have been running.

	RSAH activity		CFR scheme activity	
	Low (0–2 yrs)	High (3–4 yrs)	Low (0–3 yrs)	High (4–5 yrs)
2014				
Non-EMS witnessed OHCA cases (n)	663	245	412	496
OHCA cases receiving bystander CPR (n)	257	92	151	198
Bystander CPR rate	38.8%	37.6%	36.7%	39.9%
2018				
Non-EMS witnessed OHCA cases (n)	652	292	423	521
OHCA cases receiving bystander CPR (n)	448	210	285	373
Bystander CPR rate	68.7%	71.9%	67.4%	71.6%
Difference in bystander CPR rate 2014–2018	+29.9%	+34.3%	+30.7%	+31.7%

NB: Difference in bystander CPR rate 2014–2018 significant ($p < 0.001$). No statistical difference in the increase between groups.

Table 3 – Comparison of bystander CPR rates between different combinations of years RSAH campaign and CFR programmes have been running.

RSAH category	CFR category	Number of non-EMS witnessed cases	Bystander CPR		Difference 2014–2018
			Number	Rate	
2014					
Low (0–2 yrs)	Low (0–3 yrs)	321	121	37.7%	
High (3–4 yrs)	Low (0–3 yrs)	91	30	33.0%	
Low (0–2 yrs)	High (4–5 yrs)	342	136	39.8%	
High (3–4 yrs)	High (4–5 yrs)	154	62	40.3%	
2018					
Low (0–2 yrs)	Low (0–3 yrs)	300	197	65.7%	+28%
High (3–4 yrs)	Low (0–3 yrs)	123	88	71.5%	+38.5%
Low (0–2 yrs)	High (4–5 yrs)	352	251	71.3%	+31.5%
High (3–4 yrs)	High (4–5 yrs)	169	122	72.2%	+31.9%

NB: Difference in bystander CPR rate 2014–2018 significant ($p < 0.001$). No statistical difference in the increase between groups.

Table 4 – Results of logistic regression analysis of bystander CPR on RSAH and CFR years, and categories.

	Odds ratio	P> z	95% Confidence intervals
Bivariate analysis			
RSAH years	1.03	0.58	0.92–1.17
CFR years	1.03	0.41	0.96–1.12
Interaction			
RSAH years	1.03	0.60	0.92–1.17
CFR years	1.03	0.41	0.96–1.11
RSAH/CFR category combinations			
Low/Low	Reference		
High/Low	1.20	0.46	0.74–1.96
Low/High	1.21	0.29	0.85–1.72
High/High	1.49	0.08	0.95–2.36

Discussion

The 2021 European Resuscitation Guidelines emphasise the importance of training non-healthcare professionals, including children, to increase CPR rates.⁹ It is known that CPR training can also positively improve confidence in CPR skills.^{1,10} Mass training of students has been used successfully in other parts of the world,¹¹ and this strategy is recommended as a means to improve willingness to provide bystander CPR.¹² The rationale behind training children is consistent with the aspirations of the World Restart a Heart and KIDS SAVE LIVES initiatives to train whole generations with life-long skills.^{13,14} It is also known that, given the correct instructional media, children can cascade such training to several household members as well.¹⁵ In some parts of the world, CPR training has become a mandatory part of the school curriculum,¹⁶ with a positive impact on bystander CPR and survival rates as a result.³ In the UK, the RSAH initiative was an annual event that was historically used to target school-children in the absence of any inclusion on the curriculum. From 2020, CPR training has become a mandatory requirement in schools in England and Scotland which will further broaden the access to training.

Bystander CPR rates for non-EMS witnessed OHCA have risen steadily in England, from 58.2% in 2014 to 69.5% in 2018.⁵ Prior to 2016, there had been occasional high profile national media campaigns, such as the television advert by the BHF promoting compression-only CPR in 2012. However, until the instigation of the RCUK RSAH initiative in 2016, there were no other comparable national face-to-face mass training approaches. There are many other potential factors that could have contributed to this increase, including targeting family members of patients at risk, community CPR training, and *ad hoc* training in schools and workplaces.¹⁷ Local and regional public awareness campaigns make an important contribution to public education, including those occurring as a result of either successful or tragic individual outcomes from OHCA. Following the national roll out of RSAH in 2016, these case stories were more likely to be strategically shared widely as a collateral benefit to the RSAH programme. In Yorkshire, case stories of successful patient outcomes formed an important component of the regional RSAH initiative between 2014 and 2016, thus adding to the success of this approach.

The situation in West Yorkshire in 2014 was bleak. Bystander CPR rates reported to the OHCAO Registry for non-EMS witnessed OHCA cases were 38.6%, which were significantly lower than national mean rates. At that time, the Yorkshire region had many areas with increased rates of OHCA coupled with low rates of bystander CPR.¹⁸ It

was against this backdrop that RSAH training in Yorkshire was introduced by YAS on 16 October 2014. In that first year, 23 schools in West Yorkshire participated and 3016 children were taught CPR in one day. By 2018, this had risen to 44 schools and 11,155 trained respectively, with a cumulative total of 39,413 children trained over five years in West Yorkshire. The regional bystander CPR rates in 2018 had increased to 69.7%, which now marginally exceeded the national mean. This represented an increase of 31.6%, in comparison with the national difference of 11.3%. It is postulated that RSAH training played a significant role in this improvement in West Yorkshire.

In this study, the most pronounced increase in bystander CPR rates in West Yorkshire between 2014 and 2018 were in the PCDs with high levels of RSAH activity (+34.3%). The lowest increase (+29.9%) was seen in the PCDs with minimal RSAH training. In contrast, there was minimal difference between PCDs with high and low CFR scheme activity (31.7% vs 30.7%), suggesting a lesser impact on bystander CPR in non-EMS witnessed OHCA cases than we had hypothesised. OHCA cases where a CFR was dispatched to assist by YAS were excluded from this study, so the minimal difference in impact may be explained by the small number of trained CFRs ($n = 363$) and the low probability of one of them coincidentally being an immediate bystander for an arrest.

When analysing combinations of groups, PCDs with low levels of both RSAH and CFR scheme activity had the smallest increase in rates (+28%) between 2014 and 2018. The most pronounced increase (+38.5%) over the same time period was seen in PCDs with a combination of high rates of RSAH activity and low rates of CFR activity. With minimal coexistent CFR scheme activity in these PCDs, the inference is that the sustained delivery of RSAH training over the five-year period played an important role in the improvement of bystander CPR rates. In addition, PCDs with both interventions had increased odds of receiving bystander CPR with regression analysis showing results approaching statistical significance. Whilst none of these results achieved statistical significance when compared with each other, it would appear that annual RSAH training in particular may be a beneficial intervention to improve bystander CPR rates in non-EMS witnessed OHCA cases.

Limitations

The main limitation of this study is that it is observational in nature. The analysis is also reliant upon the accuracy of data submitted to the OHCAO Registry. This ultimately means that the authors are only able to suggest causality and a degree of caution should be used as the trends may also have occurred through random variation.

There is a very small chance that participants who received RSAH training on 16 October 2014 witnessed an OHCA in the remainder of that year, thus influencing the baseline bystander CPR rate. Similarly, participants who received RSAH training for the first time in October 2018 may have influenced the annual rates for that year. We feel that the chances of this are extremely small and unlikely to have made any material difference to the reported annual bystander CPR rates.

RSAH training was allocated to the PCD of the school where training was delivered. Some of the children who participated in this training may have lived in another PCD or witnessed an OHCA in another part of the region. Similarly, CFR schemes were allocated to the PCD of their base location but may have covered broader geographical areas. We were unable to accurately map RSAH and CFR trained bystander status with individual OHCA cases. If this had been achievable, there is a possibility that the association between the

variables and non-EMS bystander CPR rates may have been stronger than presented in this study.

Finally, there may be other factors that influenced the improvement in bystander CPR rates in West Yorkshire that we have not considered.

Conclusion

Bystander CPR rates for OHCA cases in West Yorkshire have improved from a position in 2014 when they were markedly below national mean levels to slightly better than national mean levels in 2018. It was postulated that the delivery of annual RSAH training and/or CFR scheme activity over a 5-year period of time may have been associated with greater improvements in bystander CPR rates for non-EMS witnessed OHCA cases when compared with PCDs with no such historic activity. Whilst other factors may have impacted upon these changes, the analysis presented in this descriptive study of Registry data infers the possibility of a non-significant association between improved bystander CPR rates and RSAH training and CFR scheme activity.

This finding is of importance because it infers that coordinated mass training of the public (and schoolchildren in particular) in CPR can lead to improved bystander CPR rates, which will hopefully then lead to improved patient outcomes. This is particularly relevant to other regions and parts of the world where CPR training is not a mandatory aspect of the school curriculum, and therefore represents a successful interim strategy that is in concordance with the principles promoted by World Restart a Heart and KIDS SAVE LIVES.

Conflict of interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

- Lockey A — Vice President of Resuscitation Council UK.
- Brown T — employed by The University of Warwick.
- Carlyon J — RSAH Project Manager (Resuscitation Council UK) and RSAH Lead (Yorkshire Ambulance Service).
- Hawkes C — employed by The University of Warwick.

CRedit authorship contribution statement

Andrew S. Lockey: Conceptualization, Methodology, Validation, Investigation, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration. **Terry P. Brown:** Conceptualization, Methodology, Validation, Investigation, Formal analysis, Data curation, Writing - review & editing, Visualization. **Jason D. Carlyon:** Conceptualization, Methodology, Validation, Investigation, Data curation, Writing - review & editing. **Claire A. Hawkes:** Conceptualization, Methodology, Validation, Investigation, Writing - review & editing.

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