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## Simulation and education

# Association of state-level CPR training initiatives with layperson CPR knowledge in the United States



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### Abstract

**Study aim:** Recent work has demonstrated low rates of layperson CPR training across the US. In an attempt to increase rates, some states passed legislation that requires CPR training before high school graduation. We hypothesized laypeople in states with required training would exhibit a greater likelihood of being currently trained in CPR when compared with laypeople in states without required CPR training.

**Methods:** We used a previously conducted nationwide cross-sectional random-digit dial survey of the US adult population (09/2015–11/2015). Survey weighted descriptive statistics and logistic regression were used to assess the primary association of likelihood of CPR training and required CPR training by graduation.

**Results:** Of the 9022 participants, 677 healthcare workers were excluded. Among those living in states with required training, 17% of laypersons were currently trained, while 14% of laypersons in states without required training were currently trained ( $p < 0.01$ ). Amongst younger individuals (18–24), 29% were currently trained in states with required CPR training compared with 19% currently trained in states without required training ( $p < 0.01$ ). Those in required training states were 34% more likely to be currently trained than individuals in states without required training (OR: 1.34, 95%CI: 1.20–1.50,  $p < 0.01$ ). In a secondary analysis, younger laypersons in required training states were almost two times more likely to be currently trained (OR: 1.81, 95% CI: 1.18–2.78,  $p = 0.01$ ).

**Conclusions:** Individuals were more likely to be currently trained in CPR in states with mandatory CPR training for high school graduation, suggesting a need for additional research on this public policy.

**Keywords:** Cardiopulmonary resuscitation (CPR), State laws, High school graduation, Education, Health policy

## Introduction

Recent work has demonstrated a low prevalence of layperson cardiopulmonary resuscitation (CPR) training throughout the US.<sup>1,2</sup> In an attempt to increase the number of trained laypersons, individual states have passed laws that require high school students to complete CPR training before graduation. However, is it unknown how well schools have complied with these laws and whether the

policies have appreciably increased the number of US laypeople trained in CPR.

Studies have correlated CPR training with increased rates of bystander delivery.<sup>3–6</sup> Layperson training has also been associated with an increased likelihood of survival and stronger neurologic outcomes following cardiac arrest.<sup>7–9</sup> In Denmark, CPR training has been a requirement for middle school students since 2005, and Danish national efforts have been correlated with increased proportions of those CPR trained.<sup>5,6,10</sup> No such investigation has

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<https://doi.org/10.1016/j.resuscitation.2019.04.037>

Received 6 February 2019; Received in revised form 17 April 2019; Accepted 26 April 2019

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been conducted in the US. While studies have described implementation challenges with required CPR training legislation in the US,<sup>11–14</sup> understanding the associations of these laws with rates of CPR training, in relationship to barriers, could aid in the development of better-informed policies to increase public knowledge of CPR and ultimately layperson CPR delivery.

Therefore, we utilized data from a nationwide telephone-based survey to assess whether required high school CPR training legislation was associated with an increased likelihood of an individual being currently CPR trained ( $\leq 2$  years). We considered states with CPR training started in schools by the 2013–2014 school year. We hypothesized laypeople in states with required CPR training for high school graduation would exhibit a greater likelihood of being currently trained in CPR when compared with laypeople in states without required CPR for high school graduation.

## Methods

The primary objective of this analysis was to analyze whether state required legislation for high school CPR training was correlated with an increased likelihood of individuals being currently CPR trained. In order to accomplish this, we used data from a 2015 nationwide survey with information on CPR training and state required CPR training legislation information from the AHA. Key aspects of the analysis hinged upon correlations between the likelihood of current training for non-healthcare workers of all ages, as it related to whether their states required CPR training for high school graduation by the 2013–2014 school year. Secondary analyses focused on the same correlations for younger individuals (18–24 years old).

### Study design, methodology, and population

The retrospective study used data from a survey designed to collect demographic and CPR training information from a sample representative of the adult United States population. Data were queried from a random-digit telephone dialing omnibus survey conducted from September 2015 to November 2015. Respondents were ages 18 years and older and spoke English or Spanish. The detailed survey methodology and description of the CPR training survey have been reported in prior publications.<sup>1,15</sup> The study was determined exempt by the Institutional Review Board at the University of Pennsylvania (Philadelphia, PA).

### State laws

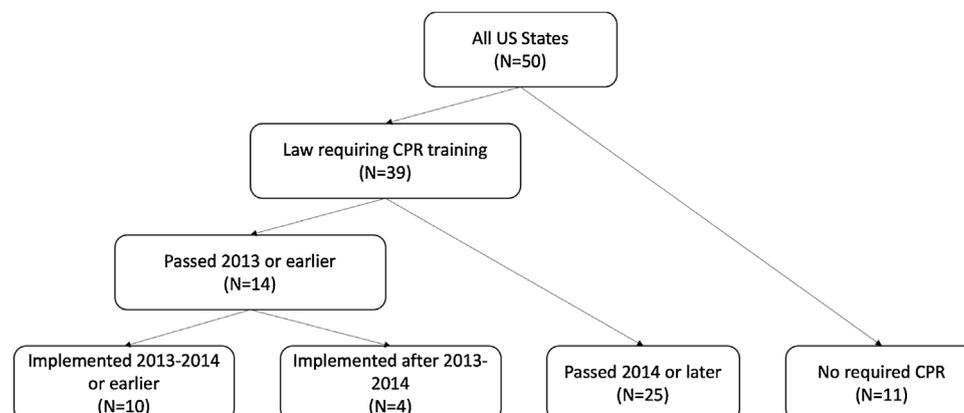
All fifty US states were included in the nationwide analysis. Each state was categorized based on whether or not they passed a law that required CPR training before high school graduation (Fig. 1). Information was obtained from the AHA and cross-referenced with the Sudden Cardiac Arrest Foundation (a cardiac arrest advocacy group) as well as ProTrainings (a CPR training LLC focused on school training, Ada MI).<sup>14,16</sup> States were initially dichotomized by whether they had passed any mandatory CPR training laws. Of the states that had passed the law at any time, a division was made on whether the state passed the law before or after 2013. States which passed the law in 2013 or before were then separated by the year in which the law was to be implemented; laws implemented in the 2013–2014 school year or earlier were considered. The marker of 2013 as the dividing year was chosen because the survey was conducted in 2015 and any laws implemented after 2013 may not have had enough time to be fully disseminated in the state (Fig. 2).

### Variable definition

Variables for current CPR training were defined in a manner consistent with similar studies, specifically current training was defined as anyone that identified receiving CPR training in the last two years.<sup>1,15</sup> The term layperson was used synonymously with non-healthcare worker and was defined as anyone who did not identify as having a healthcare position on the survey. In addition, those 18–24 years old at the time of survey administration were defined as “younger” individuals. This category of individuals was particularly important because respondents between the aforementioned ages were those most likely impacted by the legislation at the time of survey administration.

### Statistical analysis

Data were analyzed using a statistical package software (STATA 14; StataCorp LP, College Station, TX). Survey results were weighted to represent the national population of US adults eighteen and older based on age, sex, income, race, religion and education. The data were initially analyzed using basic descriptive statistics. Respondents identifying their current work as a healthcare job were removed from analyses. Relevant chi-squared analyses were conducted for the proportion individuals of all ages and then, separately younger, for likelihood of current training. Data were then modeled using a



**Fig. 1 – Outline displaying selection process of states.**



**Table 2 – Prevalence of current training for all ages and younger individuals.**

	Respondents		P
	State required school training (N = 1988)	No state required school training (N = 6357)	
Currently trained, %			
All ages	17%	14%	<0.01
Younger	29%	19%	<0.01

### Variation in laws across states

We observed variation in the type of requirement across states, partially because of the absence of a uniform federal requirement requiring CPR training for high school graduation (Table 4). Of states that passed CPR training laws, time until required implementation varied greatly. Certain states received incentives tied to funding while other states received no incentives. For some states, CPR training was a suggestion and not a requirement. Most states required AED training in addition to CPR training. Most states also required a hands-on component to training as well. Grades in which training was to occur varied slightly with most being 7th through 9th grade up until 12th grade. As a sensitivity analysis to account for variation across states, the laws were included in the final multivariable analysis. We observed no changes to the overall multivariable model when accounting for differences in strength of the law (see Electronic Supplement for additional methods).

## Discussion

Through our study, we found there was an increased likelihood of CPR training for individuals in states with laws requiring school-based training. In a secondary analysis of younger individuals, we observed a strengthened relationship with younger individuals in states with required training laws being significantly more likely to be currently CPR trained. To our knowledge, this is the first study to assess for an association between CPR training and whether states have required training laws. These data and analyses are important for beginning to consider the implication of health policy and education. Further, these data are important pieces of evidence for the development of future public health initiatives aimed at increasing rates of CPR training.

### CPR training initiatives in schools

The school has traditionally been the site of targeted CPR educational efforts.<sup>17,18</sup> Initially statements introduced by the AHA emphasized training more strongly for educators and administrators.<sup>19</sup> More recently though the AHA and, separately, the WHO endorsed the recommendation to train schoolchildren in CPR.<sup>20,21</sup> However, the effectiveness of required CPR training laws in the US was not a well-studied topic and much of the evidence that existed came from analyzing overseas initiatives. Our study was the first of its kind to assess statewide training laws in the US and their effect on the likelihood of layperson CPR training.

We found a correlation at all ages between the likelihood of current CPR training and residing in a state with required CPR training for high school graduation. We also found a strengthened relationship for younger individuals, who are almost twice as likely to be currently trained when living in a state with mandatory CPR than not. We also observed the interesting phenomenon of all ages being more likely to be currently trained in states with mandatory CPR laws, which suggested the possibility of diffusion of information and an increased awareness or incentive for people to become CPR trained, regardless of whether or not they are of a younger age.

### Barriers to implementation of initiatives in schools

Various studies have identified barriers associated with the implementation of public health policies.<sup>11–13,22</sup> Principal among those barriers were cost and trainer availability. Even though the overall cost of implementation was relatively low, states often did not allocate funding for such training. A 2017 study by Hoyme and Atkins identified cost as a barrier but as surmountable if funding of even \$1000 yearly were to be set aside.<sup>13</sup> The second major barrier of training competency and availability was more challenging to overcome due to a lack of highly qualified instructors and a decreased comfort of teachers with providing the education themselves.<sup>13,22</sup> Interestingly, the trainer availability barrier was described as surmountable if a more rigorous structure were to be provided to the teachers.<sup>22</sup> Both barriers highlight the need to implement consistent and evidence-backed legislation in order to both, secure funding and provide consistency for CPR training in schools.

### Modalities for implementation and training

Lastly, another consideration for training was the various modalities through which the CPR training could have been

**Table 3 – Likelihood of current training, modeled by a multivariable logistic regression, for all ages and for younger individuals (HS = high school, no grad = did not graduate, ref = reference). 509 of 8345 respondents dropped due to missing data.**

	All ages (N = 7836)		Younger individuals (N = 766)	
	Odds of being currently trained	Global P value	Odds of being currently trained	Global P value
Passed law 2013 (ref. no law)	1.34 (95%CI: 1.20–1.50)	<0.01	1.81 (95%CI: 1.18–2.78)	0.01
Age	0.97 (95%CI: 0.96–0.98)	<0.01	0.97 (95%CI: 0.88–1.07)	0.56
Female (ref. male)	1.13 (95%CI: 0.94–1.36)	0.20	1.79 (95%CI: 1.24–2.59)	<0.01
Race (ref. white)	0.92 (95%CI: 0.84–1.00)	0.06	0.83 (95%CI: 0.69–1.00)	0.05
Graduate HS (ref. no grad)	3.35 (95%CI: 2.08–5.39)	<0.01	5.55 (95%CI: 2.12–14.5)	<0.01

**Table 4 – Categorization of states based off of law type (hs = high school, AED = automated external defibrillator, ed = education, rec = recommended).**

State	Notes	Psychomotor requirement	All victim sizes <sup>a</sup>	Meets national standards <sup>b</sup>	Certificate provided <sup>c</sup>	Psychomotor requirement	Link to state law
During or before 2013–2014							
AL	hs students	No	No	No	Yes	No	<a href="https://bit.ly/2RLj1WX">https://bit.ly/2RLj1WX</a>
GA	hs students; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2CGZdzU">https://bit.ly/2CGZdzU</a>
IA	hs students	No	No	No	No	Rec.	<a href="https://bit.ly/2yzL7vI">https://bit.ly/2yzL7vI</a>
NV	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2Eg6lEX">https://bit.ly/2Eg6lEX</a>
RI	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2Ej5XFH">https://bit.ly/2Ej5XFH</a>
TN	7th–12th grade	No	Yes	No	No	No	<a href="https://bit.ly/2C9dDrv">https://bit.ly/2C9dDrv</a>
TX	7th–12th grade	No	Yes	No	Yes	No	<a href="https://bit.ly/2yCIG52">https://bit.ly/2yCIG52</a>
VT	7th–12th grade; health ed	Yes	No	No	No	No	<a href="https://bit.ly/2Ojyfod">https://bit.ly/2Ojyfod</a>
WA	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2pPyIjl">https://bit.ly/2pPyIjl</a>
WI	7th–12th grade; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2yeY7Yk">https://bit.ly/2yeY7Yk</a>
After 2013–2014							
AR	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2CclG6L">https://bit.ly/2CclG6L</a>
CA	hs students; health ed	Rec.	Yes	No	Yes	No	<a href="https://bit.ly/2RL1DBJ">https://bit.ly/2RL1DBJ</a>
CO	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2PsixUd">https://bit.ly/2PsixUd</a>
CT	7th–12th grade	No	Yes	No	Yes	No	<a href="https://bit.ly/29iYB4q">https://bit.ly/29iYB4q</a>
DC	hs students; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2cClbu">https://bit.ly/2cClbu</a>
DE	hs students; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2CERp1r">https://bit.ly/2CERp1r</a>
ID	hs students; health ed	Yes	Yes	No	No	No	<a href="https://bit.ly/2pPRE1e">https://bit.ly/2pPRE1e</a>
IN	hs students; health ed	Yes	Rec.	No	Yes	No	<a href="https://bit.ly/2IQe8YF">https://bit.ly/2IQe8YF</a>
KY	hs students; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2RLx4fi">https://bit.ly/2RLx4fi</a>
LA	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2Pwj1IO">https://bit.ly/2Pwj1IO</a>
MD	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2QS2teX">https://bit.ly/2QS2teX</a>
ME	hs students	Yes	Yes	No	Yes	Rec.	<a href="https://bit.ly/2RLx4fi">https://bit.ly/2RLx4fi</a>
MI	7th–12th grade	Yes	Yes	No	Yes	Rec.	<a href="https://bit.ly/2yvGbru">https://bit.ly/2yvGbru</a>
MN	7th–12th grade	Yes	Yes	No	No	No	<a href="https://bit.ly/2PBgEEY">https://bit.ly/2PBgEEY</a>
MO	hs students	No	No	No	Yes	No	<a href="https://bit.ly/2RIn3zD">https://bit.ly/2RIn3zD</a>
MT	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2RJ8NXb">https://bit.ly/2RJ8NXb</a>
NC	hs students	No	Yes	No	No	No	<a href="https://bit.ly/2A69Eu7">https://bit.ly/2A69Eu7</a>
NJ	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2EeRWJ6">https://bit.ly/2EeRWJ6</a>
NM	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2CGPedE">https://bit.ly/2CGPedE</a>
NY	hs students; health ed	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2A7dSSI">https://bit.ly/2A7dSSI</a>
OH	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2PDnVDS">https://bit.ly/2PDnVDS</a>
OK	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2pS9Ya8">https://bit.ly/2pS9Ya8</a>
OR	7th–12th grade	Yes	Yes	No	No	No	<a href="https://bit.ly/2NEY2ll">https://bit.ly/2NEY2ll</a>
SC	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2RMvoIU">https://bit.ly/2RMvoIU</a>
SD	hs students; health ed	Yes	Rec.	No	Yes	No	<a href="https://bit.ly/2Eg7lDv">https://bit.ly/2Eg7lDv</a>
UT	hs students; health ed	Yes	No	No	No	No	<a href="https://bit.ly/2CcQRyT">https://bit.ly/2CcQRyT</a>
VA	hs students	Yes	Yes	No	Yes	No	<a href="https://bit.ly/2A6COcA">https://bit.ly/2A6COcA</a>
WV	hs students	No	Yes	No	Yes	Rec.	<a href="https://bit.ly/2RJeRyO">https://bit.ly/2RJeRyO</a>

States with bills introduced but no requirements: HI, IL, MA, ND, PA.

States with no bills: AK, FL, KS, NE, NH, WY.

<sup>a</sup> Adults, children, and infant manikins are to be used throughout the course.

<sup>b</sup> Meets either AHA or Red Cross requirements for layperson CPR training.

<sup>c</sup> Indicates a certification card can be provided upon completion of the course.

administered. While many state laws mentioned a psychomotor training requirement, most laws did not specify the pedagogical approach for delivering the hands-on training. CPR training could be delivered through video self-instruction (VSI) kits in addition to traditional instructor-led courses, among other modalities. VSI kits have been shown as effective modalities of CPR training with similar outcomes to traditional training styles in laypeople and also in schoolchildren in particular.<sup>23,24</sup> For schools facing previously identified barriers, VSI kits could be useful tools for overcoming cost and trainer availability particularly due to their low cost, ease of implementation, and effectiveness.<sup>24–26</sup>

### Limitations and future studies

Principal among the limitations was the ecological design of the study; while we are able to assess for correlation, we do not claim causation among variables. In addition, the study was limited by the number of states which passed required training laws at the time of survey administration — something which could be addressed by conducting a more current study since more states have passed such training laws by this time. Further, there were slight differences in law requirements and modes of implementation across states. Unfortunately, due to the sample size, we were

limited to the level of analysis we could perform to assess differences in law requirements and implementation within states. Future work could consider this line of inquiry with a robust sample size. Additionally, though there are challenges with conclusions from an ecologically designed study, specifically limitations regarding causal inference, the information remains pertinent for developing a stronger understanding of state-level health policies and their implication on CPR education. Further work may consider prospectively collecting CPR training data and state-level health policy implementation variation within states.

## Conclusion

Laypeople residing in states with required CPR for high school graduation were more likely to indicate being currently trained in CPR than laypeople in states without required training. The same relationship was strengthened for younger individuals. With an increased number of states passing required training laws, additional work is needed to assess implementation variation across states.

## Conflict of interest statement

AB has research funding through the American Heart Association (AHA; Mentored Clinical Research Program Award). ML has research funding through the American Heart Association, Laerdal Foundation, and Medtronic Foundation. ML has received in-kind support from Laerdal and Physio-Control. ML is licensing IP related to CPR training technologies. BA has received research funding from the NIH, Patient Centered Outcomes Research Institute, the Medtronic Foundation, the American Heart Association, and Stryker Medical. He has received honoraria from Philips Healthcare and CR Bard.

## Funding source

This work was supported by a Mentored Clinical and Population Award from the American Heart Association (15MCPRP25090161).

## Acknowledgements

The authors would like to thank Dr. Comilla Sasson of the Colorado School of Public Health and the American Heart Association, for her feedback and revisions of the manuscript as a whole. The authors also would like to thank Jeffrey Ranous of the American Heart Association for his contribution to interpreting individual state CPR requirements. The authors would finally like to thank Andrew Murray and David Buckler of Penn's Center for Resuscitation Science for their overall feedback and comments to the paper structure and format.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.resuscitation.2019.04.037>.

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