

High School Cardiac Emergency Response Plans and Sudden Cardiac Death in the Young

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Abbreviations:

AED: Automated External Defibrillator
CERP: cardiac emergency response plan
SCD: sudden cardiac death
SES: socioeconomic status

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Abstract

Introduction: Sudden cardiac death (SCD) is responsible for 5%-10% of all deaths among children 5-19 years-of-age. The incidence of SCD in youth in Michigan (USA) and nationwide is higher in racial/ethnic minorities and in certain geographic areas. School cardiac emergency response plans (CERPs) increase survival after cardiac arrest. However, school cardiac emergency preparedness remains variable. Studying population-level factors associated with school cardiac emergency preparedness and incidence of SCD in the young may improve understanding of disparities in the incidence of SCD.

Hypothesis/Problem: The objective of this pilot study was to determine the association of elements of high school cardiac emergency preparedness, including Automated External Defibrillator (AED) distribution and the presence of CERPs with county sociodemographic characteristics and county incidence of SCD in the young.

Methods: Surveys were sent to representatives from all public high schools in 30 randomly selected Michigan counties. Counties with greater than 50% response rate were included (n = 19). Association of county-level sociodemographic characteristics with incidence of SCD in the young and existence of CERPs were evaluated using Spearman correlation coefficient.

Results: Factors related to the presence of AEDs were similar across counties. Schools in counties of lower socioeconomic status (SES; lower-median income, lower per capita income, and higher population below poverty level) were less likely to have a CERP than those with higher SES (all $P < .01$). Lack of a CERP was associated with a higher incidence of SCD in youth ($r = -0.71$; $P = .001$). Overall incidence of SCD in youth was higher in lower SES counties ($r = -0.62$ in median income and $r = 0.51$ in population below poverty level; both $P < .05$).

Conclusion: County SES is associated with the presence of CERPs in schools, suggesting a link between school cardiac emergency preparedness and county financial resources. Additionally, counties of lower SES demonstrated higher incidence of SCD in the young. Statewide and national studies are required to further explore the factors relating to geographic and socioeconomic differences in cardiac emergency preparedness and the incidence of SCD in the young.

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Introduction

Sudden cardiac death (SCD) is typically defined as sudden death due to a cardiac etiology when other causes can be reasonably excluded. Sudden cardiac death affecting individuals less than 40 years of age, often termed SCD in the young, is responsible for 75% of all sudden deaths in athletes and affects 2.28 out of every 100,000 children and young adults.^{1,2} In Michigan (USA) and nationwide, there are significant racial and geographic disparities in the incidence of SCD in the young, raising questions about differences in access to secondary prevention.^{2,3}

Cardiac emergency preparedness, including Automated External Defibrillator (AED) response, is a key aspect of prevention of SCD in the young.⁴ As sites of athletic activity and community gathering places for children and adults, schools have become a focus of public access defibrillation strategy. At least one in 73 high schools will have a sudden cardiac arrest on campus each year.⁵ Additionally, schools have a relatively high out-of-hospital cardiac

Characteristic	Counties Included in the Analysis ^a		P Value ^b
	Yes (N = 19)	No (N = 11)	
County Population	63,105 (41,968-160,369)	17,196 (11,386-26,245)	.005
Per Capital Income, US\$	21,950 (19,184-23,719)	20,048 (18,868-21,725)	.19
Median Household Income, US\$	43,180 (38,507-48,528)	38,571 (34,955-40,349)	.03
Percent Below Poverty Level, %	17.3 (14.1-19.5)	18.7 (14.9-20.7)	.28
Percent Minority, %	10.1 (5.9-13.9)	4.4 (3.6-14.6)	.05
Persons per Square Mile	122 (59.6-228)	39.6 (17.9-51.2)	.01
Age-Adjusted SCD Rate per 100,000	3.1 (2.1-4.3)	4.8 (3.5-5.4)	.17
Number of SCDs	16 (12-27)	8.5 (6.5-36)	.38

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Table 1. Comparison of County Characteristics between Counties Included/Not Included in the Analysis

Abbreviation: SCD, sudden cardiac death.

^aData are presented as Median (25th percentile–75th percentile).^bP value from Wilcoxon rank sum test.

arrest survival rate of up to 71% compared to other locations.⁵ Recommended by the American Heart Association (AHA; Dallas, Texas USA), cardiac emergency response plans (CERPs) aim to create a coordinated school-wide response to cardiac arrest in concert with local Emergency Medical Services.⁶ Schools with CERPs, including the use of AEDs, demonstrate increased survival compared to schools without such plans.⁷ It has been previously demonstrated that high schools with student populations of lower socioeconomic status (SES) were less likely to have CERPs.⁸ The objective of this pilot study was to determine if there might be an association between county-level sociodemographic characteristics and the presence of CERPs in public high schools. Additionally, association between county sociodemographic characteristics and county incidence of SCD in the young also was examined.

Materials and Methods

The methodology for this study was previously published as part of a school-level analysis of AED distribution and cardiac emergency preparedness.⁸ This was a cross-sectional survey study of the distribution of AEDs, AED-trained individuals, and CERPs in Michigan public high schools. Thirty Michigan counties were selected randomly from three population strata. Charter schools and alternative schools were excluded. This study was deemed exempt from regulation by the Institutional Review Board of the University of Michigan (Ann Arbor, Michigan USA).

Survey Administration

A brief online survey was designed using Qualtrics (Qualtrics; Provo, Utah USA) to collect information regarding each school's cardiac emergency preparedness, including the number of AEDs on campus,

the number of AED-trained individuals, AED maintenance frequency, and the presence of CERPs. A representative for each school within the 30 counties was identified by contacting school administrators via email. Surveys were sent via email to the school representatives from May 2014 to October 2014.

Data Source

County-level incidence data of SCD from 2003 to 2012 was obtained from the Michigan Department of Health and Human Services (Lansing, Michigan USA). These data were adjusted for age, including only persons aged 1–39 years old at time of death. The absolute number of deaths during this time period also was obtained. County-level sociodemographic characteristics included population, per capita income, median income, proportion below the federal poverty level, proportion of the population counted as racial/ethnic minority, and population density. This information was collected from publicly accessible US Census data.

Data Analysis

Counties were included in the analysis if more than 50% of the eligible schools in a county responded to the survey and those schools represented more than 50% of the county-wide high school population. Association of county-level sociodemographic characteristics with the incidence of SCD in the young and existence of CERPs were evaluated using Spearman correlation coefficient.

Results

Nineteen of 30 counties met criteria for inclusion. Automated External Defibrillator distribution, maintenance frequency, and

County Characteristic	<i>r</i>	P Value
County Population	0.74	.0003
Per Capita Income, US\$	0.66	.002
Median Household Income, US\$	0.90	<.0001
Percent below Poverty Level	-0.72	.0004
Percent Racial/Ethnic Minority	0.003	.99
Population Density (Persons per Square Mile)	0.65	.003
Age-Adjusted SCD Incidence per 100,000	-0.71	.001
<i>r</i> , Spearman Correlation Coefficient		

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Table 2. Association of County Characteristics with the Presence of Cardiac Emergency Response Plans in Public High Schools
Abbreviation: SCD, sudden cardiac death.

County Characteristic	SCD Incidence per 100,000		Total Number of SCDs	
	<i>r</i>	P Value	<i>r</i>	P Value
Per Capita Income, US\$	-0.44	.08	0.34	.18
Median Household Income, US\$	-0.62	.01	0.47	.06
Percent below Poverty Level, %	0.51	.04	-0.30	.24
Percent Minority, %	0.10	.72	0.57	.02
Persons per Square Mile	-0.40	.11	0.81	<.0001

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Table 3. Age-Adjusted SCD Incidence and County Characteristics
Abbreviations: *r*, Spearman correlation coefficient; SCD, sudden cardiac death.

training were similar across counties. Counties included in the analysis tended to be more populous, urban counties compared to counties that were not included in the final analysis (Table 1).

County characteristics associated with the absence of a CERP in schools included smaller population, lower population density, lower median and per capita income, and larger population below poverty level (all $P \leq .01$; Table 2).

Lack of a CERP was associated with a higher county incidence of SCD in the young ($r = -0.71$; $P = .001$). The incidence of SCD in the young was higher in lower SES counties ($r = -0.62$ in median income and $r = 0.51$ in population below poverty level; both $P < .05$). In addition, counties with a greater proportion of minorities demonstrated a higher absolute number of SCDs in youth ($r = 0.57$; $P = .02$; Table 3).

Discussion

It has been previously noted that schools serving students of lower SES were less likely to have CERPs.⁸ In this study, an association between county SES and the presence of CERPs in high schools was noted. These findings suggest a relationship between school cardiac emergency preparedness and county-level financial resources whereby counties with higher SES populations may be able allocate more funding for school cardiac emergency preparedness. Socioeconomic differences in emergency preparedness

and response have been previously documented, including socioeconomic disparities in knowledge of Basic Life Support techniques and response to out-of-hospital cardiac arrest.^{9,10} To the authors' knowledge, this is the first study to indicate an association between population-level SES and school cardiac emergency preparedness, despite equitable distribution of AEDs. Notably, since the distribution of AEDs, often a privately funded resource,¹¹ was similar across counties, there may be differences in awareness and education about SCD in the young to account for this association.

Age-adjusted SCD incidence at the county level was observed to correlate significantly with absence of CERPs in the schools. This finding is ecological in nature and warrants further in-depth study. It is possible that cardiac emergency preparedness in schools is a marker of the overall degree of cardiac emergency preparedness in the county, where factors such as community AED placement and bystander awareness contribute to out-of-hospital cardiac arrest outcomes. Prospective assessment of out-of-hospital cardiac arrest events and utilization of public-access defibrillation would help elucidate the etiology of this association.

The higher incidence of SCD in the young in counties of lower SES mirrors adult SCD data which has shown a higher incidence of SCD in individuals and areas of lower SES.¹² Although county availability and allocation of financial resources may again play

a role, socioeconomic differences in access to primary prevention of SCD in the young should be explored. Also, an assessment of the etiologies of SCD in the young in lower SES populations is warranted and may yield more specific targets for primary prevention.

Limitations

The study findings are limited by reliance on self-reported data regarding AEDs and CERPs, as it was not feasible to visit each school to verify responses. Therefore, these data may have been affected by recall bias and social desirability bias. Additionally, this was a preliminary study including data from a limited number of schools and counties. This study should serve as a catalyst for broader assessments of school cardiac emergency preparedness and factors contributing to differences in SCD outcomes in the young.

Conclusions

Cardiac emergency response plans are an important evidence-supported element of a school's response to a cardiac arrest event affecting a child or an adult on campus. This study reveals important

associations between county-level SES and both the presence of CERPs in schools and the incidence of SCD in the young. Schools in lower SES areas may serve a population with a higher incidence of SCD in youth. Paradoxically, these lower SES schools may also be less prepared in the event of a cardiac arrest on campus. Directed efforts to improve awareness of SCD in the young and cardiac emergency response planning in all schools but particularly schools in low SES areas should be considered. Advocacy at the state level for legislation regarding cardiac emergency response planning may help to decrease disparities in cardiac emergency preparedness.

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